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Australian Academy of Science submission on the
Impact of microplastics and other toxics on human health

The Australian Academy of Science (the Academy) welcomes the opportunity to comment on the Community Affairs References Committee (the Committee) inquiry into the *Impact of microplastics and other toxics on human health*.

This submission focusses on microplastics. Generally, microplastics refer to particles between <5 mm, while smaller particles <1 µm are called nanoplastics. In this submission, microplastics includes nanoplastics.

Microplastics vary in size, shape, polymer and chemical composition. Plastics are a complex chemical mixture and can contain a wide variety of chemicals. Primary microplastics are intentionally generated, such as microbeads in cosmetic products. Secondary microplastics are generated from the breakdown of plastic products.

The evidence base regarding the impacts of microplastics on human health is limited, with major gaps, such that the impacts of microplastics are uncertain. This means that many of the questions posed in the inquiry's terms of reference cannot yet be answered with certainty. When conclusions are drawn by the Community Affairs Reference Committee, the limitations of knowledge and the extent of uncertainty must be considered. Further coordinated, comprehensive research is required to build the evidence-base to inform policy and regulatory decisions.

Rather than focussing on specific areas of health outlined in terms of reference, this submission provides an overview of the limitations and knowledge gaps in microplastics research to aid in the interpretation of current evidence on the health impacts of microplastics.

Further developments in methods for detecting and quantifying microplastics are required to more confidently identify health risks. Expertise in analytical chemistry will be essential to improve and standardise methodological approaches to measuring microplastics. Expertise in toxicology and ecotoxicological testing is also required. Future multidisciplinary research in this area should be supported.

The Academy emphasises the following key points:

- The study of microplastics is a growing field of research, and the conclusions that can be drawn face limitations due to developing analytical techniques and a lack of harmonisation for both the methods used and how results are reported in studies.
- Available evidence indicates microplastics are suspected to harm human health. However, given the limitations of analytical techniques, there is considerable uncertainty relating to the specific quantities and types of microplastics that humans are exposed to and are present in the human body. Current evidence on the health impacts of microplastics must be evaluated within the context of these limitations.

Challenges for measuring microplastics and impact on human health

The association between microplastics and human health is a growing field of research, involving several scientific disciplines including toxicology, environmental epidemiology, medical science, and analytical chemistry. Scientists use different techniques to detect and measure microplastics, and report the results with different units, which makes it difficult to compare studies. Some researchers are actively involved in efforts to

harmonise research methods to quantify microplastics. For example, recent papers provide guidance on standardising methods and communicating the level of confidence in the results.[1,2,3]

Critiques of current studies and areas of active scientific discussion include what degree of false positives are being reported, calls for improved reporting of levels confidence, and requirements for quality control and assurance. This would be addressed through the harmonisation of methods.

Below we outline a series of specific limitations, knowledge gaps and critiques to provide the Committee with context on the evidence base and current debate within the science community:

- **Exposures and exposure pathways are not sufficiently quantified to assess human health risks**, with specific knowledge gaps including what types, sizes and concentrations of microplastics humans are exposed to in their external environment and where along a product's life cycle microplastics are shed. Many of the limitations described below apply to measuring microplastics in the environment and in the human body.
- **Measuring microplastics within complex mixtures**, such as biological samples can lead to false positives. There are possible false positives for microplastic in samples from humans and other living creatures when using pyrolysis gas chromatography–mass spectrometry (Py-GCMS), one method used to measure microplastics. In Py-GCMS, the sample is heated to break it down into smaller molecules. While it is a well-established technique for measuring pure polymers, it has limitations when measuring complex biological samples. Some biological matter may be measured as specific types of plastics due to similarities in the smaller molecules they break down into when processed for measurement. This only applies to certain types of polymers, for example polyethylene which is similar in structure to lipids.[4,5]
- **Smaller particles are more likely to cross biological barriers, and are challenging to measure.** There are no validated methods that allow definitive identification and quantification for smaller particle fractions (< 10 µm) in complex biological samples like human body fluids and tissues. Smaller particles — particularly those below 10 µm and in the nano-size range (< 1 µm) — have greater potential for movement through biological barriers, systemic distribution and cellular interaction. However, most studies focus on particles above 20–50 µm due to methodological constraints on their analysis. As a result, the smaller particles most relevant to potential systemic human exposure remain largely uncharacterised. Further, there is no standardised reporting of lower detection limits in the current literature (i.e. not all papers report the lower limit of what their method can detect).
- **There are biological plausibility concerns with some findings**, where the size of particles found in areas of the body contradict physiological knowledge of what size particles can pass through relevant biological barriers.
- **Microplastic distribution is heterogenous**, making collections of representative samples challenging. If a sample is not representative, it cannot be effectively used to extrapolate the prevalence of microplastics in the environment or body it is collected from. As well as the types and characteristics of microplastics varying widely, how they are distributed in the environment is inconsistent even in small areas. More complex sampling methods involving computational statistical analysis may be required.

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[1] Thomas, K. v. *et al.* Communicating Confidence in the Reliability of Micro- and Nanoplastic Identification in Human Health Studies. *Environment & Health* https://doi.org/10.1021/envhealth.5c00671 (2026).
[2] Wootton, N. *et al.* A field and laboratory manual for sampling, processing and reporting microplastics in coastal and marine environments. *Front Mar Sci* **12**, 1674412 (2025).
[3] Cowger, W. *et al.* Reporting Guidelines to Increase the Reproducibility and Comparability of Research on Microplastics. *Appl Spectrosc* **74**, 1066–1077 (2020).
[4] Rauert, C. *et al.* Assessing the Efficacy of Pyrolysis–Gas Chromatography–Mass Spectrometry for Nanoplastic and Microplastic Analysis in Human Blood. *Environ Sci Technol* https://doi.org/10.1021/acs.est.4c12599 (2025) doi:10.1021/acs.est.4c12599.
[5] A. Monikh, F. *et al.* Challenges in studying microplastics in human brain. *Nature Medicine 2025 31:12* **31**, 4034–4035 (2025).

- **Contamination of biological and environmental samples with microplastics.** Contamination risks occur at every stage including sample collection, transport and storage, analytical processing and analytical instrumentation.
- **Limited availability of quality of reference databases** for determining the type of plastic, as well as whether what is measured is plastic.
- **Assessing risk and safe exposure thresholds is complex.** People are likely to be exposed to a range of doses of microplastics and plastic-associated chemicals over time depending on their environment and activities and may be exposed to multiple chemicals at once. Traditional 'threshold' approaches to risk assessment assume exposures below a threshold for a chemical present no appreciable risk to the general population. However, this may not adequately protect susceptible groups from cumulative and simultaneous exposures. Individual health risk is also determined by extrinsic factors like socioeconomics or location and intrinsic factors like other diseases or conditions they may already have. This means that risk of harm to health may vary widely across a diverse population. [6,7]
- **Lack of harmonisation** for sampling protocols, contamination controls, analytical methods, reporting standards and data-sharing practices limit cross-study comparison and reduce the reliability of studies.

Microplastics are suspected to impact human health

Plastics are manufactured materials comprised of a polymer "backbone" (matrix) and chemical additives that give function to the product such as colour, flexibility, durability and form. Polymers are large molecules made from multiple repeating subunits joined together.

Plastics are a complex chemical mixture, and there is great variability in the types of chemicals in plastics on the market. There is emerging evidence on the health impacts related to microplastics and plastic-associated chemicals.

Microplastics

As discussed above, the limitations of current analytical techniques and methods mean that the specific quantities and types of microplastics that humans are exposed to and are found in the human body is uncertain. This means that the level of human exposure to microplastics and threshold for exposure to harm human health are not known.

Based on current evidence, microplastics have been reported in a range of human tissues and may harm human health.

Microplastics are widespread and persistent, and have chemical additives that may be harmful at sufficiently high concentrations. The physical presence of microplastics could also potentially cause harm by disrupting the structure or function of cells and tissues.[8]

Additionally, microplastics may carry adsorbed chemical and biological contaminants. Plastics which break down into microplastics increase their surface area—which increases their potential to accumulate toxins from environments.

A systematic review found that microplastics are suspected harm to human digestive, respiratory, and reproductive systems.[9] The review included three human observational studies and 28 animal studies. Animal

[6] Lee, D. H. Microplastics and Cardiovascular Diseases: Importance of Coexisting Environmental Pollutants. *Circulation* **150**, 908–910 (2024).
[7] Woodruff TJ, Rayasam SDG, Axelrad DA, Koman PD, Chartres N, et al. A science-based agenda for health-protective chemical assessments and decisions: overview and consensus statement. Environ Health. 2023 Jan 12;21(Suppl 1):132. doi: 10.1186/s12940-022-00930-3. PMID: 36635734; PMCID: PMC9835243.
[8] Landrigan, P. J. *et al.* The Lancet Countdown on health and plastics. *The Lancet* **406**, 1044–1062 (2025).
[9] Chartres, N. *et al.* Effects of Microplastic Exposure on Human Digestive, Reproductive, and Respiratory Health: A Rapid Systematic Review. *Environ Sci Technol* **58**, 22843–22864 (2024).

and *in vitro* (cell) studies have an important role in studying the potential impact of toxins as it is not ethical to perform randomised controlled trials on humans in this case.

Human research in this area includes prospective observational studies[10]. These types of early human studies indicate potential harms, for example, a prospective human study found increased composite risk of myocardial infarction (heart attack), stroke or death from any cause associated with microplastics. [11]

Plastic-associated chemicals

Research on plastic-associated chemicals is also relevant to microplastics. Some of these individual chemicals may potentially harm human health if present at sufficiently high concentrations.

Different types of plastic contain different polymers and chemical additives with different properties. It is estimated that there are more than 16,000 plastic-associated chemicals including additives and non-intentionally added substances.[12] Of these, around one quarter have been identified as chemicals of possible concern to human health and around two thirds did not have official regulatory or industry hazard classifications.

An umbrella review of the health impacts of plastic-associated chemicals (plastic additives and non-intentionally added substances) found evidence for multiple health effects at all stages of human life for five chemical classes that have attracted research, including per and polyfluoroalkyl substances (PFAS).[13]

For comment on PFAS specifically, the Academy refers the Committee to our previous submission to the Select Committee on PFAS. The Academy recommends Australia enhance its monitoring efforts on PFAS and expand the scientific evidence base on PFAS to inform robust policy responses to address legitimate concerns. This should include a coordinated national monitoring program to determine the extent of environmental PFAS contamination and creating a national human biomonitoring program to monitor bioaccumulation of PFAS and other contaminants of emerging concern.

Plastic pollution

In 2022, the UN Environment Assembly resolved to develop and internationally legally binding instrument on plastic pollution, demonstrating an international recognition of the environmental threat of plastic pollution.[14] While a treaty has not been negotiated to date, the Australian Government has stated its commitment to push for an effective global treaty to achieve the goal of ending plastic pollution by 2040.[15]

The Academy has previously recommended that future plastics strategies should follow the waste hierarchy. The waste hierarchy categorises waste management into the following actions in order of favourability: prevention, minimisation, reuse (including remanufacturing), recycling, energy recovery, and disposal. Disposal is considered the least favoured option, while prevention is preferred.

For comment on plastic pollution, the Academy refers the Committee to previous submissions to the House Standing Committee on Climate Change, Energy, Environment and Water's inquiry into plastic pollution in Australia's oceans and waterways and the NSW Plastics: Next steps consultation.

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[10] Prospective observational studies collect data from a group of participants over a period of time to study how a suspected risk or protective factor might impact future outcomes.
[11] Marfella, R. *et al.* Microplastics and Nanoplastics in Atheromas and Cardiovascular Events. *New England Journal of Medicine* **390**, 900–910 (2024).
[12] Monclús, L. *et al.* Mapping the chemical complexity of plastics. *Nature* **643**, 349–355 (2025).
[13] Symeonides, C. *et al.* An Umbrella Review of Meta-Analyses Evaluating Associations between Human Health and Exposure to Major Classes of Plastic-Associated Chemicals. *Ann Glob Health* **90**, (2024).
[14] UN Environment Program. Intergovernmental Negotiating Committee on Plastic Pollution, https://www.unep.org/inc-plastic-pollution (2026).
[15] Watt, M. Australia's push to finalise global plastics treaty, https://minister.dcceew.gov.au/watt/media-releases/australias-push-finalise-global-plastics-treaty, (2025).

The Academy can convene scientists from multiple disciplines to provide further science advice to the Committee on the issues covered in this submission.

To discuss or clarify any aspect of this submission, please contact Lauren Sullivan, Science Policy and Advice Manager at science.policy@science.org.au.