Microplastic Effects on Human Health & Climate Change:

What you and your patients should know

Melissa Roop, MD

IAFP 2026 Annual Conference

May 16, 2026

Learning Objectives

- Define microplastics
- Recognize that microplastics have “upstream” effects that contribute to climate change and therefore harm human health, as well as “downstream” effects that may have human health harms
- Describe the findings of most recent publications on microplastics found in human tissues
- Understand the limitations of current data on microplastics and know what to look for when reading about new publications
- Formulate a “bite-sized” summary of the human health effects of microplastics that can be shared with patients in day-to-day clinical work

Disclosures

I have no financial disclosures

We all live here…

“For all of us, becoming indigenous to a place means living as if your children’s future mattered, to take care of the land as if our lives, both material and spiritual, depended on it.”

- Robin Wall Kimmerer

“All flourishing is mutual”

- Robin Wall Kimmerer, “The Serviceberry”

Knowledge is power

What is your 100 year plan?

Life is beautiful and worthy of our care and protection

Okay,
Let’s talk about plastic

Plastic: TL;DR

- Plastic: A synthetic material made from a carbon-based backbone to which additional chemicals are added to achieve desire properties
- First produced in the late 1800 (celluloid, PVC, bakelite)
- Use started in earnest in the 1950s (post WWII)
  - 2 Mt/yr in 1950 → 380Mt/yr 2015 → 460 Mt/yr in 2019
- Vast majority of monomers for plastic production come from fossil hydrocarbons (98%)
- No commonly used plastics are biodegradable → environmental accumulation

Gyer, Jambeck, Law. Sci Adv 2017
Minderoo-Monaco Commission on Plastics

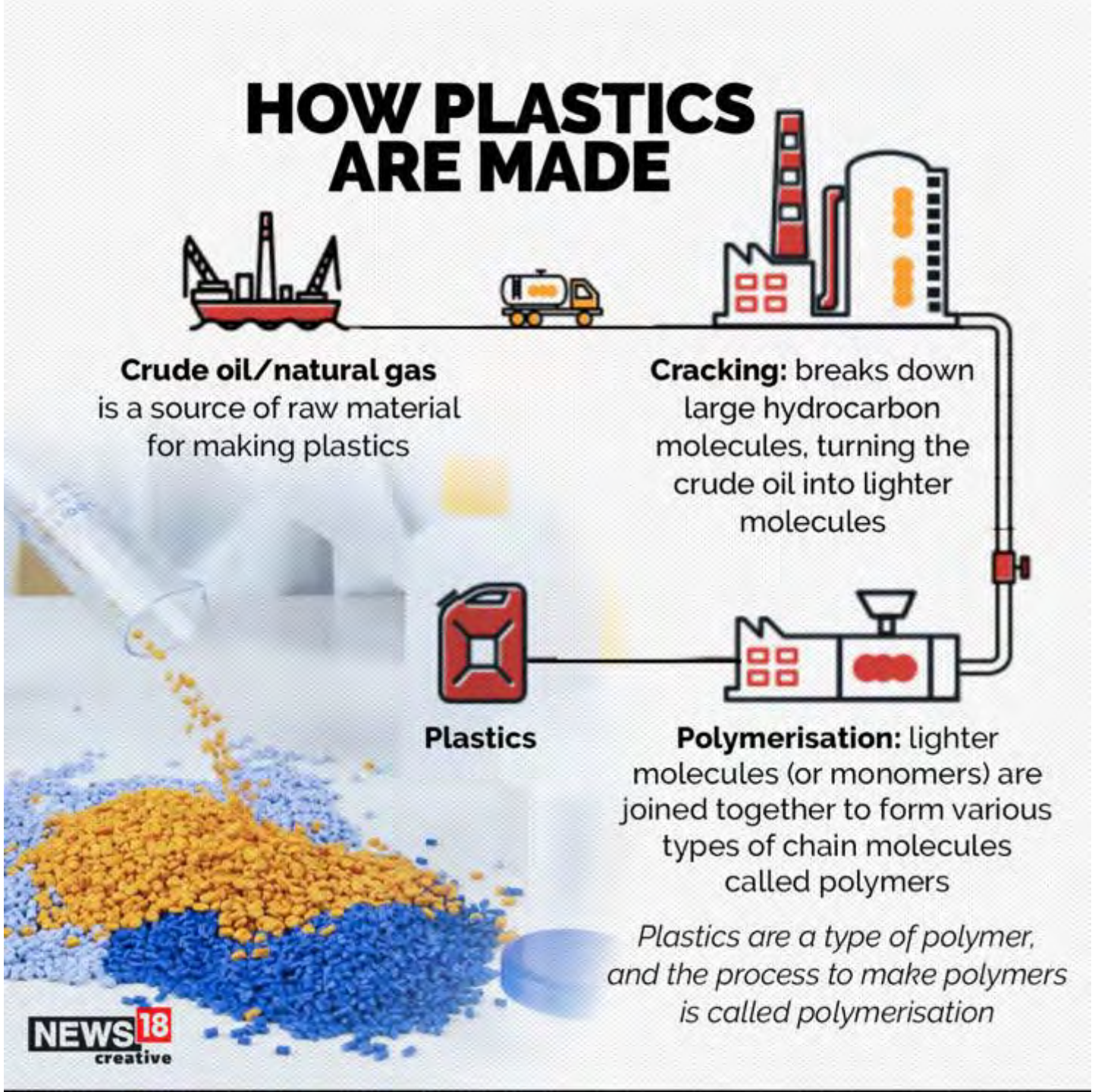


Image: News18 Creative

Types of Plastic

- Polyethylene Terephthalate (PET)
- High Density Polyethylene (HDPE)
- Low Density Polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene (PS)
- Polyvinylchloride (PVC)
- Polyurethane Resins (PUR)
- Fibers: polyester, polyamide, acrylic

Plastic is in just about everything these days…

40 % of all plastics today are *single use

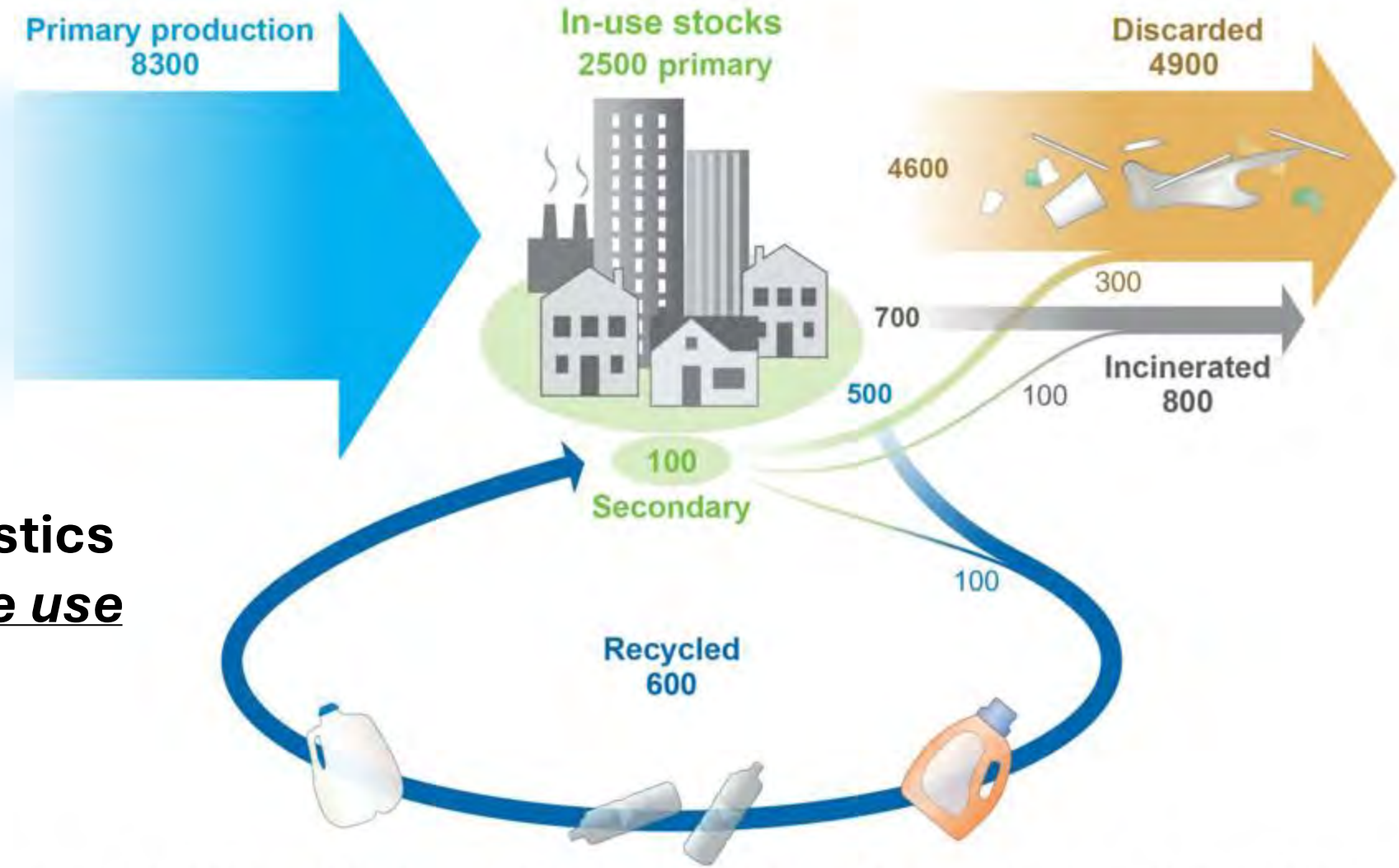


Fig. 2. Global production, use, and fate of polymer resins, synthetic fibers, and additives (1950 to 2015; in million metric tons).

Gyer, Jambeck, Law. Sci Adv 2017
Minderoo-Monaco Commission on Plastics

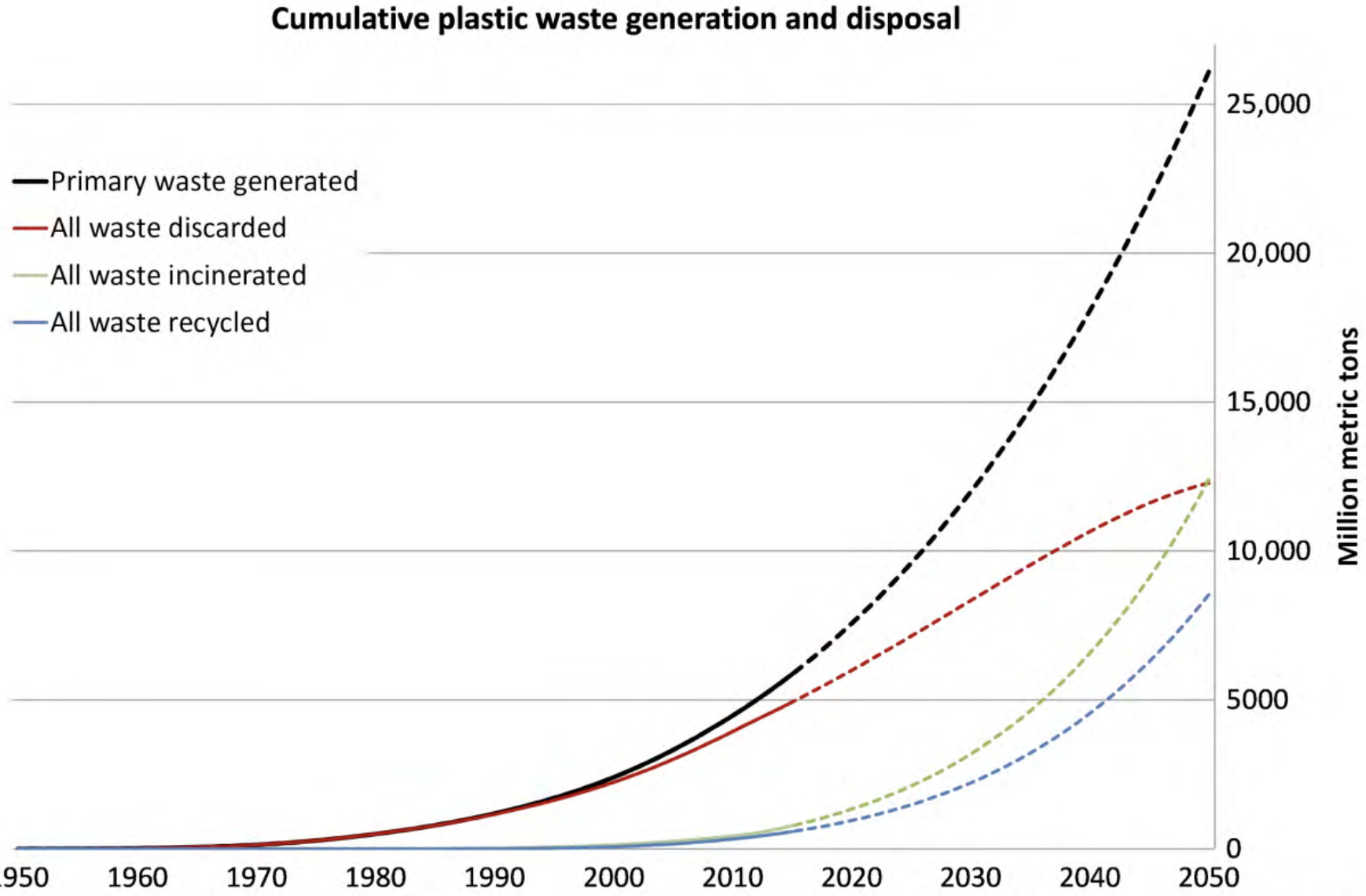
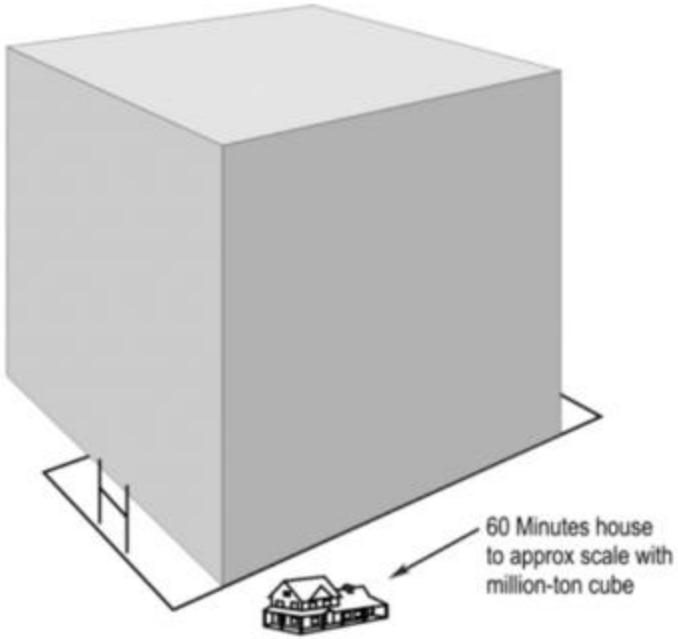


Fig. 3. Cumulative plastic waste generation and disposal (in million metric tons). Solid lines show historical data from 1950 to 2015; dashed lines show projections of historical trends to 2050.

Gyer, Jambeck, Law. Sci Adv 2017

FIGURE 1 -- A million tons of water would fill a cube measuring 100 meters (109 yards) on each edge, compared here to a football field. A million tons of a denser substance such as coal would fill a slightly smaller cube (one measuring about 97 yards on each edge).



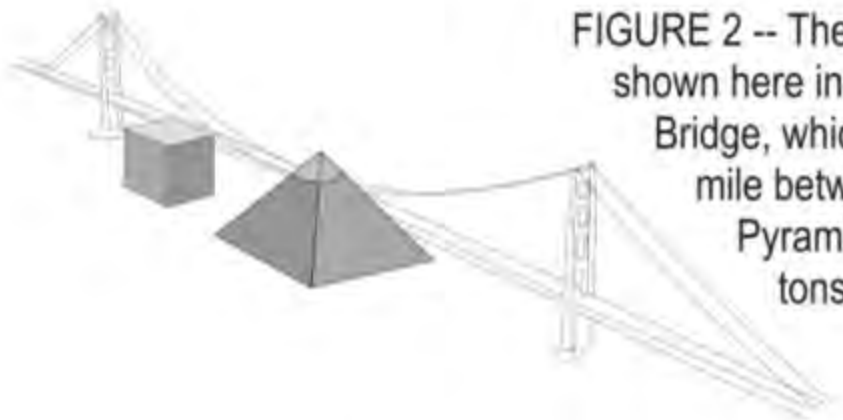


FIGURE 2 -- The million-ton cube of FIGURE 1 shown here in relation to the Golden Gate Bridge, which measures eight-tenths of a mile between the towers. (The Great Pyramid, weighing about 6-million tons, is shown for scale.)

https://www.esva.net/~flash/bigthings.htm

“Upstream” Effects of Plastic Production

CO2 pump handle:

Carbon Cost

- Plastic Manufacturing in energy intensive
- Plastic production is responsible for 4-5% of global Greenhouse Gas emissions

Landrigan et al. Ann Glob Health. 2023

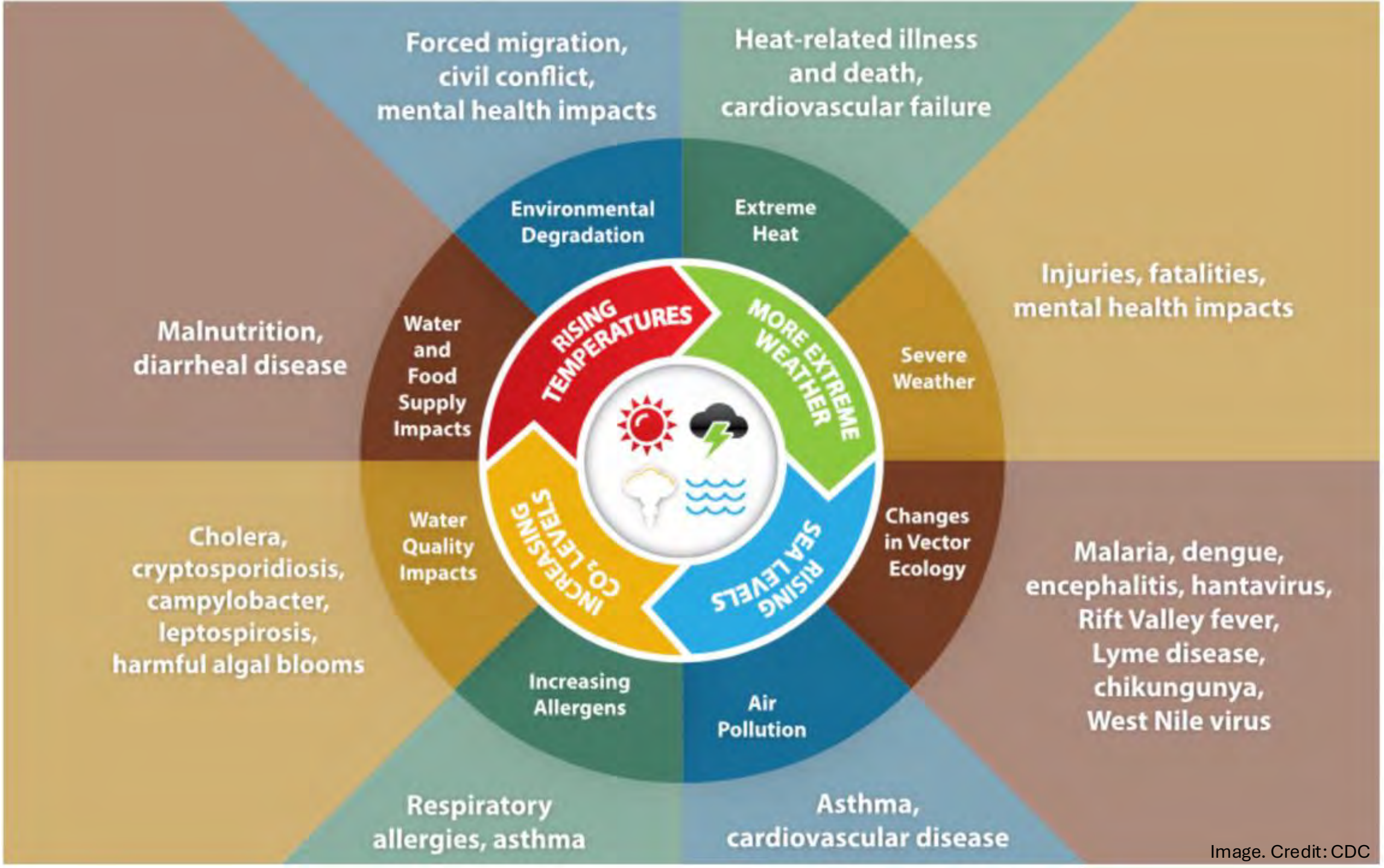


Image. Credit: CDC

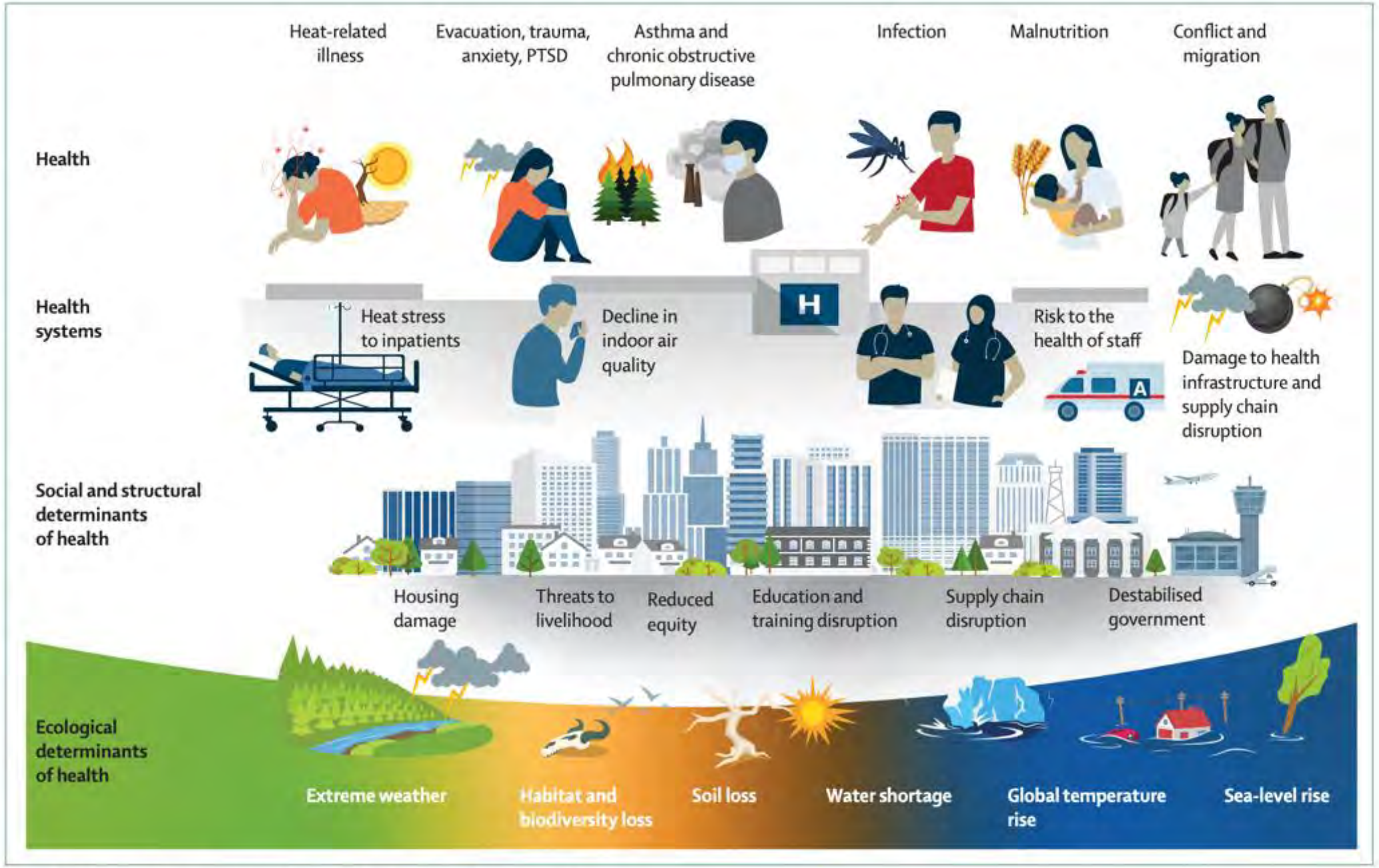
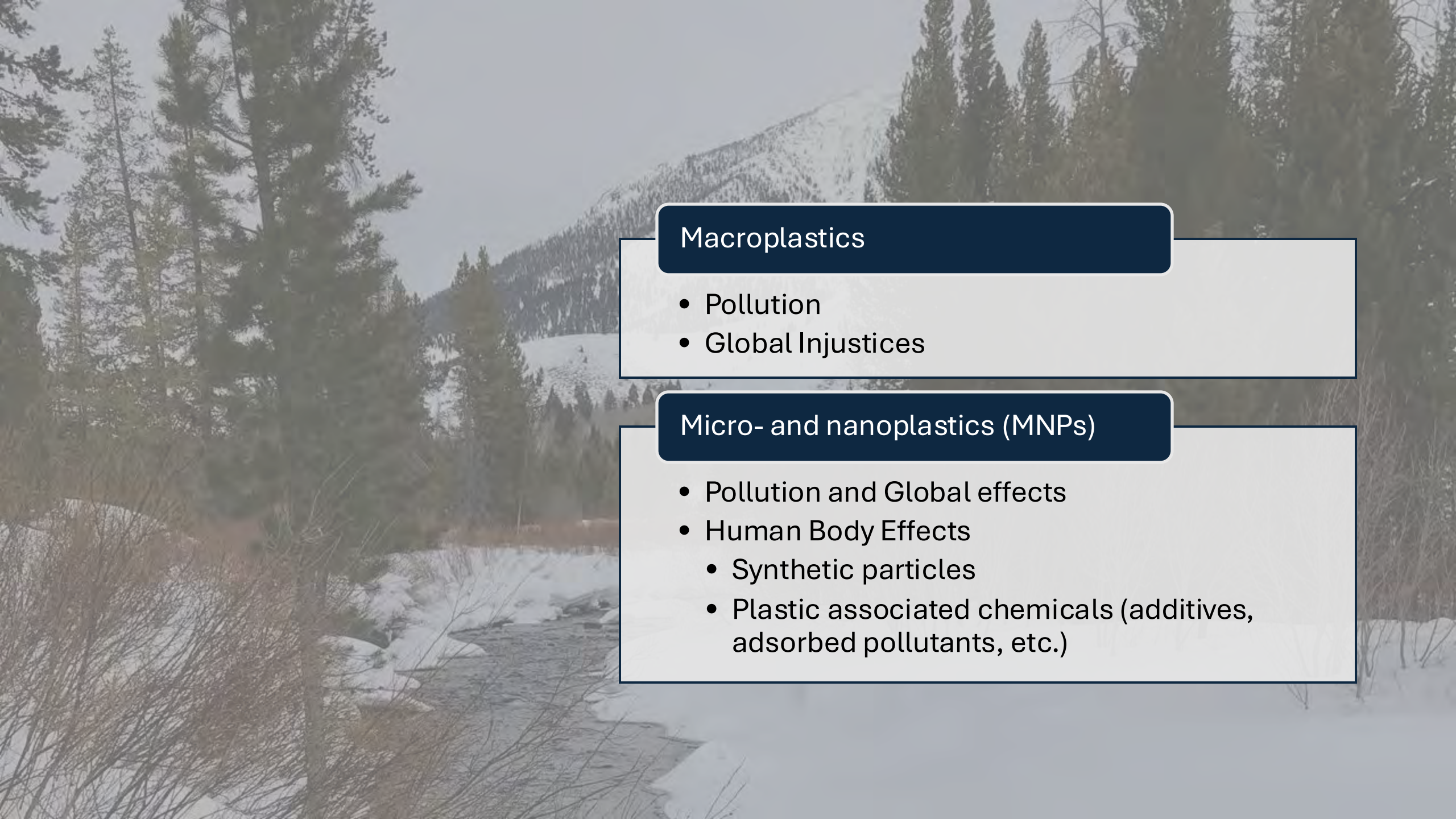


Figure 1: **Climate change-related impacts on health and health systems**

Howard et al. Lancet Planet Health 2023

“Downstream” effects of plastic production



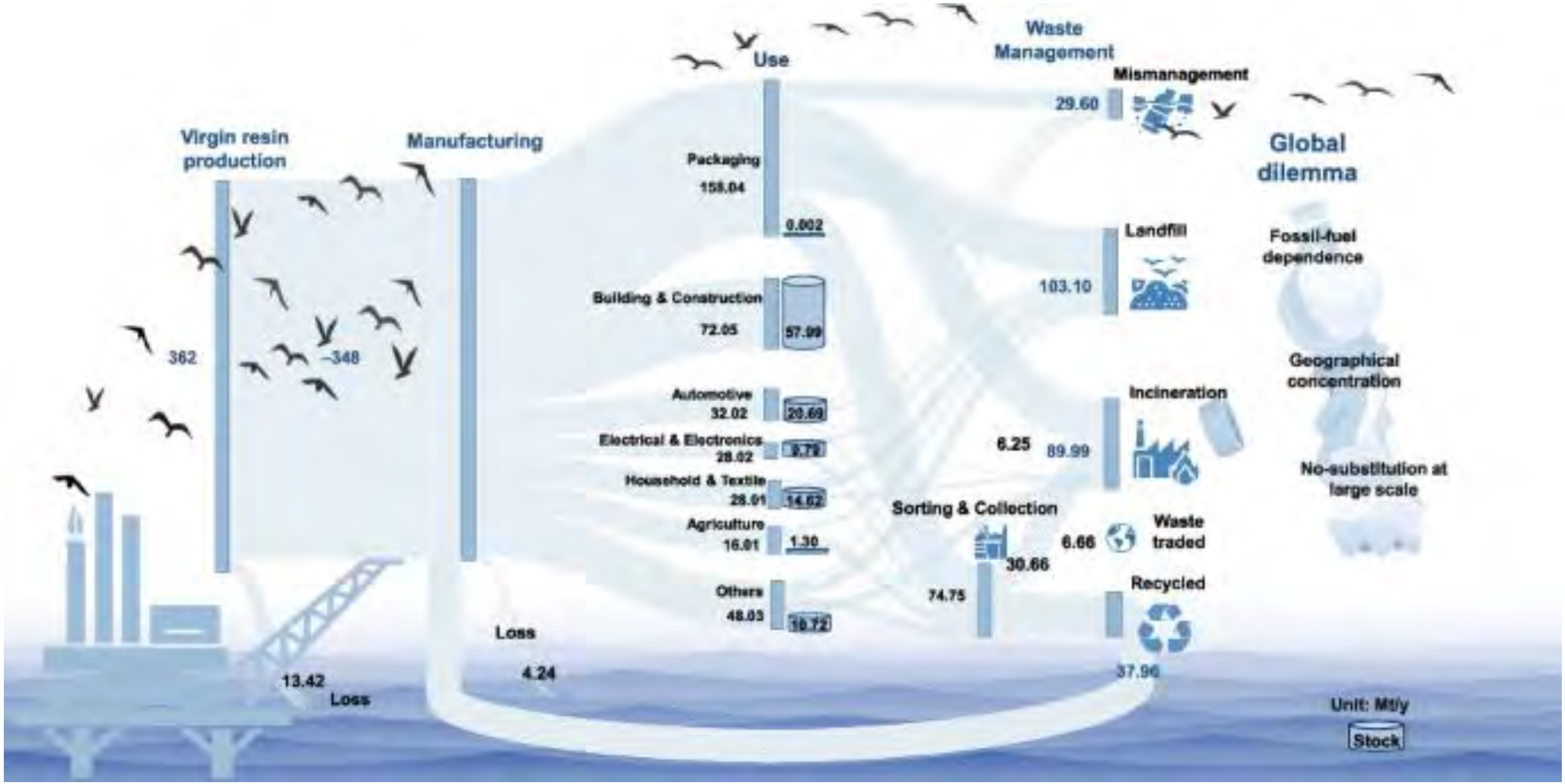
Macroplastics

- Pollution
- Global Injustices

Micro- and nanoplastics (MNPs)

- Pollution and Global effects
- Human Body Effects
  - Synthetic particles
  - Plastic associated chemicals (additives, adsorbed pollutants, etc.)

Macroplastics



https://www.nature.com/articles/s43247-025-02169-5

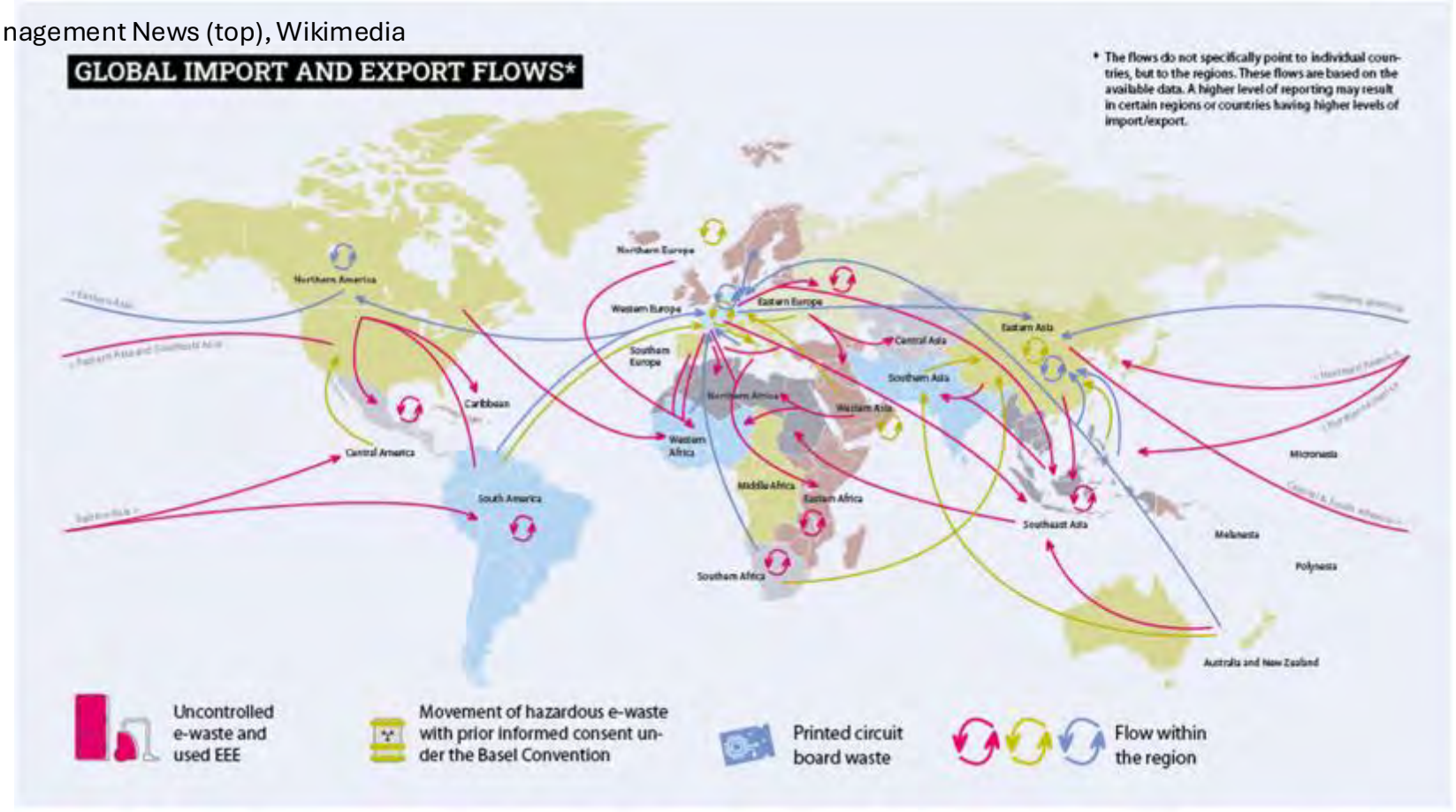
Top Plastic Waste Trading Regions

Primary Importing Countries

- United States
- Canada
- United Kingdom
- European Union
- Germany
- The Netherlands
- Australia
- Japan
- Malaysia
- Indonesia
- Turkey
- Vietnam
- Hong Kong
- India
- Thailand
- Mexico

Photo credits: Basal action network (top L, bottom R)
Pexels: Mumtahina Tanni (Top R, bottom L)

Photo credits: Global Waste Management News (top), Wikimedia commons (bottom)

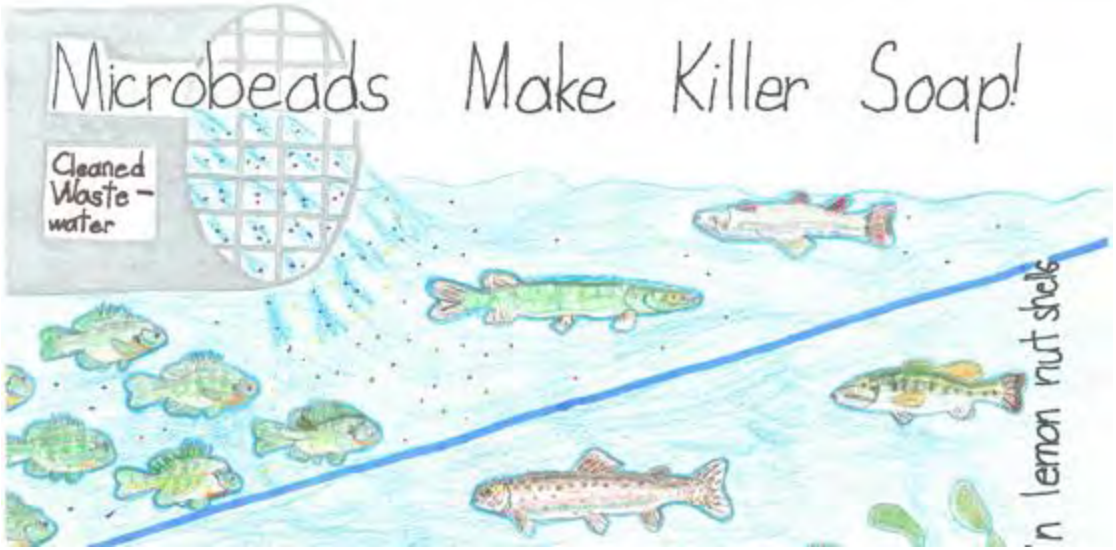


Microplastics

Microplastics (MNPs)

- Microplastic: < 5mm
- Nanoplastic: < 1000 nm (or 1 µm)

Photo: Wikimedia commons



Where do MNPs come from?

- Macroplastic breakdown
  - Synthetic clothing, car tires, construction materials, plastic bags & bottles, etc.
- Manufactured microplastics
  - Nurdles
  - Microbeads (found in cosmetics, detergents, paints medications, disposable diapers)

Osman et al, Env Chem 2023
Image credit: NOAA Marine Debris Program: Johanna B., grade 1, Minnesota

MNPs are Everywhere in the Environment

- Water:
  - MNPs found on ocean surfaces, coasts, deep see (Mariana Trench), polar sea ice, tap water, bottled water
  - Macro and micro plastic have been found in hundreds of marine species (all major taxa)
  - Plastic-associated chemicals have been shown to bioaccumulate in marine animals
- Land
  - Microplastics are in our soils
  - Degrades soil quality and can harm seed growth
- Air:
  - Indoor particle burden is often higher due to plastic fibers in our furniture, carpet, clothing, etc.
  - Particle burden highest in higher urban density areas, but have been recorded in remote areas as well
  - May pose highest risk d/t can be both ingested and inhaled

Gardiner 2026
Simon 2022
Landrigan et al. Ann Glob Health. 2023
Zhao et al, Sci Total Env 2023

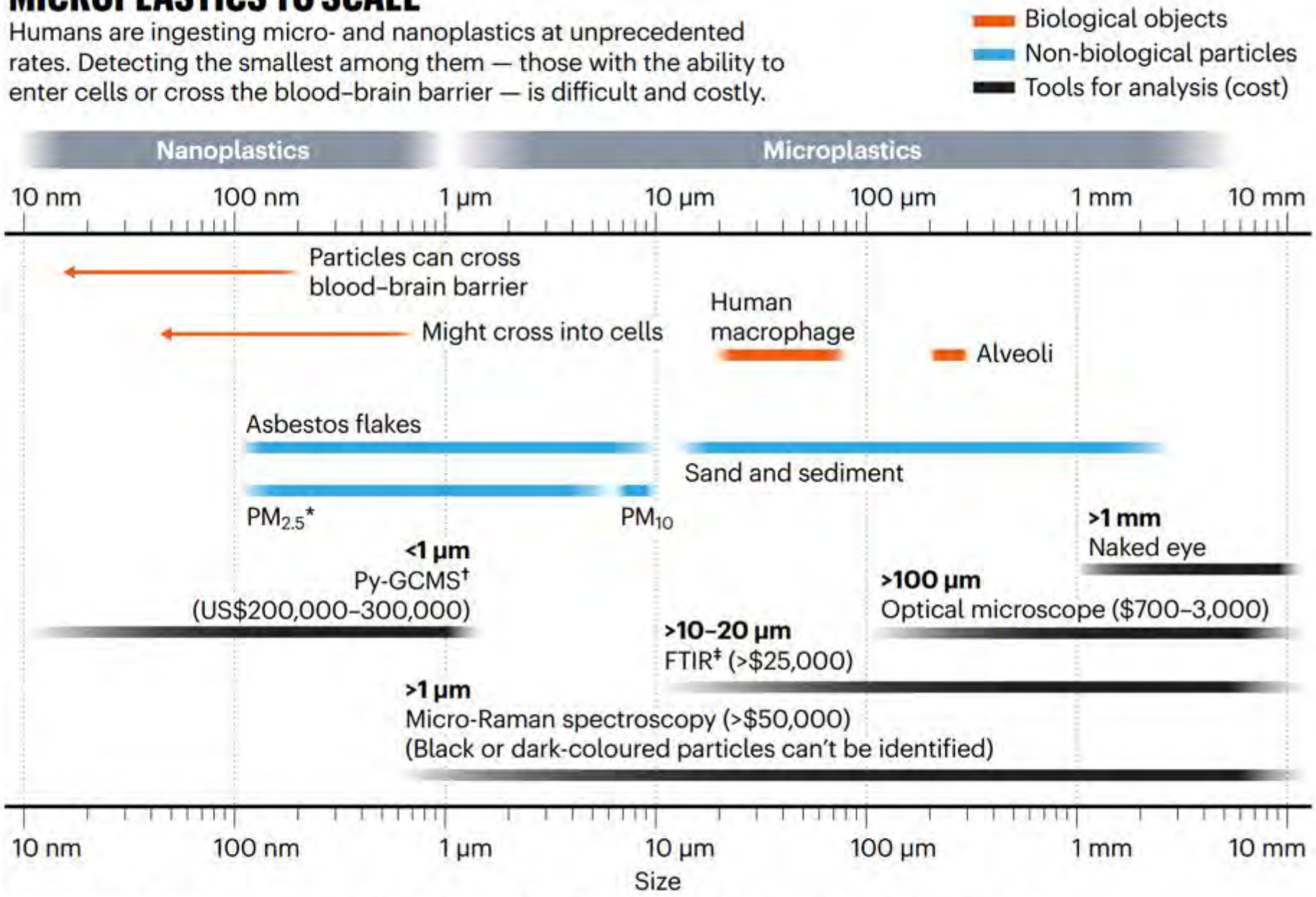
MNPs are also Inside Humans

- MNPs have been found in human:
  - Urine
  - Blood
  - Placentas
  - Breast milk
  - Livers
  - Lung tissue
  - Carotid plaques
  - Brain tissue

Landrigan NEJM 2024
Kozlov Nature 2025
Marfella et al NEJM 2024

MICROPLASTICS TO SCALE

Humans are ingesting micro- and nanoplastics at unprecedented rates. Detecting the smallest among them — those with the ability to enter cells or cross the blood–brain barrier — is difficult and costly.



*Particulate matter less than 2.5 micrometres ($PM_{2.5}$) or less than 10 µm (PM_{10}) in diameter, often from soot, vehicle exhaust or dust;
†Py-GCMS, pyrolysis–gas chromatography–mass spectrometry; ‡FTIR, Fourier-transform infrared spectroscopy.

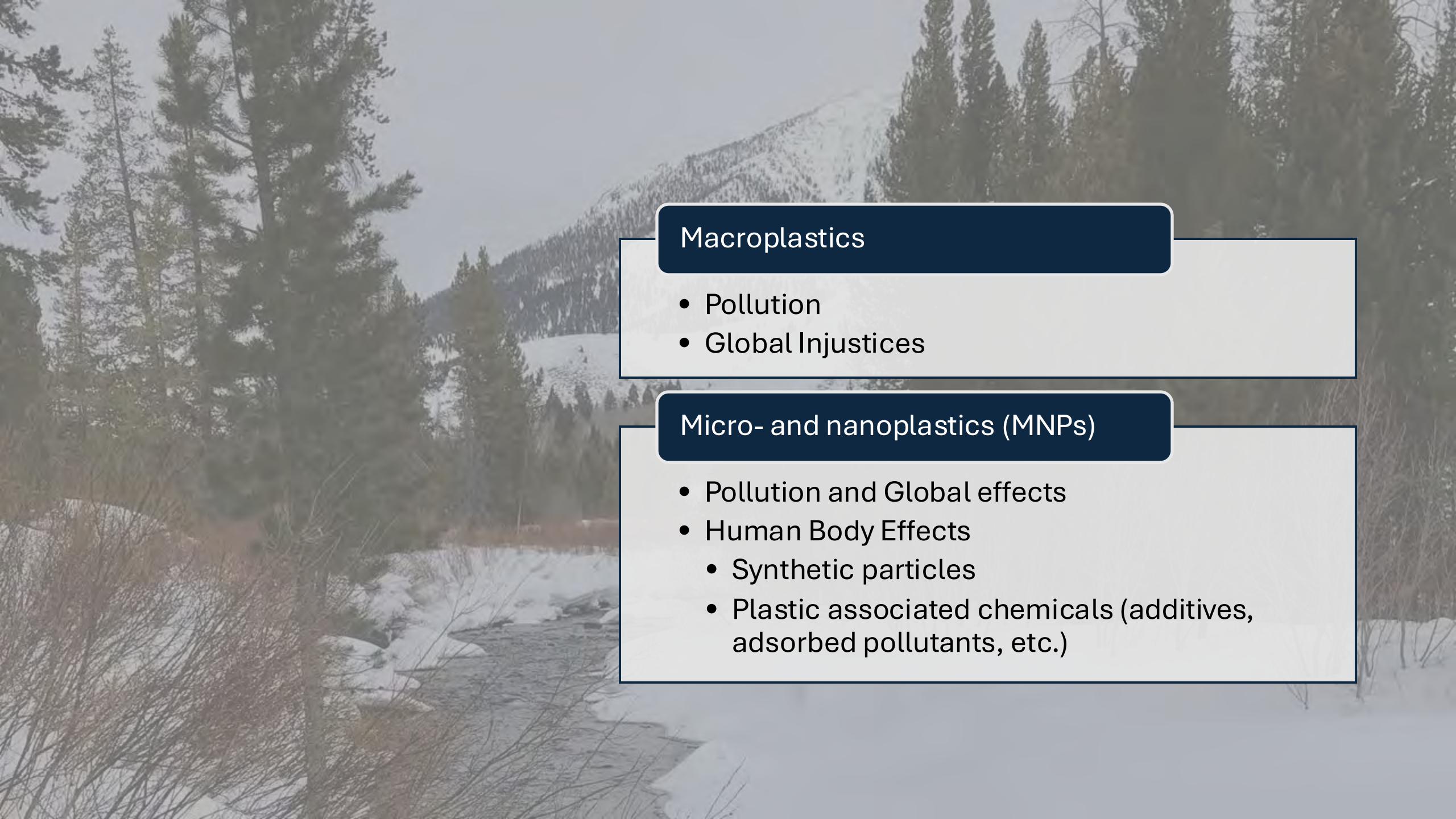
SOURCE (TOOLS AND COSTS): S. PRIMPKE *ET AL. APPL. SPECTROSC.* **74**, 1012–1047 (2020).

Kozlov, Nature 2025

This is probably bad for us…

- Petrochemical “fenceline” communities have higher rates of preterm birth, LBW, asthma, COPD, CVD, lung cancer, breast cancer, leukemia and lymphoma
  - Cancer Alley
- Textile workers in Rhode Island exposed to nylon flocking with higher rates of ILD
- PVC manufacturers with higher rates of hepatic angiosarcomas

Landrigan et al. Ann Glob Health. 2023
Landrigan, NJEM 2024



Macroplastics

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Micro- and nanoplastics (MNPs)

- Pollution and Global effects
- Human Body Effects
  - Synthetic particles
  - Plastic associated chemicals (additives, adsorbed pollutants, etc.)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Microplastics and Nanoplastics in Atheromas and Cardiovascular Events

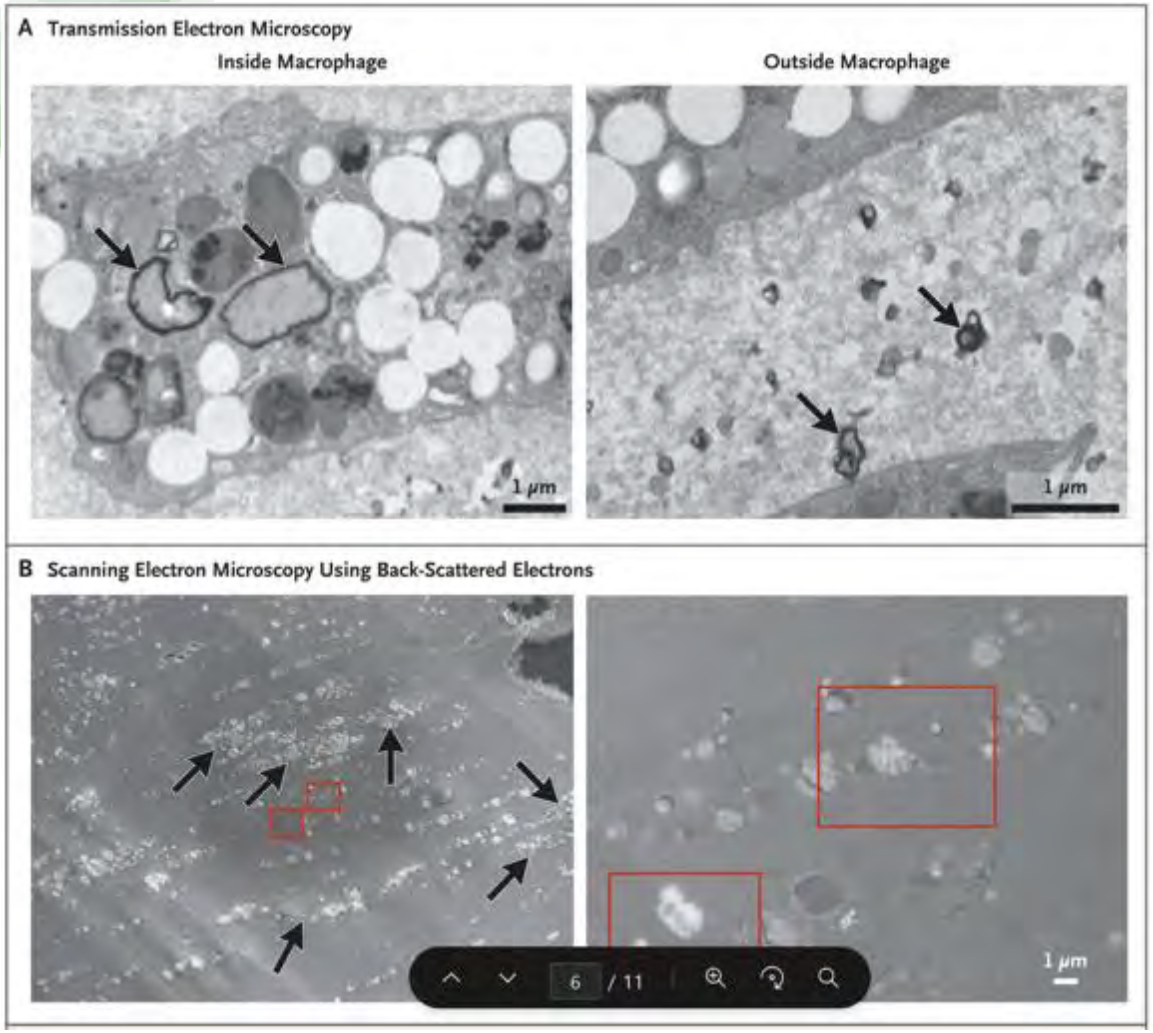
R. Marfella, F. Prattichizzo, C. Sardu, G. Fulgenzi, L. Graciotti, T. Spadoni, N. D'Onofrio, L. Scisciola, R. La Grotta, C. Frigé, V. Pellegrini, M. Municinò, M. Siniscalchi, F. Spinetti, G. Vigliotti, C. Vecchione, A. Carrizzo, G. Accarino, A. Squillante, G. Spaziano, D. Mirra, R. Esposito, S. Altieri, G. Falco, A. Fenti, S. Galoppo, S. Canzano, F.C. Sasso, G. Matacchione, F. Olivieri, F. Ferraraccio, I. Panarese, P. Paolisso, E. Barbato, C. Lubritto, M.L. Balestrieri, C. Mauro, A.E. Caballero, S. Rajagopalan, A. Ceriello, B. D'Agostino, P. Iovino, and G. Paolisso

APAChE Study
(Pollutants in the Atherosclerotic Plaque and Cardiovascular Events)

- NEJM March 2024
- Prospective observational study in Italy.
- Looked for MNPs in carotid artery plaques in patients undergoing endarterectomy
  - 18-75 yo with high grade, asymptomatic ICS (>70%)
  - n = 257 (304 enrolled)
- Divided into groups with & without MPNs in plaque and assessed outcomes at 34 mos
  - Primary end points: nonfatal MI, nonfatal stroke, all cause mortality
  - Secondary outcomes: inflammatory markers

150 (58.4%) had polyethylene (PE) in their excised plaque

31 (12.1%) ALSO had polyvinyl chloride (PVC)



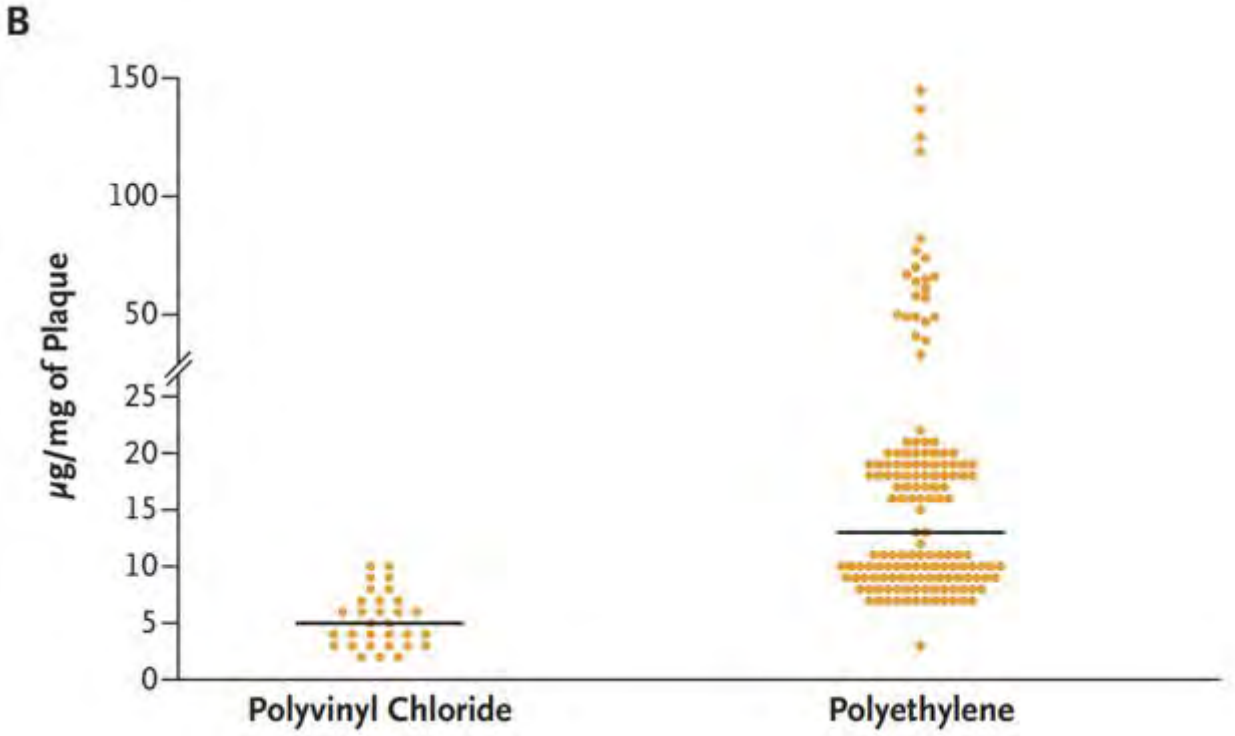


Table 1. Characteristics of the Patients at Baseline.*

Variable	MNPs Present (N=150)	MNPs Not Present (N=107)
Age (IQR) — yr	71 (65–75)	73 (67–77)
Male sex — no. (%)	116 (77.3)	79 (73.8)
Body-mass index (IQR)†	28 (27–29)	28 (26–29)
Hypertension — no. (%)	78 (52.0)	69 (64.5)
Systolic blood pressure (IQR) — mm Hg	124 (118–130)	127 (118–129)
Diastolic blood pressure (IQR) — mm Hg	78 (75–83)	77 (75–85)
Heart rate (IQR) — beats/min	85 (79–91)	81 (76–86)
Stenosis severity (IQR) — %	77 (73–83)	78 (73–83)
Diabetes — no. (%)	36 (24.0)	32 (29.9)
Cardiovascular disease — no. (%)‡	50 (33.3)	35 (32.7)
Dyslipidemia — no. (%)	55 (36.7)	40 (37.4)
Total cholesterol (IQR) — mg/dl	150 (145–158)	147 (139–158)
LDL cholesterol (IQR) — mg/dl	77 (69–84)	74 (69–82)
HDL cholesterol (IQR) — mg/dl	42 (40–43)	42 (40–44)
Triglycerides (IQR) — mg/dl	178 (165–192)	182 (163–193)
Creatinine (IQR) — mg/dl	1.00 (0.90–1.10)	0.96 (0.96–1.06)
Smoker — no. (%)	24 (16.0)	17 (15.9)
Medication use — no. (%)		
Beta-blockers	48 (32.0)	35 (32.7)
ACE inhibitors	75 (50)	53 (49.5)
ARBs	35 (23.3)	31 (29.0)
Calcium-channel blockers	13 (8.7)	8 (7.5)
Diuretics	17 (11.3)	16 (15.0)
Heparin	12 (8.0)	10 (9.3)
Antiplatelet drugs	146 (97.3)	105 (98.1)
Statin	143 (95.3)	101 (94.4)
Ezetimibe	26 (17.3)	20 (18.7)

Primary Outcomes

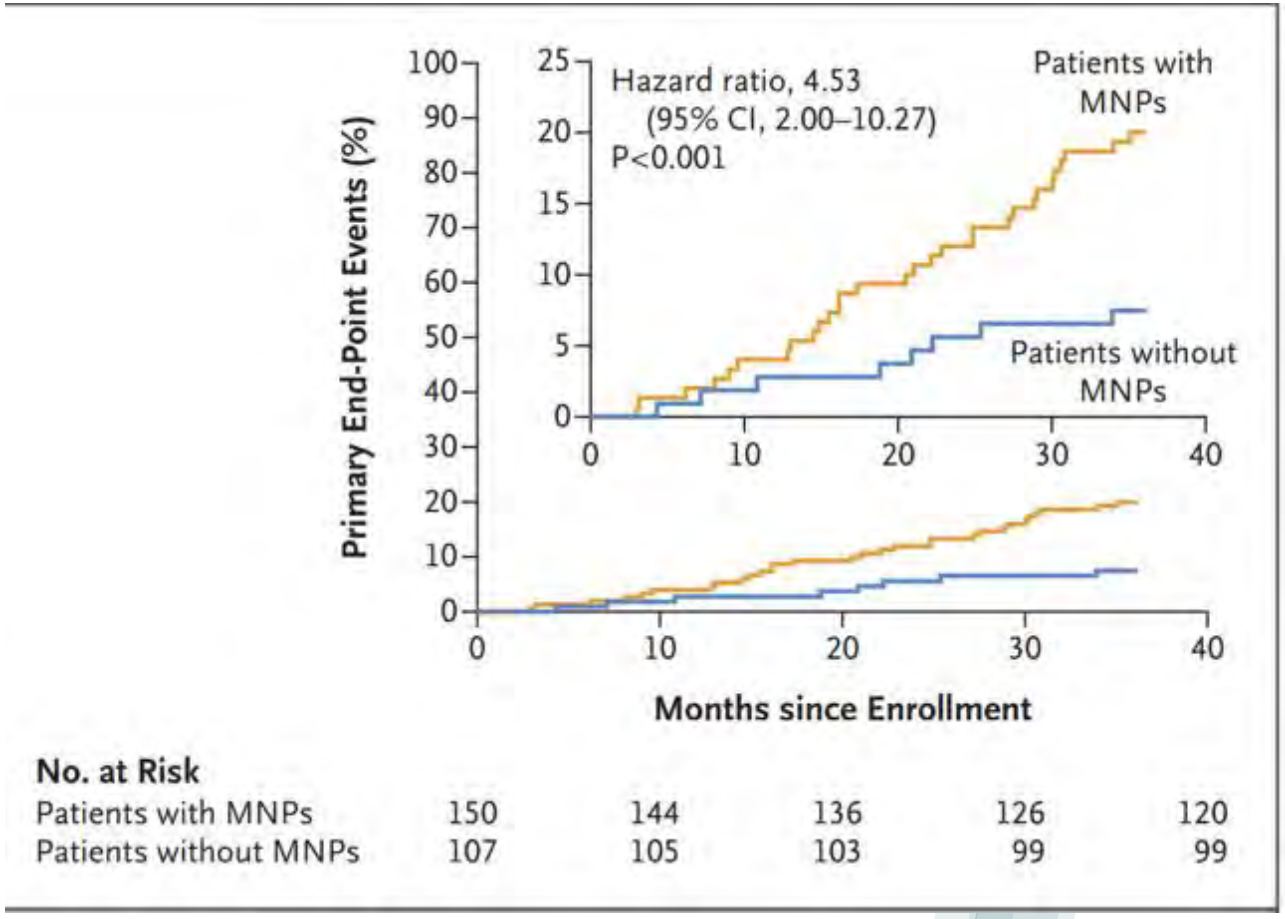
* Non fatal MI, nonfatal stroke, all cause mortality at 34 mos

8/107 non-MPN patients (7.5%)

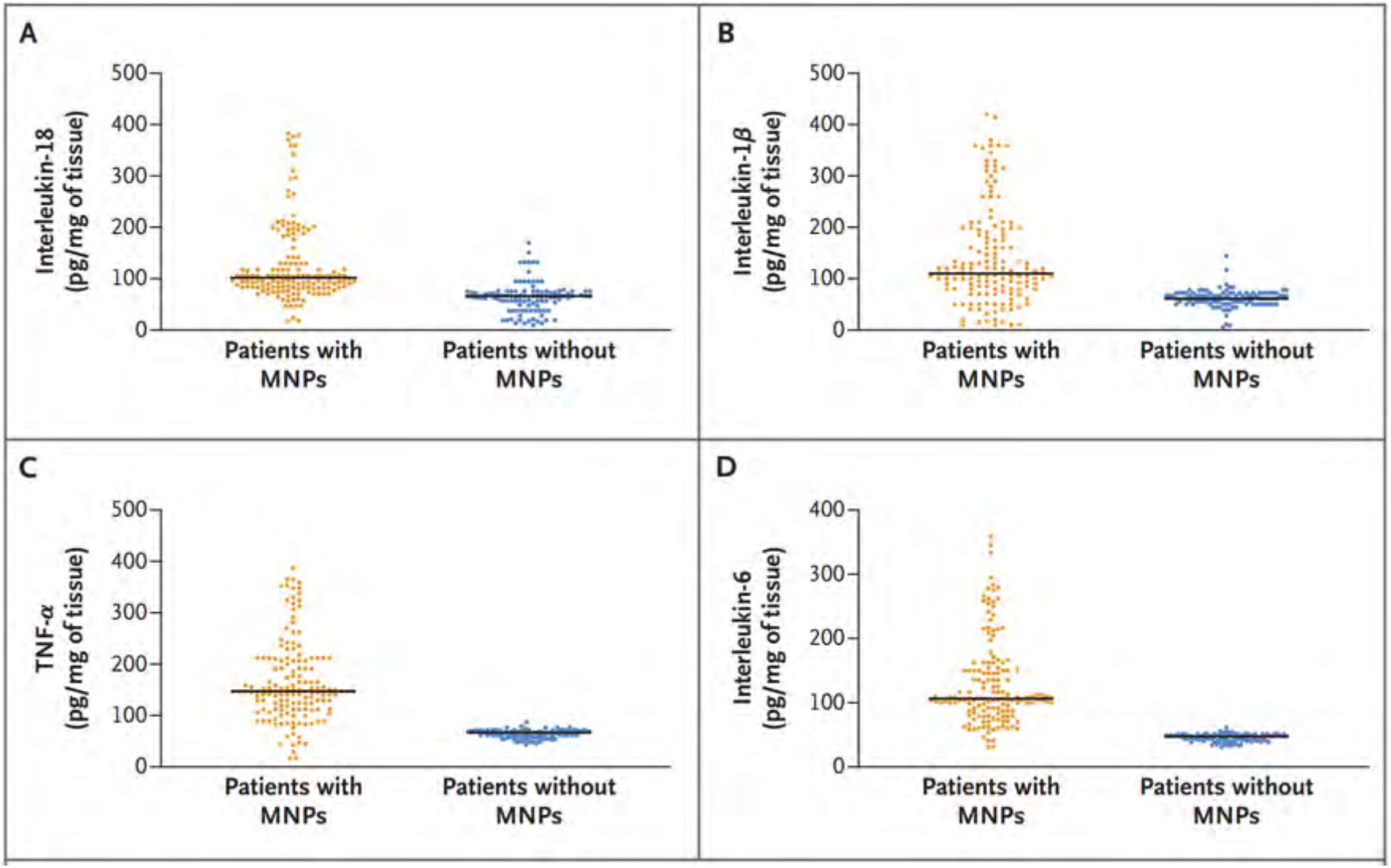
30/150 MPN patients (20%)

Adjusted Hazard ratio of 4.53

(P <0.001)



Secondary Outcomes



Conclusions

- That’s a big hazard ratio!
- But this is associative only, causality is unknown
- Questions for future research:
  - Link to SES data
  - What were the different types of exposures to microplastics in these groups? (Food, water, air quality, etc)
  - Why were PE & PVC the only plastics found?
- What do we tell patients?
  - We have a lot of other risk factors that we have more confidence about
  - But, could this be compelling enough to change some “low hanging fruit”

nature medicine

Brief Communication

https://doi.org/10.1038/s41591-024-03453-1

Bioaccumulation of microplastics in decedent human brains

Received: 29 April 2024

Accepted: 9 December 2024

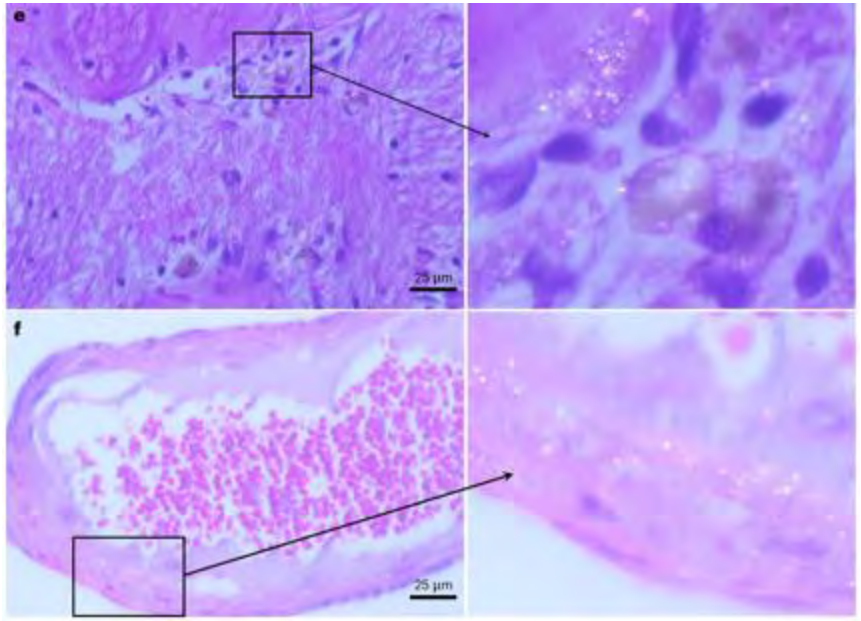
Published online: 3 February 2025

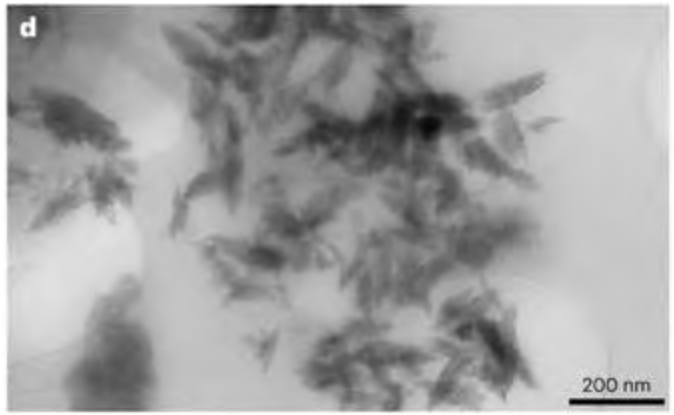
Check for updates

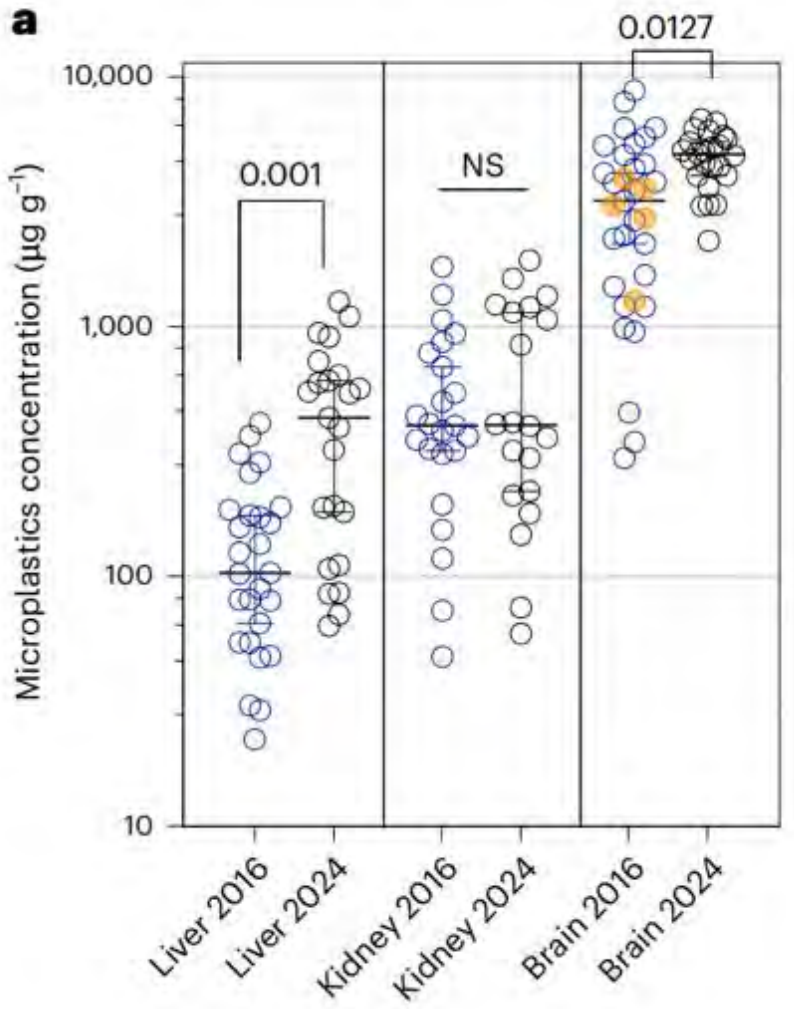
Alexander J. Nihart[1,12], Marcus A. Garcia[1,12], Eliane El Hayek[1,12], Rui Liu[1], Marian Olewine[1], Josiah D. Kingston[1], Eliseo F. Castillo[2], Rama R. Gullapalli[3], Tamara Howard[4], Barry Bleske[5], Justin Scott[6], Jorge Gonzalez-Estrella[6], Jessica M. Gross[7], Michael Spilde[8], Natalie L. Adolphi[9], Daniel F. Gallego[9], Heather S. Jarrell[9], Gabrielle Dvorscak[9], Maria E. Zuluaga-Ruiz[10], Andrew B. West[11] & Matthew J. Campen[1]

- Obtained unidentified post-mortem liver, kidney and brain samples from 2016 and 2024 autopsy specimens.
  - 10 “normal” brains (5 from 2016, 5 from 2024)
  - 12 dementia brains (6 Alzheimer's, 3 vascular, 3 ”other”)

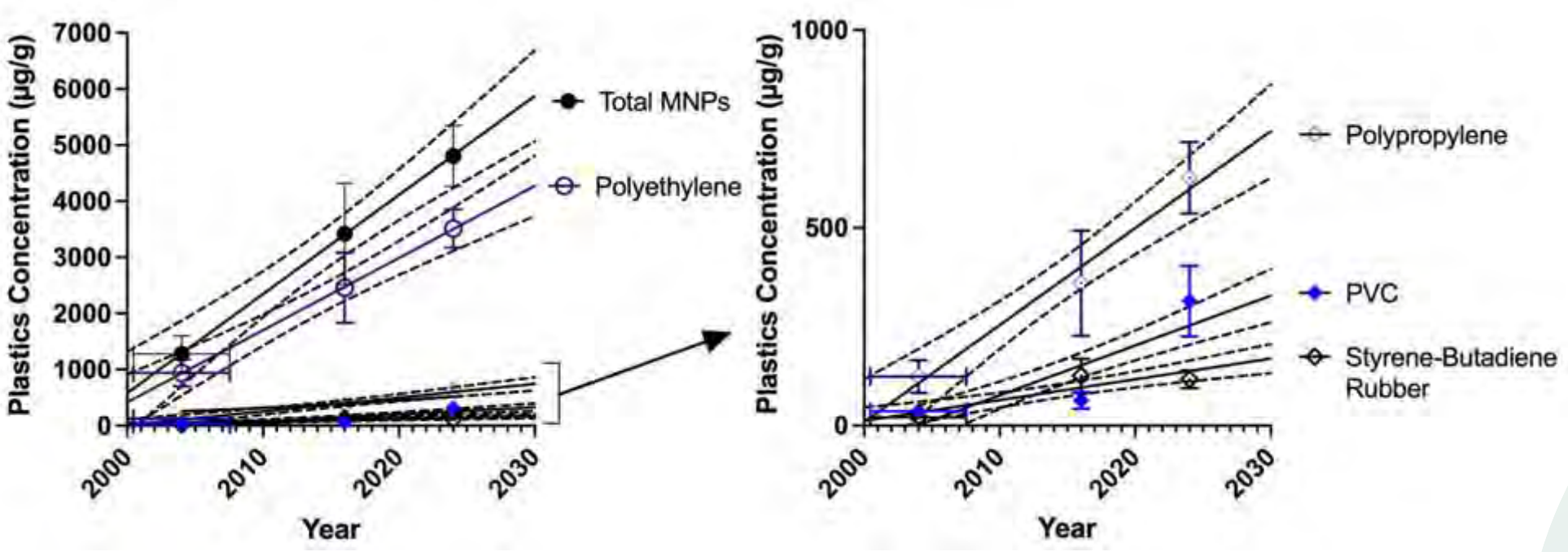
- Brain tissues had higher concentrations of MPNs than liver of kidney (4917 µg/g vs 433,404 µg/g in 2024 samples)
  - The brain tissue concentrations were comparable to those found in carotid arteries in the APAChE trial.





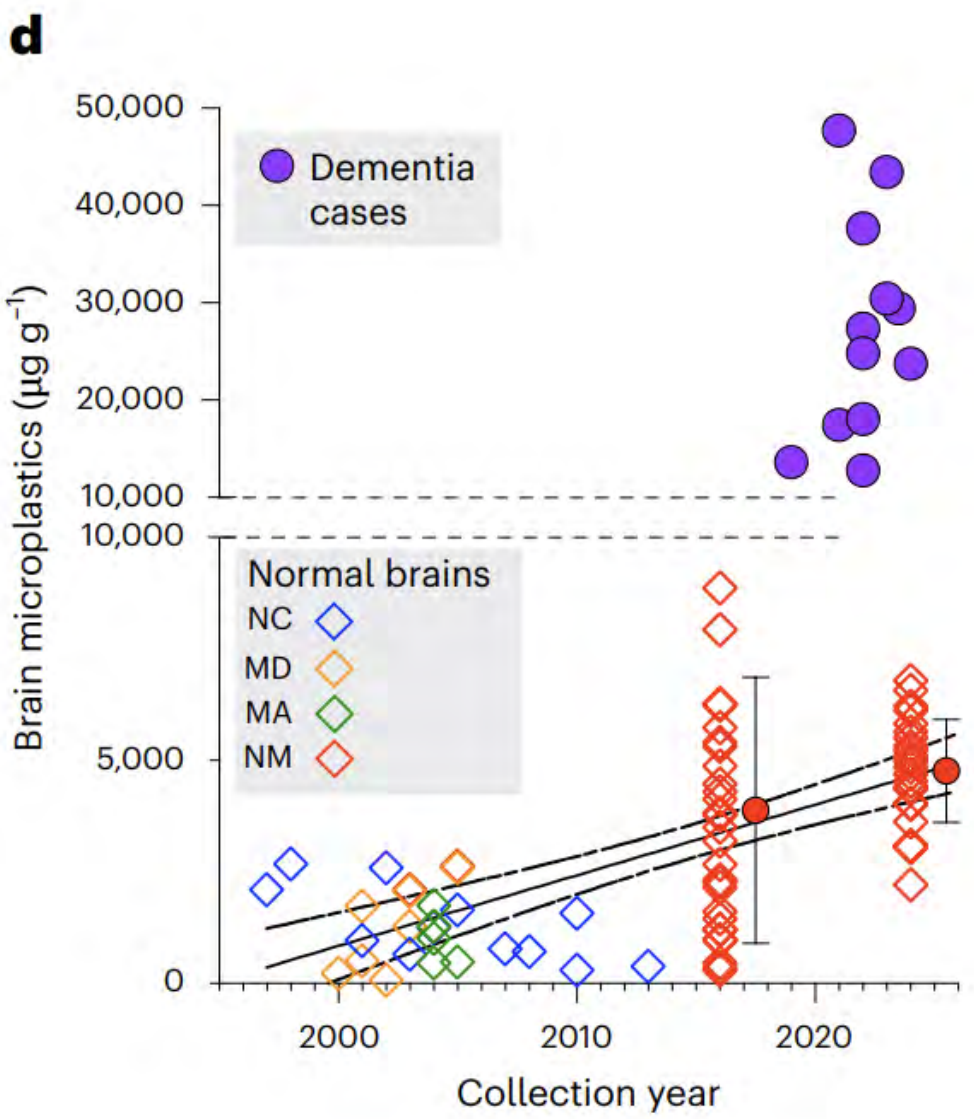


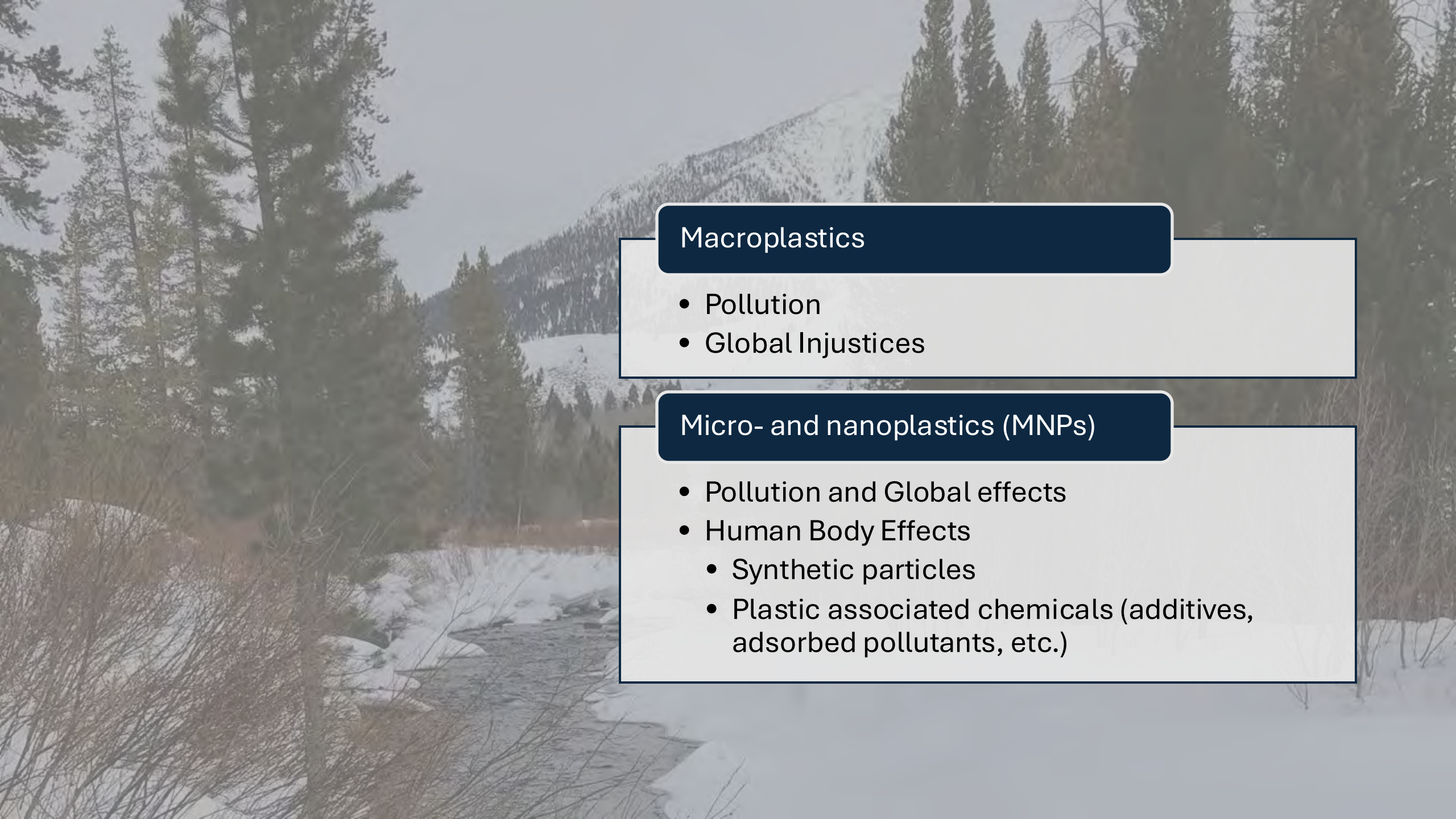
- All samples from 2024 had higher concentrations of MPNs than the 2016 samples.
  - Also pulled brains from earlier deaths (1997-2013) and found clear increase in number of MPNs
  - Interestingly, decedent age did no correlate with total plastic load



- Dementia samples had much higher concentrations of MPNs than non-dementia samples: 26,076 µg/g vs 4917 µg/g

- Study authors do note that this cannot be stated to be causal, as tissue atrophy, impaired BBB and poor clearance mechanisms are all known hallmarks of dementia that would presumably lead to increased MPN concentration as well.
  - Again, we have significant association, but cannot determine causality





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Plastic Associated Chemicals

- 16,325 unique chemicals found in plastics
- On average, non-fiber plastics are 93% polymer and 7% additives by mass
- Plasticizers, fillers and flame retardants = 75% of additives
- MNPs are also prone to adsorbing contaminants (heavy metals, bacteria, others)

Gyer, Jambeck, Law. Sci Adv 2017
Monclus et al, Nature 2025

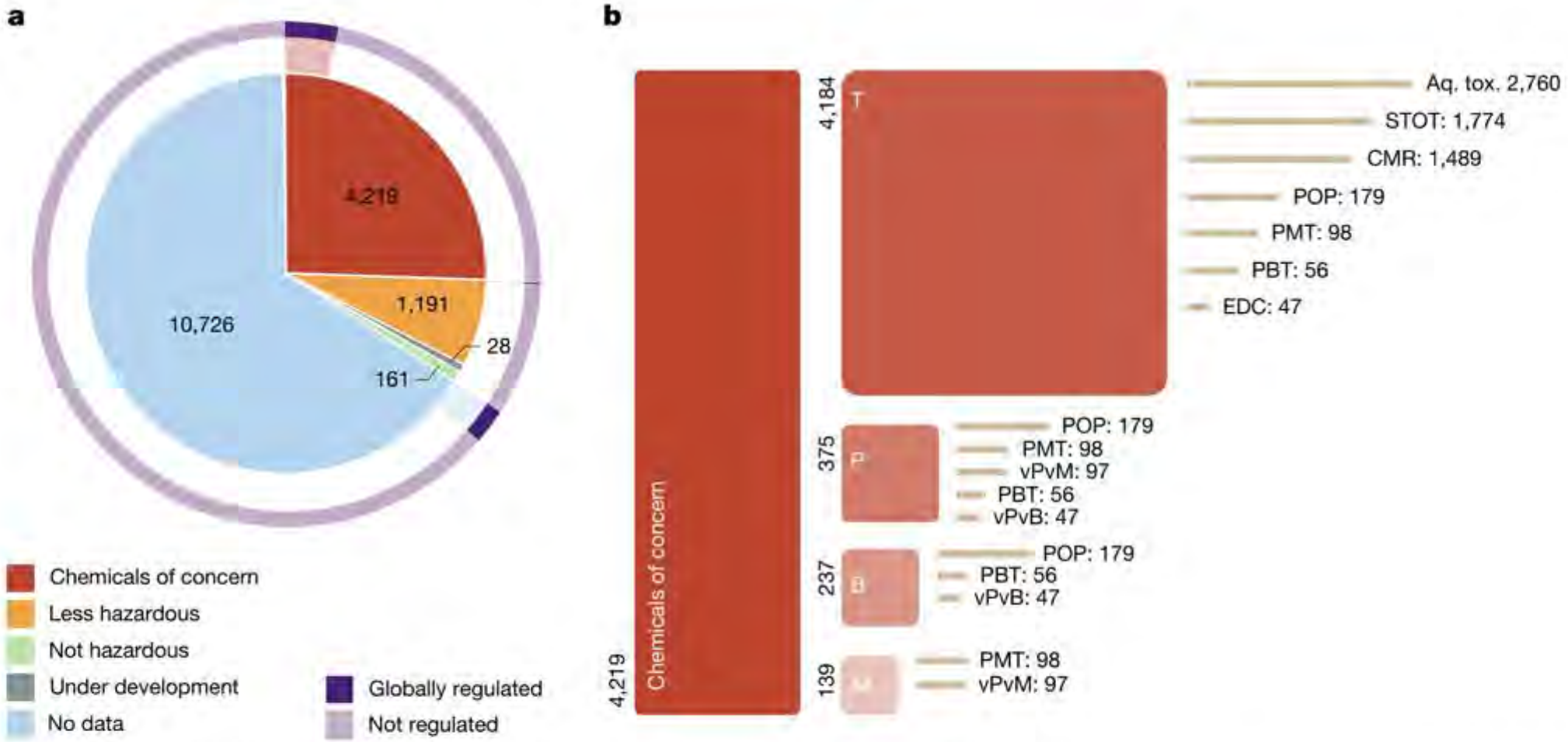


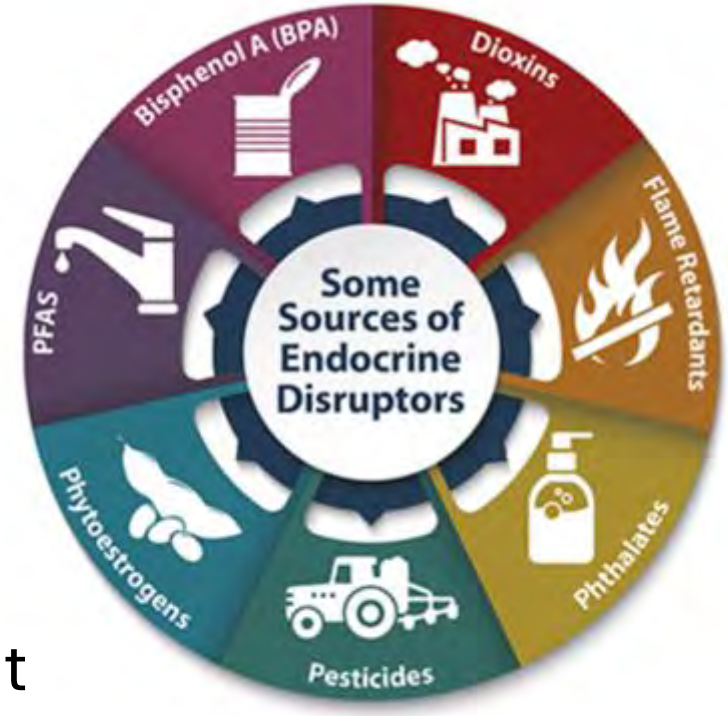
Fig. 2 | Chemicals of concern in plastics, and their hazard classes and traits. **a**, Number of the chemicals identified as of concern, less hazardous, not hazardous, and those without data or under development. The outer circle represents chemicals that are globally regulated. **b**, Number of chemicals of concern fulfilling the hazard criteria (P, persistence; B, bioaccumulation; M, mobility; and T, toxicity) and specific hazard traits (Aq. tox., aquatic toxicity; STOT, specific target organ toxicity; CMR, carcinogenic, mutagenic or toxic for reproduction; POP, persistent organic pollutant; PMT, persistent, mobile and toxic; PBT, persistent, bioaccumulative and toxic; EDC, endocrine-disrupting chemical; vPvM, very persistent and very mobile; vPvB, very persistent and very bioaccumulative). For details, see Supplementary Text 4.

Monclus et al, Nature 2025

Endocrine Disrupting Chemicals

"An exogenous chemical, or mixture of chemicals, that can interfere with any aspect of hormone action"

- Found in pesticides, biocides, plastic polymer additives, food contact materials, personal care products, etc.
- Mimic hormones in the body and can therefore disrupt hormone cascade function
- Fetal development appears to be a particularly vulnerable time, with germ cells being modified
- Can lead to effects decades later or in subsequent generations



EDCs to Know About

BPA

- Most produced chemical annually (15 billion lbs in 2013). Wide ranging uses including reusable food and beverage containers (water bottles), canned food linings, water pipes, thermal paper receipts.
- Can affect brain development & behavior, repro cell division
  - → Assoc with anxiety, depression, ADHD, PCOS, breast, prostate, ovarian and endometrial cancers
- 93% of Americans have a measurable amount of BPA in their urine
- EPA safety level = 50µg/kg/d, vs EU 4µg/kg/d

Phthalates

- Liquid plasticizer (used in food packaging, toys, beauty products, medical tubing, fillers in medications and supplements)
- Can decreased estrogen and testosterone levels, block thyroid hormone action
  - Associated with reduced fertility (across multiple generations), increased rates of miscarriage, pre-eclampsia, early menopause, insulin resistance, ?asocial behavior.
- Present in >90% of samples of amniotic fluid, cord blood samples, breast milk
- Restricted in the EU and classified as substances of very high concern

EDC-2 Endocrine Society
Plastics, EDCs and Health
“7 harmful chemicals types in plastics”

EDCs to Know About, cont.

Perfluorinated Compounds (PFAS)

- “Forever chemicals” that don’t break down in the environment and bioaccumulate
- Used in food contact wrappers, non-stick cookware, firefighting foams
- Common contaminant in groundwater, can also leach into food from packaging or be consumed in fish, meat and dairy
- Documented in human urine, plasma, placentas, breast milk
- Estrogen and metabolism disrupter (thought to create a ”thrifty phenotype” in utero
  - --> associated with obesity, insulin resistance, HLD, changes in pubertal timing.
  - Strong associations with renal, testicular, prostate, ovarian, non-hodgkin lymphoma
  - One study found poorer immune response to vaccines
- PFAS regulation in place in US

EDC-2 Endocrine Society
Plastics, EDCs and Health
“7 harmful chemicals types in plastics”

EDCs to Know About, cont.

Brominated Flame Retardants (BFRs)

- Used in foams, epoxy resins for electronics and wire casings --> electronics, appliances, furniture, carpet, toys
  - More common in recycled plastic
- Common in household dust, babies and young children esp at risk for exposure
- Affect androgen and thyroid hormone processes
  - Associated with cryptorchidism, decreased anogenital distance, ?attention and IQ changes in children

EDC-2 Endocrine Society
Plastics, EDCs and Health
“7 harmful chemicals types in plastics”

Chemical regulation in the US vs EU

- The Toxic Substances Control Act (TSCA) of 1976 is the main regulation in chemicals in the US
  - Updated in 2016 to require companies submit a “pre-manufacture notice” of all new chemicals 90 days before introducing it to market. EPA assesses for level of risk and can place restrictions or deny approval.
  - Default is “safe until proven unsafe”
  - Existing chemicals are also supposed to be retroactively assess for risk. But testing is not automatically required unless requested by EPA.
  - 11 banned chemicals

- In the EU they have the Registration, Evaluation and Restriction of Chemicals (REACH) program.
  - Makes companies responsible for proving that chemicals are safe using mandated hazards testing and reporting.
  - “No data, no market” rule
  - 1,300 banned chemicals

So, What Now?

Individual Actions to Reduce Microplastic Production and Exposure

Change disposable plastic shopping and produce bags out for reusable options, preferentially purchase items sold in glass or recyclable metal containers, drive less, use a HEPA filter in your home, wet mop daily, don't heat plastic in the microwave, don't put plastic in the dishwasher, dispose of any plastic food containers that have etching, avoid eating ultra-processed foods, avoid eating canned foods, use stainless steal reusable water bottles, use cloth diapers, buy and wear only nature fiber clothing, use a fiber filter on your washing machine, avoid "non-stick" pots and pans (opt for cast iron or stainless steel instead), natural fiber furniture only, don't use to-go cups for hot beverages, don't use to-go containers at all, never buy food in pouches, build a rain garden, eat only organic produce, avoid sea salt, don't take thermal paper receipts, get a reverse osmosis water filter, have no resource limitations

Knowledge is power

What is your 100 year plan?

Life is beautiful and worthy of our care and protection

Single Use plastics: Use your power to call for systems change

Home

Clinic

Healthcare system

City

State

Nation

EDCs: Use your power to call for better safety data and regulation

State

Nation

International

Exposure reductions: Share your knowledge & power

Changes at home

Tailored changes for patients

Healthcare systems

City & State

Questions?

Comments?

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