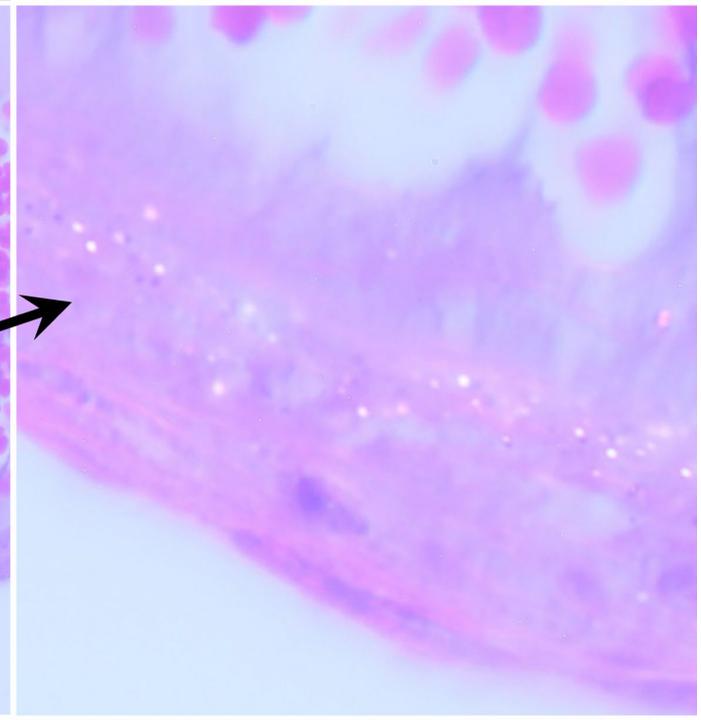
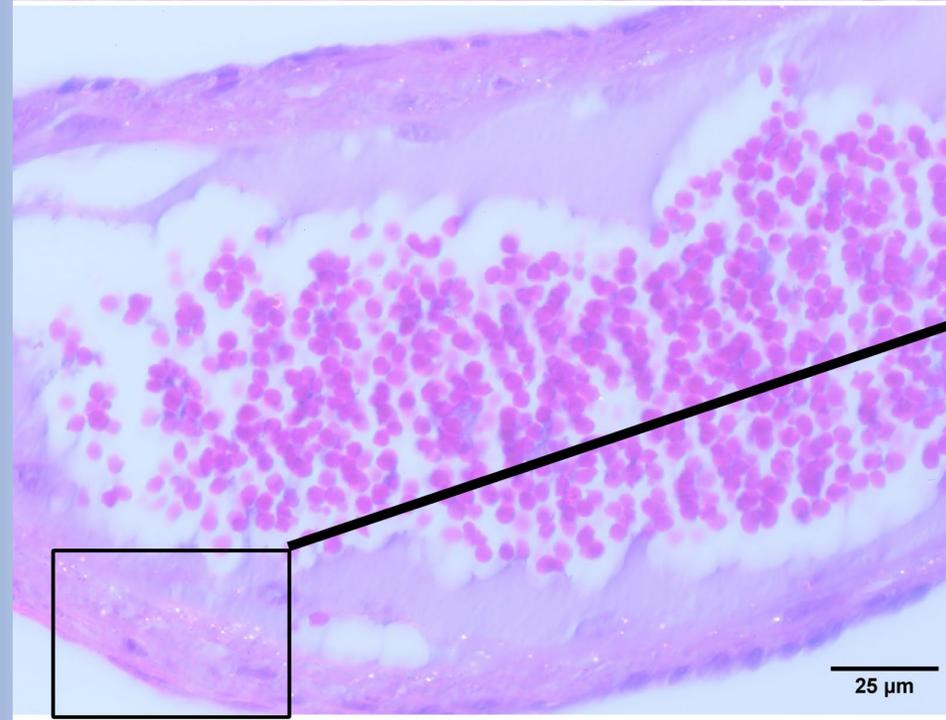
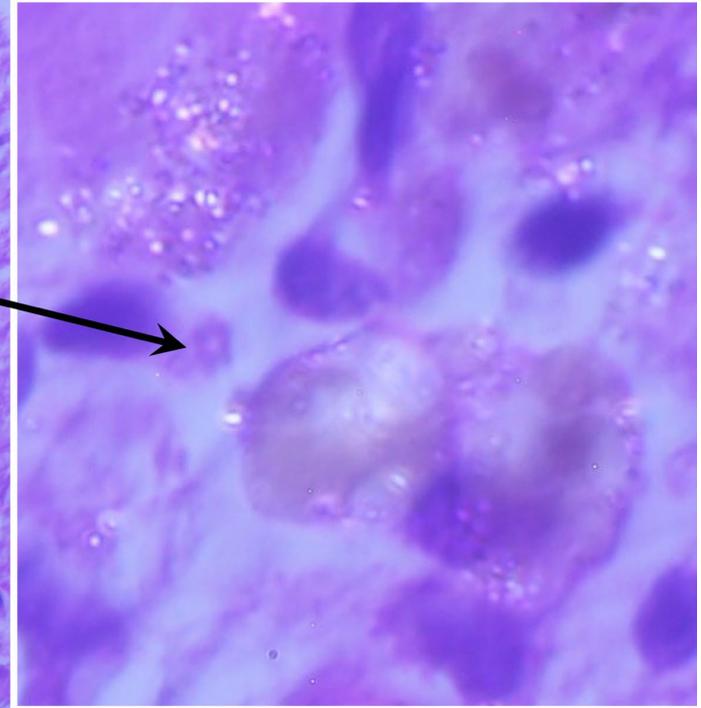
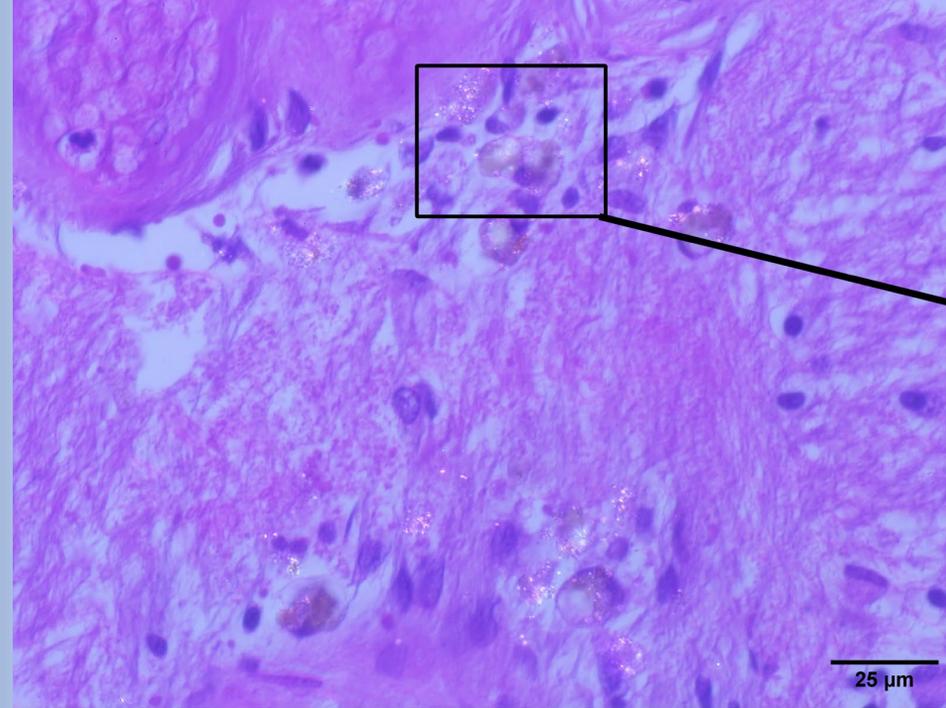


Micro- and Nanoplastics and Human Health: Essential Key Studies

Matthew Campen, PhD, MSPH

Distinguished Professor of Pharmaceutical Sciences
Co-Director, University of New Mexico Clinical and
Translational Science Center

Director, University of New Mexico Center for Metals in
Biology and Medicine



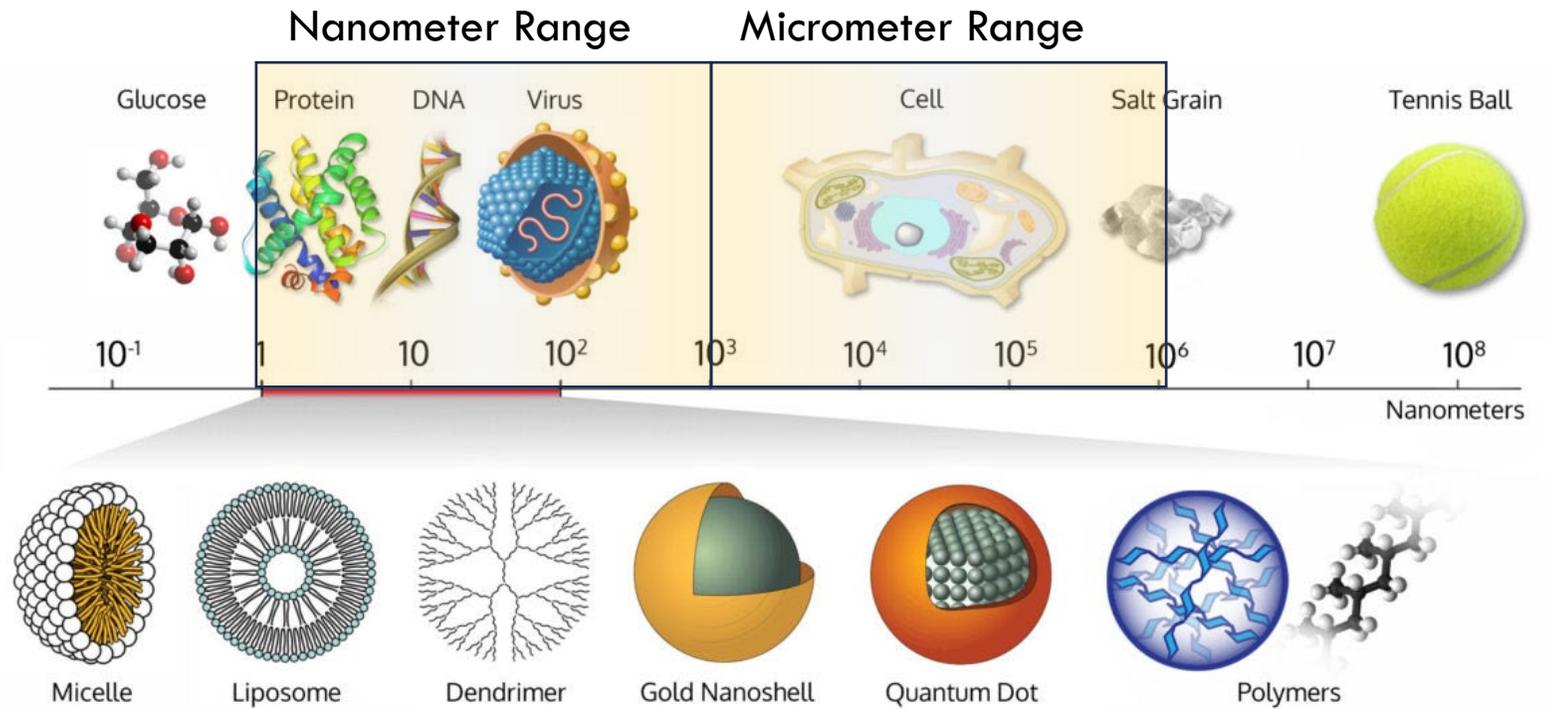
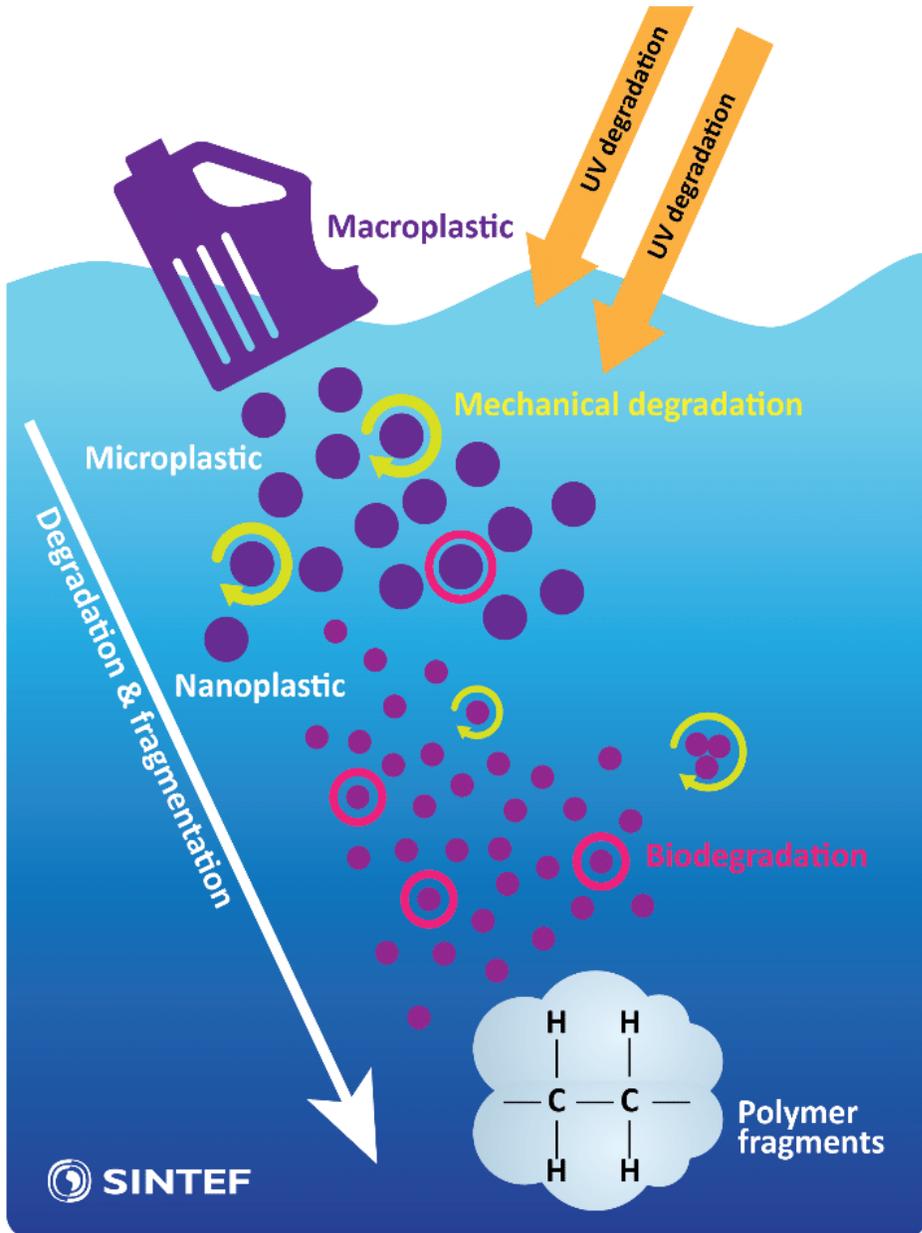
Financial Disclosure

- Research funding comes from the NIH:
- Scientific advisor for Circulate Health

NIEHS (ES014639, ES026673)
NIA (AG070776, AG088557)
NIGMS (P20 GM130422)



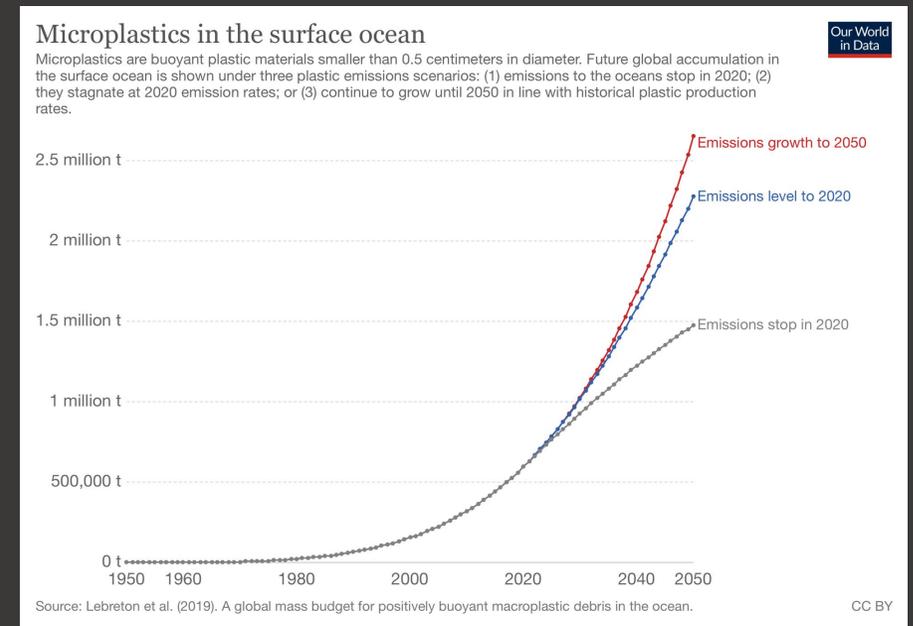
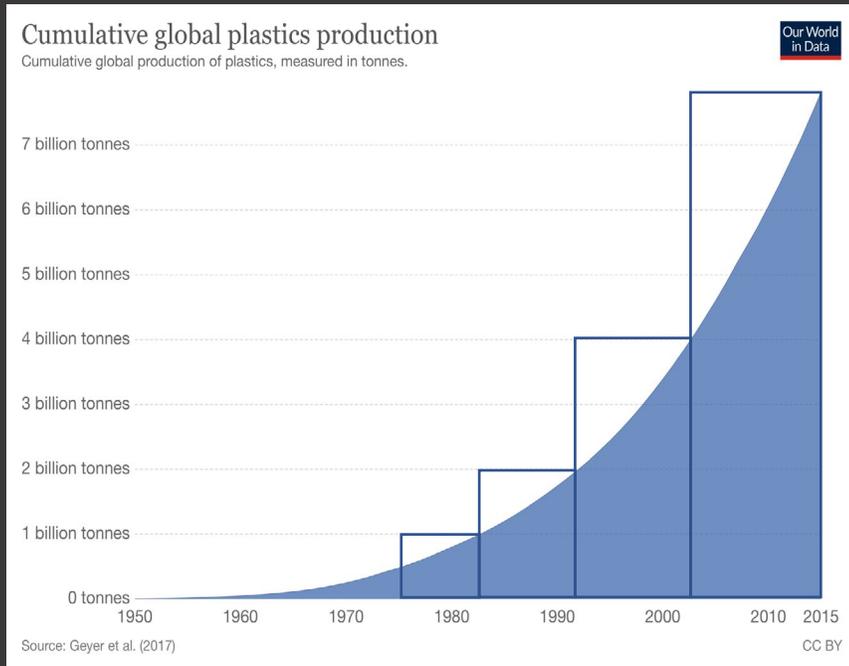
“Microplastics” include even smaller nanoplastics – but these have very different characteristics



<https://www.wichlab.com/nanometer-scale-comparison-nanoparticle-size-comparison-nanotechnology-chart-ruler-2/>

New plastic generation doubles every 14 years

Converts to micro and nanoplastics over decades



"Anyone who believes that exponential growth can go on forever in a finite world is either a madman or an economist"

-Kenneth Boulding



What is the evidence for micro- and nanoplastics and human health outcomes?

- Not strong
- While microplastics were first reported in 2004, the first report in the human body was in 2021 (Ragusa et al., Environ International)
- Currently, the information is of low quality
 - Assays are new/innovative but unvalidated
 - Lack of consensus of optimal methods
 - Skepticism remains warranted
- However, the surge of interest is improving confidence rapidly
- What are the major papers and the “forest for the trees” perspectives?
- *Note that the links between plasticizing chemicals and human health are much more robust!*

ORIGINAL ARTICLE



Microplastics and Nanoplastics in Atheromas and Cardiovascular Events

Authors: Raffaele Marfella, M.D., Ph.D. , Francesco Prattichizzo, Ph.D., Celestino Sardu, M.D., Ph.D., Gianluca Fulgenzi, Ph.D., Laura Graciotti, Ph.D., Tatiana Spadoni, Ph.D., Nunzia D'Onofrio, Ph.D., , and Giuseppe Paolisso, M.D. [Author Info & Affiliations](#)

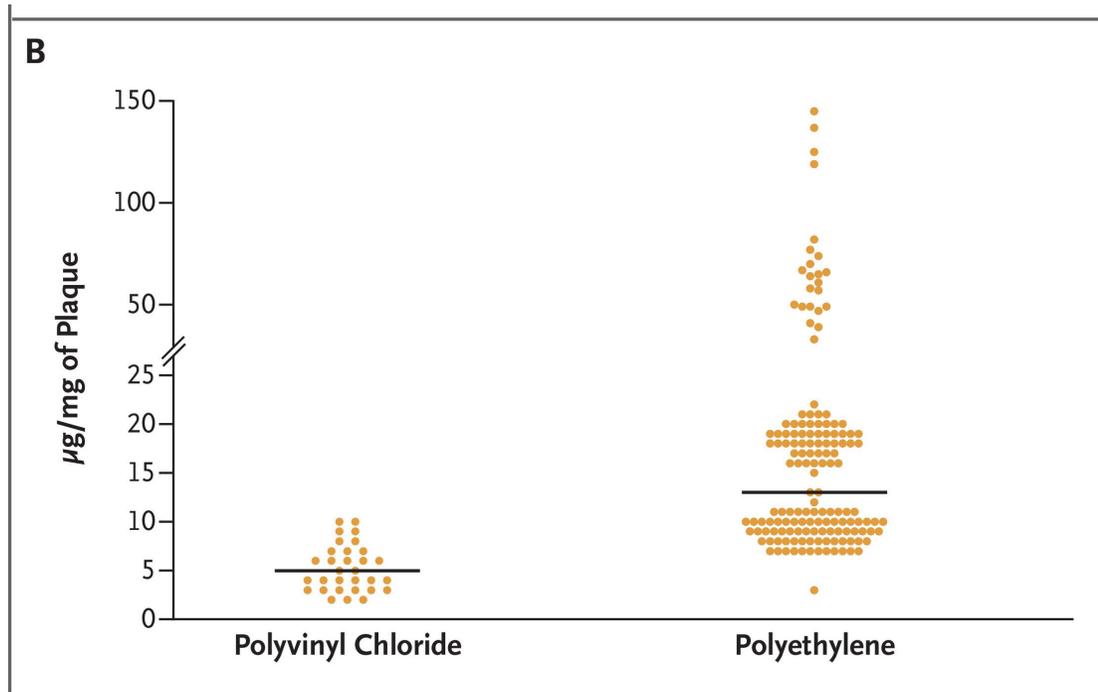
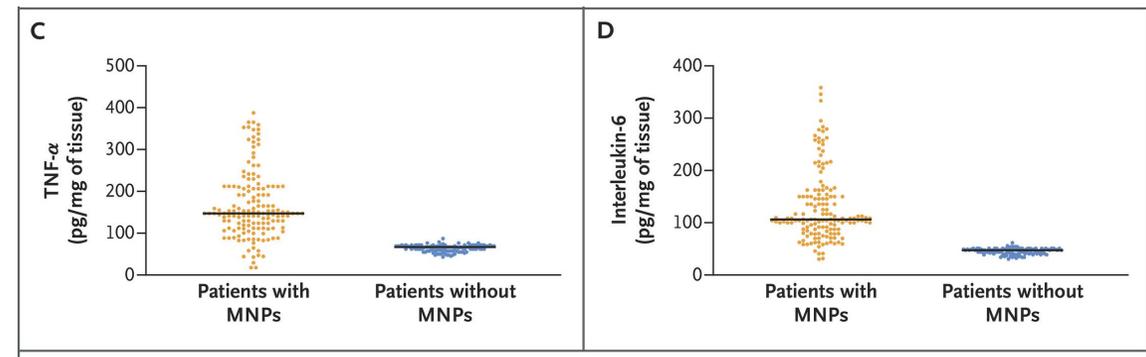


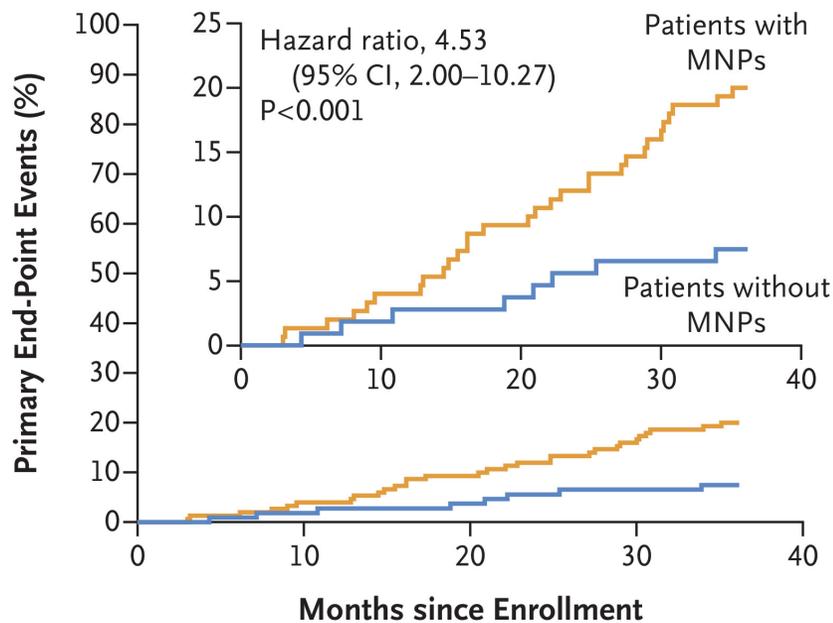
Table 1. Characteristics of the Patients at Baseline.*

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)



Microplastics and Nanoplastics in Atheromas and Cardiovascular Events

Authors: Raffaele Marfella, M.D., Ph.D. , Francesco Prattichizzo, Ph.D., Celestino Sardu, M.D., Ph.D., Gianluca Fulgenzi, Ph.D., Laura Graciotti, Ph.D., Tatiana Spadoni, Ph.D., Nunzia D'Onofrio, Ph.D.,  **+35**, and Giuseppe Paolisso, M.D. [Author Info & Affiliations](#)



No. at Risk

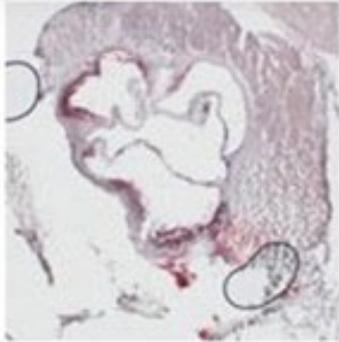
Patients with MNPs	150	144	136	126	120
Patients without MNPs	107	105	103	99	99

- Concerns expressed regarding:
- Methods used, especially the pyrolysis GC/MS method
- Associative nature of study
 - Does not assess causality

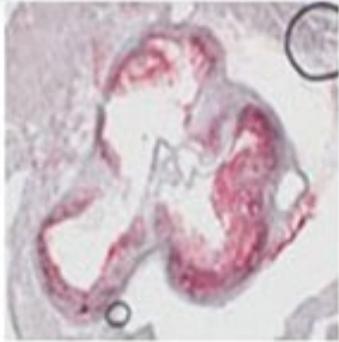
RESEARCH LETTERS

Oral Polystyrene Consumption Potentiates Atherosclerotic Lesion Formation in ApoE^{-/-} Mice

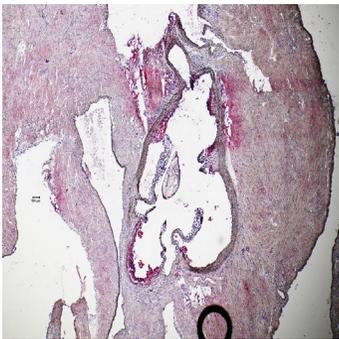
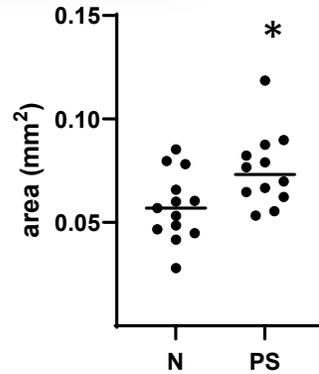
Jingjing Zhao , Daniel Gomes , Fangping Yuan, Jing Feng , Xiang Zhang , and Timothy E. O'Toole 



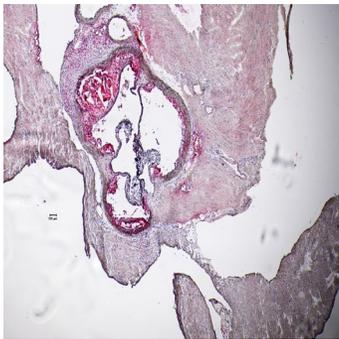
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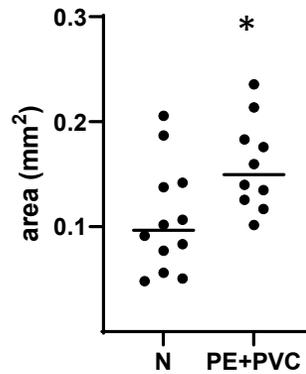
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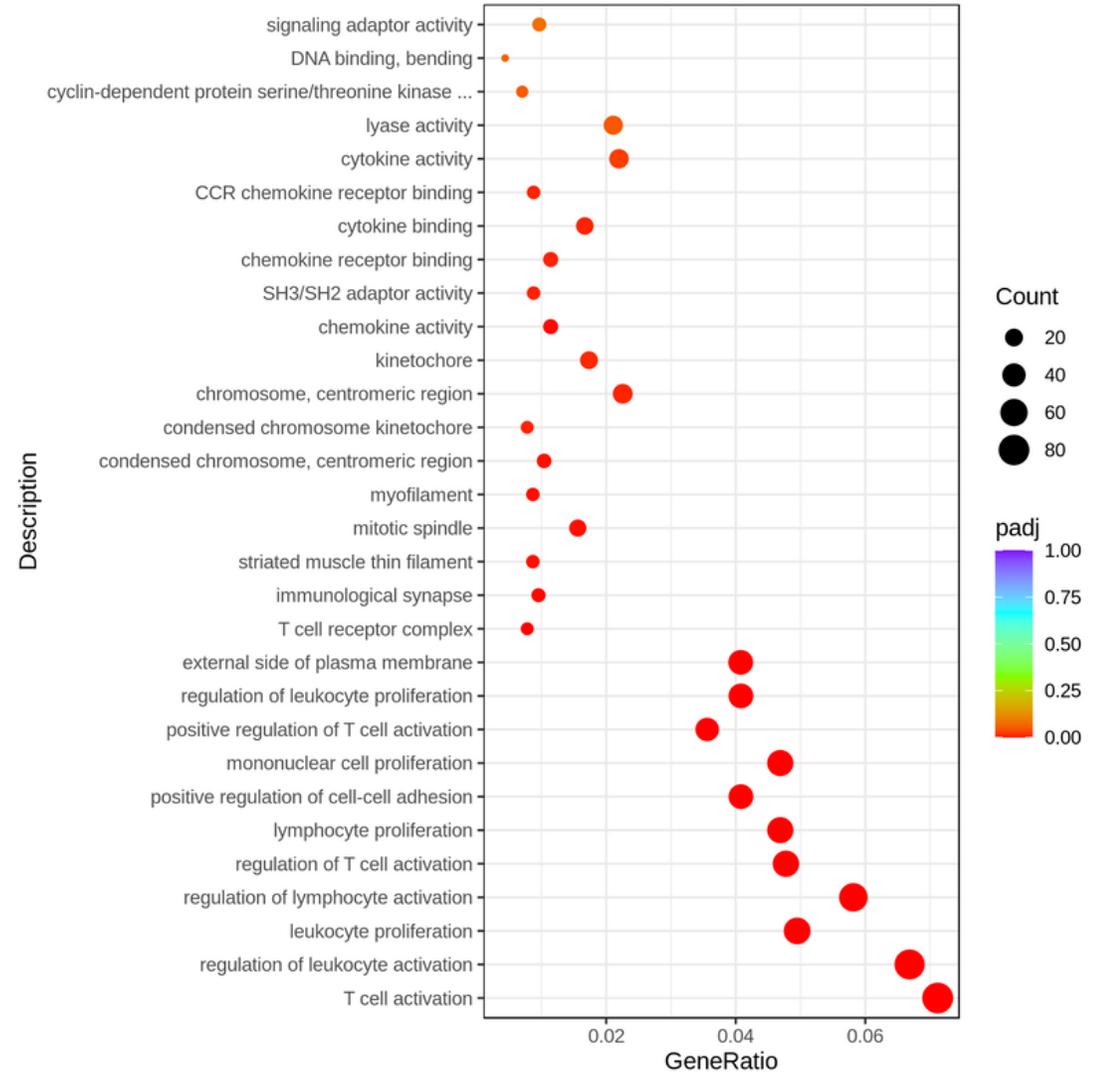
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PE+PVC

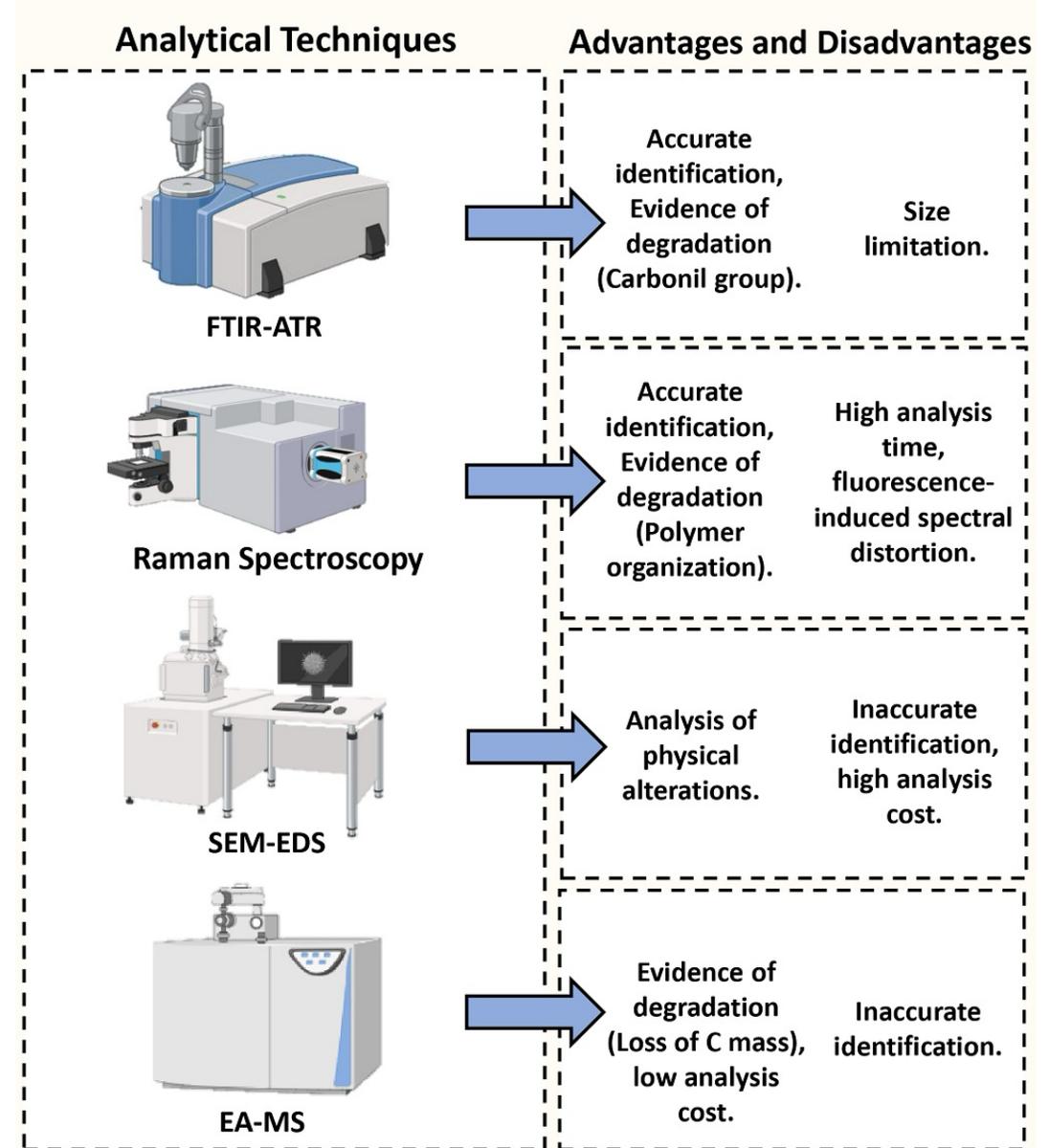


- ApoE^{-/-} (apolipoprotein E-deficient) mice (male, 8 wks)
- Treated with 0.5- μ m polystyrene or PE+PVC beads at a dose of 1 μ g/mL

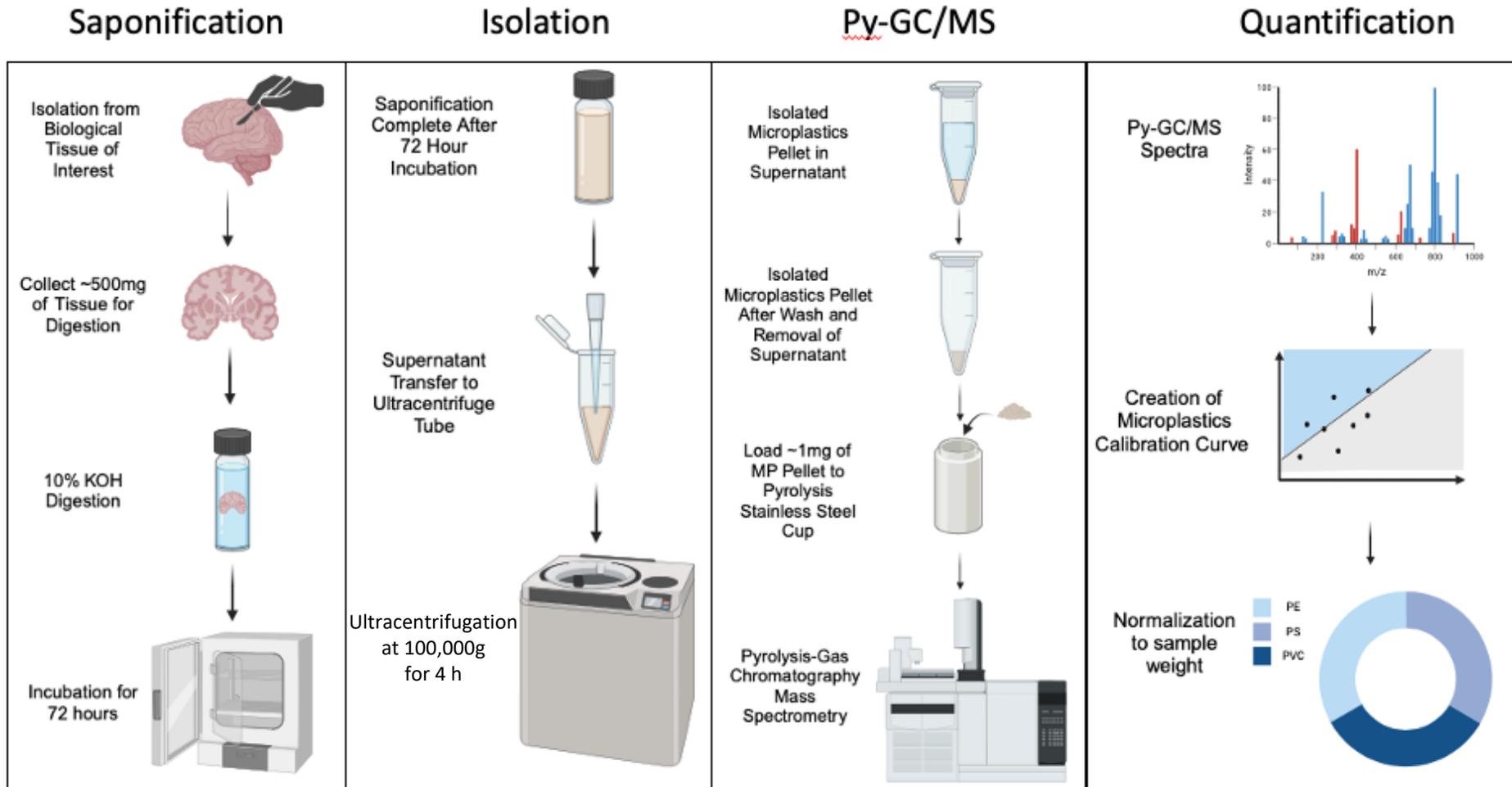


Why the Pyrolysis-GC/MS method?

- Plastics and humans are both carbon, mainly
- Visualization/microscopy methods have been used predominantly for 20 years for ecological assessments
 - Biased and time consuming
 - Visual spectroscopy (Raman or FTIR) provides a spectroscopic fingerprint, **but is limited to larger particles (>5µm)**
 - Difficult to resolve in tissues (biological material like carbohydrates, lipids interfere)
 - Mass concentration may be better for health outcomes research



The Novel Approach: Pyrolysis GC/MS to cumulatively quantify nano- and micro plastics in tissues



Saponification/digestion...
Leaves plastics intact

Spinning pulls solids to the bottom, biological material is removable

Specific polymers emit unique molecules when pyrolyzed

Combusted polymers have signature mass spectra



Bioaccumulation of microplastics in decedent human brains

Received: 29 April 2024

Accepted: 9 December 2024

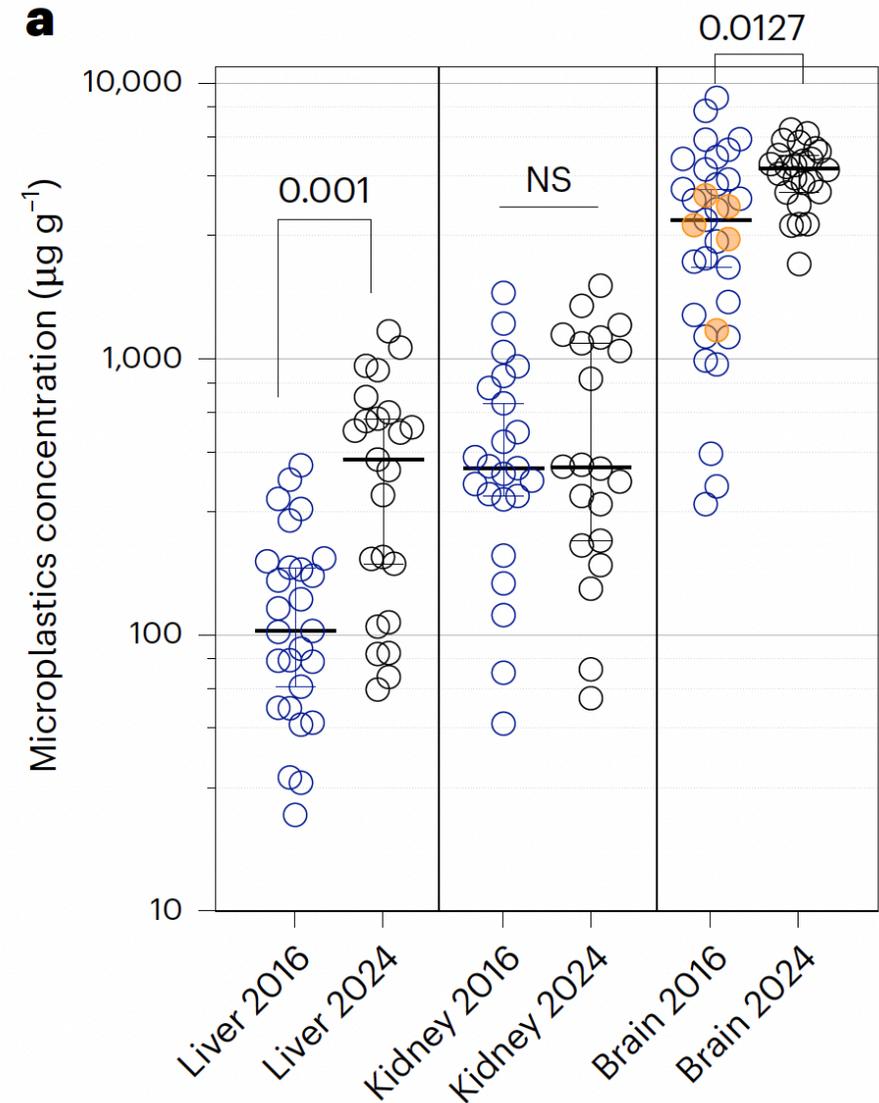
Published online: 03 February 2025

Check for updates

Alexander J. Nihart^{1,12}, Marcus A. Garcia^{1,12}, Eliane El Hayek^{1,12}, Rui Liu¹, Marian Olewine¹, Josiah D. Kingston¹, Eliseo F. Castillo², Rama R. Gullapalli³, Tamara Howard⁴, Barry Bleske⁵, Justin Scott⁶, Jorge Gonzalez-Estrella⁶, Jessica M. Gross⁷, Michael Spilde⁸, Natalie L. Adolphi⁹, Daniel F. Gallego⁹, Heather S. Jarrell⁹, Gabrielle Dvorscak⁹, Maria E. Zuluaga-Ruiz¹⁰, Andrew B. West¹¹ & Matthew J. Campen¹✉

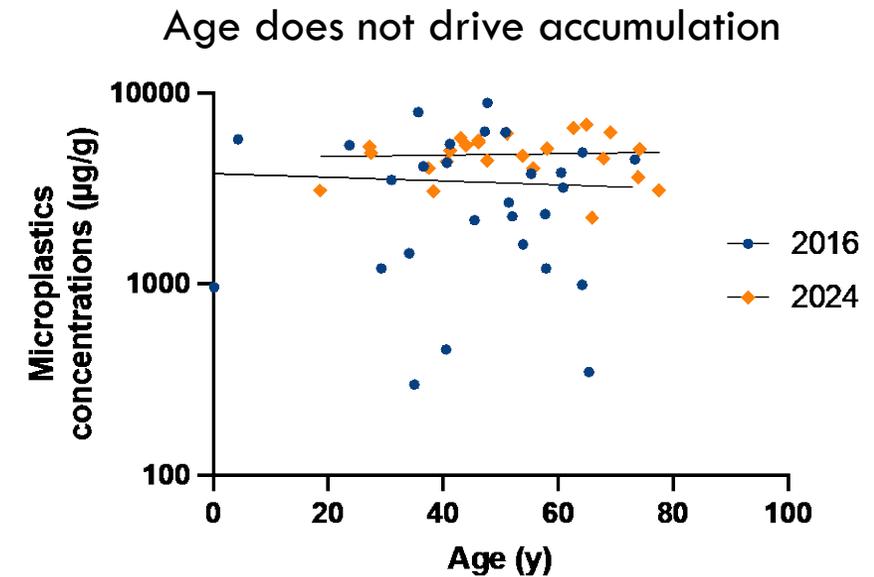
Py-GC/MS: Broader systemic distribution

- Samples from decedents (deceased humans from the Office of the Medical Investigator)
 - Liver, Kidney, Brain (Frontal cortex)
- Samples collected in 2016 and 2024 for comparison across an 8-year gap
- Initial data confirm significant presence of plastics in all organs measured
- **Orange:** independently run in a separate lab (OSU)



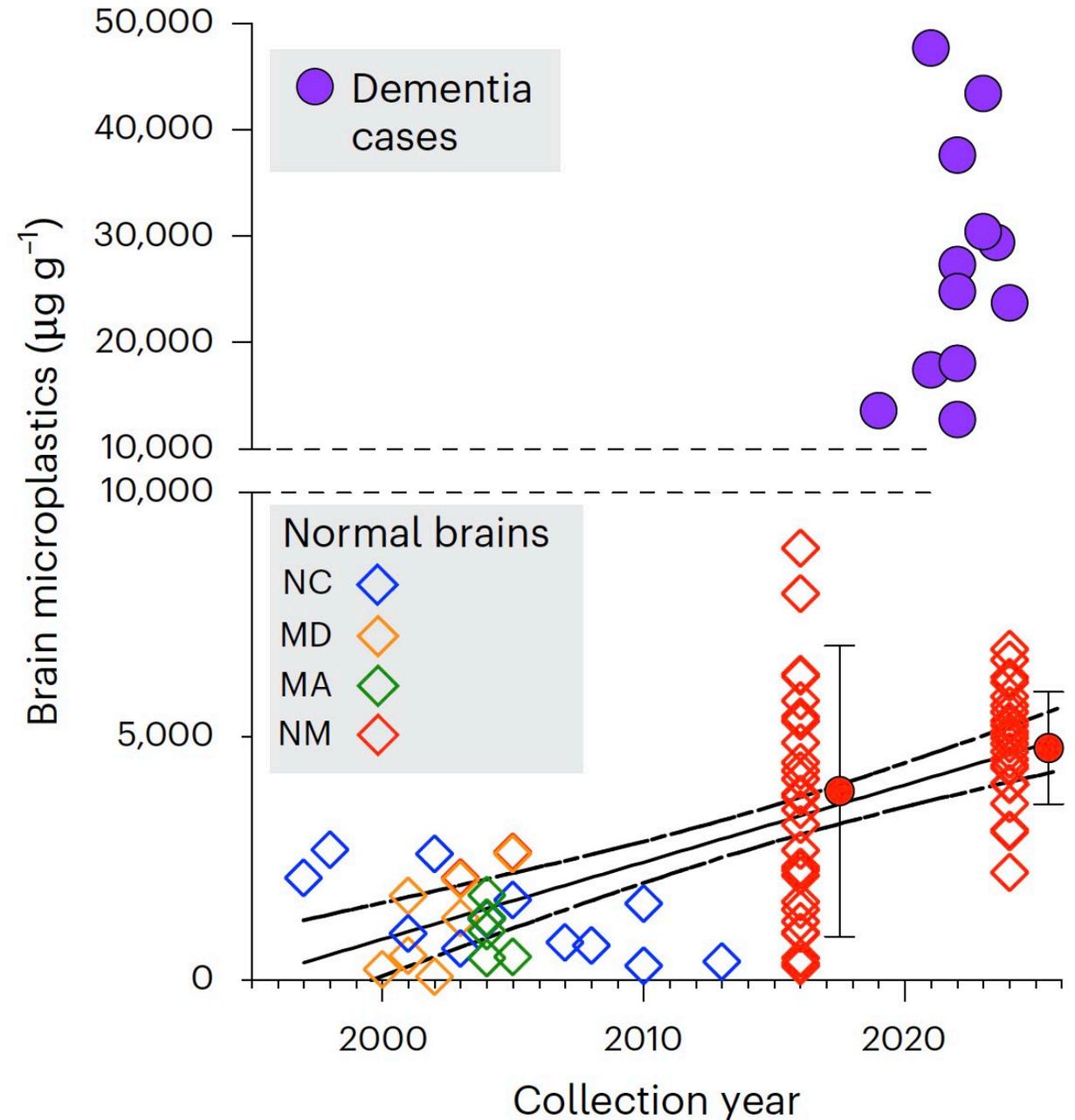
Brain specimen demographics

	2016 NM OMI	2024 NM OMI
N	28	24
Age (mean, SD)	45.0, 17.3	51.4, 16.0
Sex (Female/Male/ Undetermined)	10/17/1	10/14/0
Race (White/Native American/African American)	25/2/1	18/5/1
Ethnicity (Hispanic/ Non-Hispanic)	11/17	7/16
Collection dates	January-December, 2016	October 2023-January 2024
Cause of Death		
Violence/trauma	9	9
Substance Use	12	2
Natural Disease	7	13



Microplastics presence appears greater in dementia cases

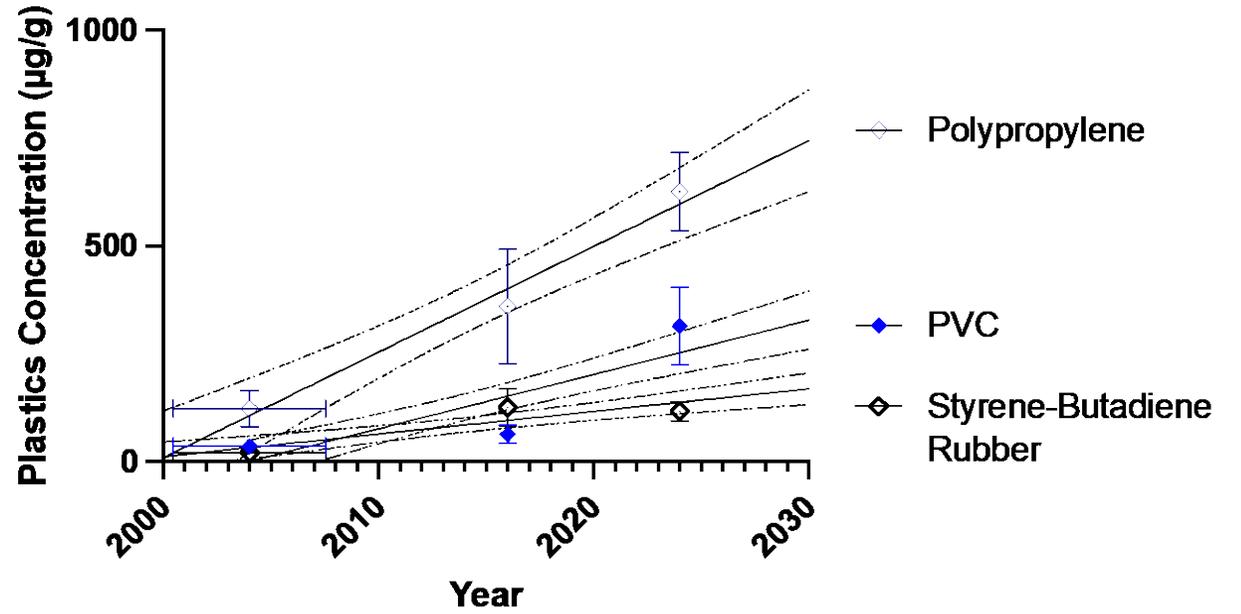
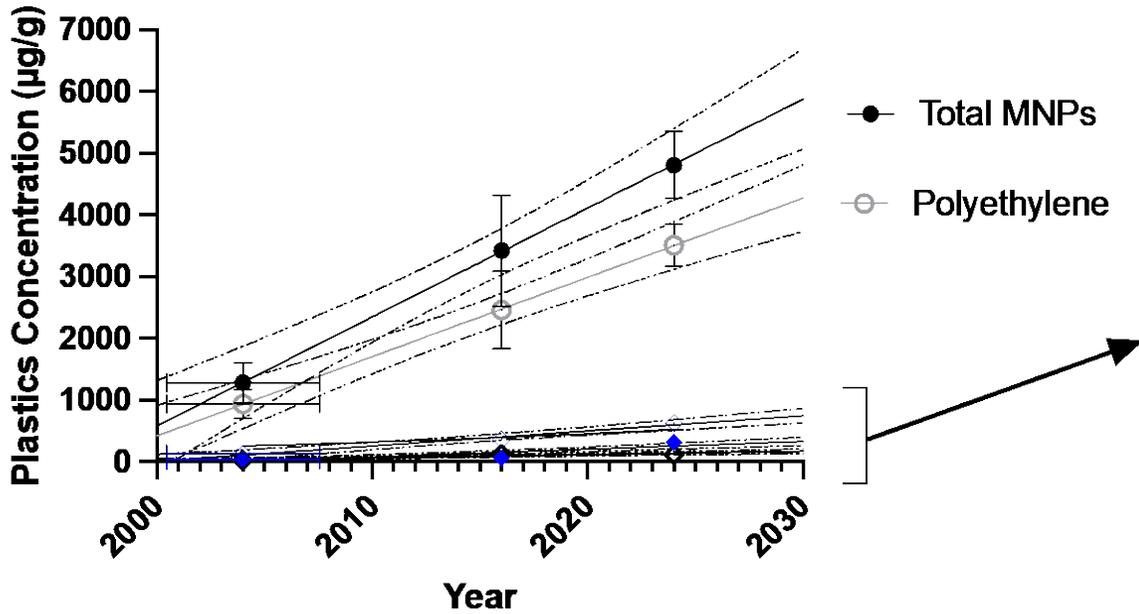
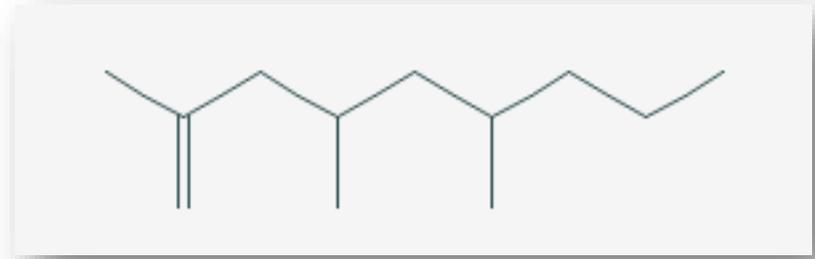
- Including 12 dementia cases (3 vascular, 6 AD, 3 other)
- Added samples from earlier time points donated from the east coast (courtesy Andrew West, PhD, Duke)
- **Increased concentrations may relate to impaired BBB or clearance, rather than being causal**



Uncertainty issues with Py-GC/MS?

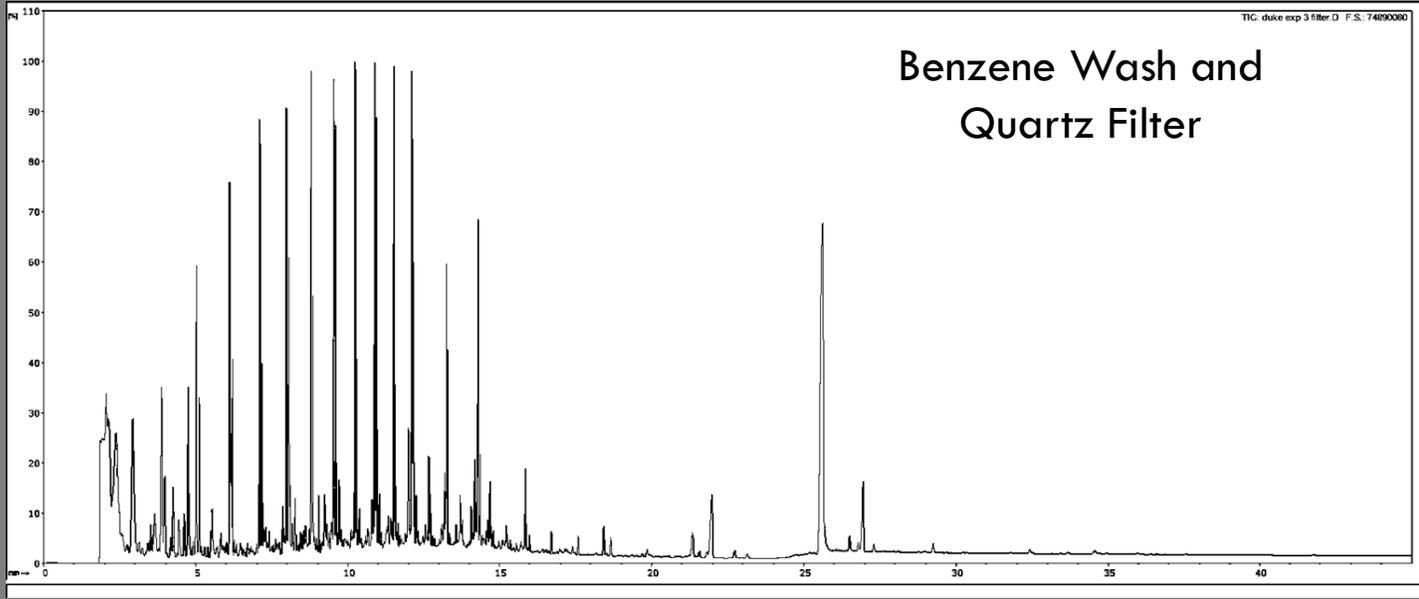
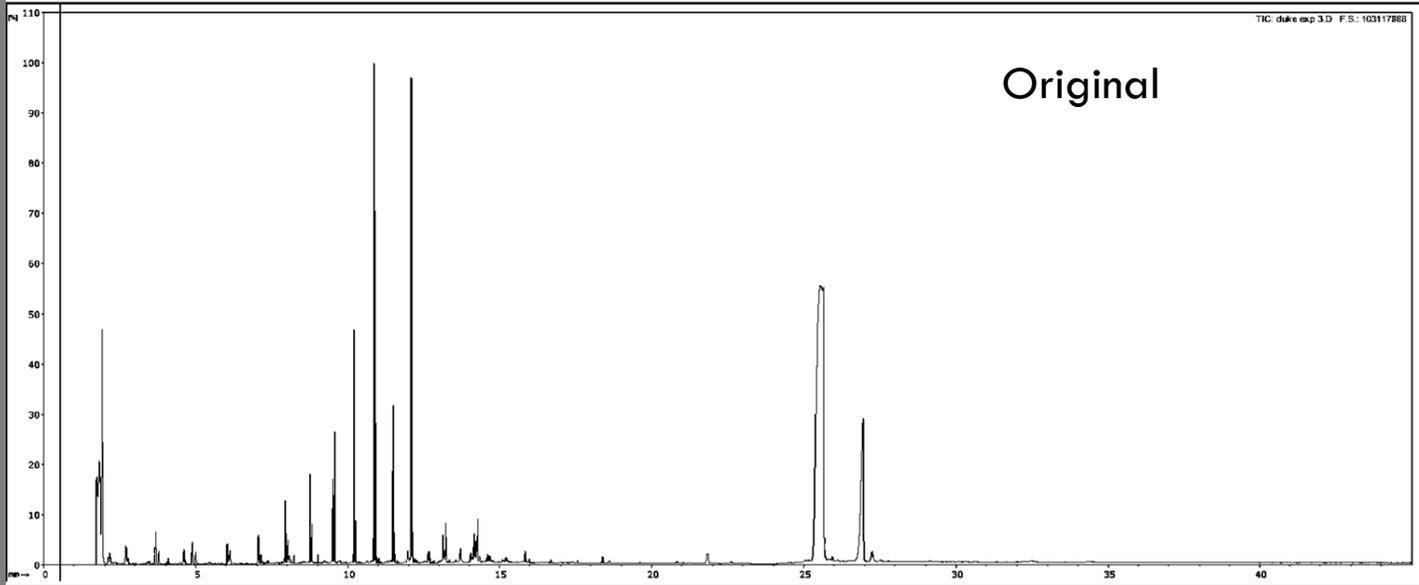
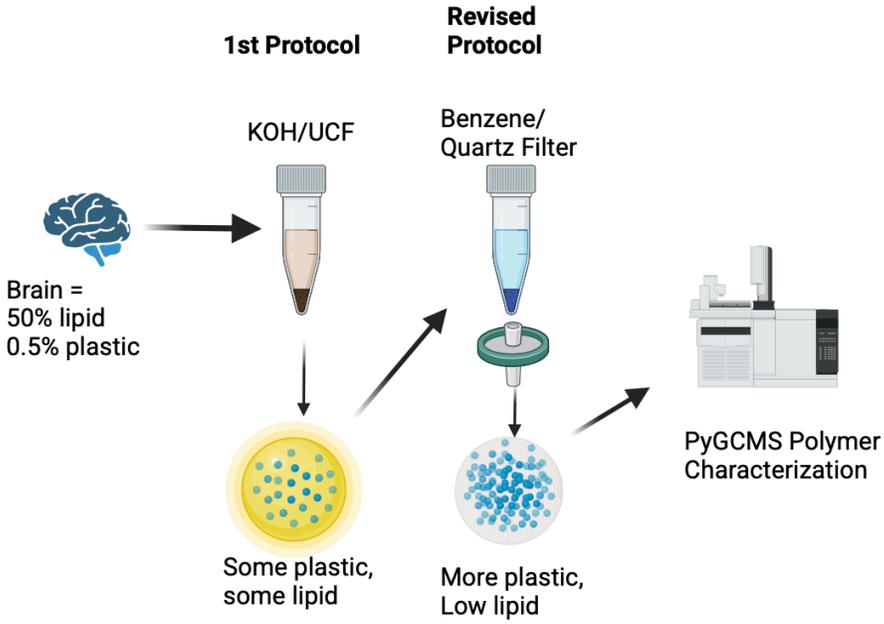
Consistent increasing trends in normal brains for all major polymers

Polypropylene pyrolyzate (2,4,6-Trimethyl-1-nonene)
not known to have interference from biomatrix

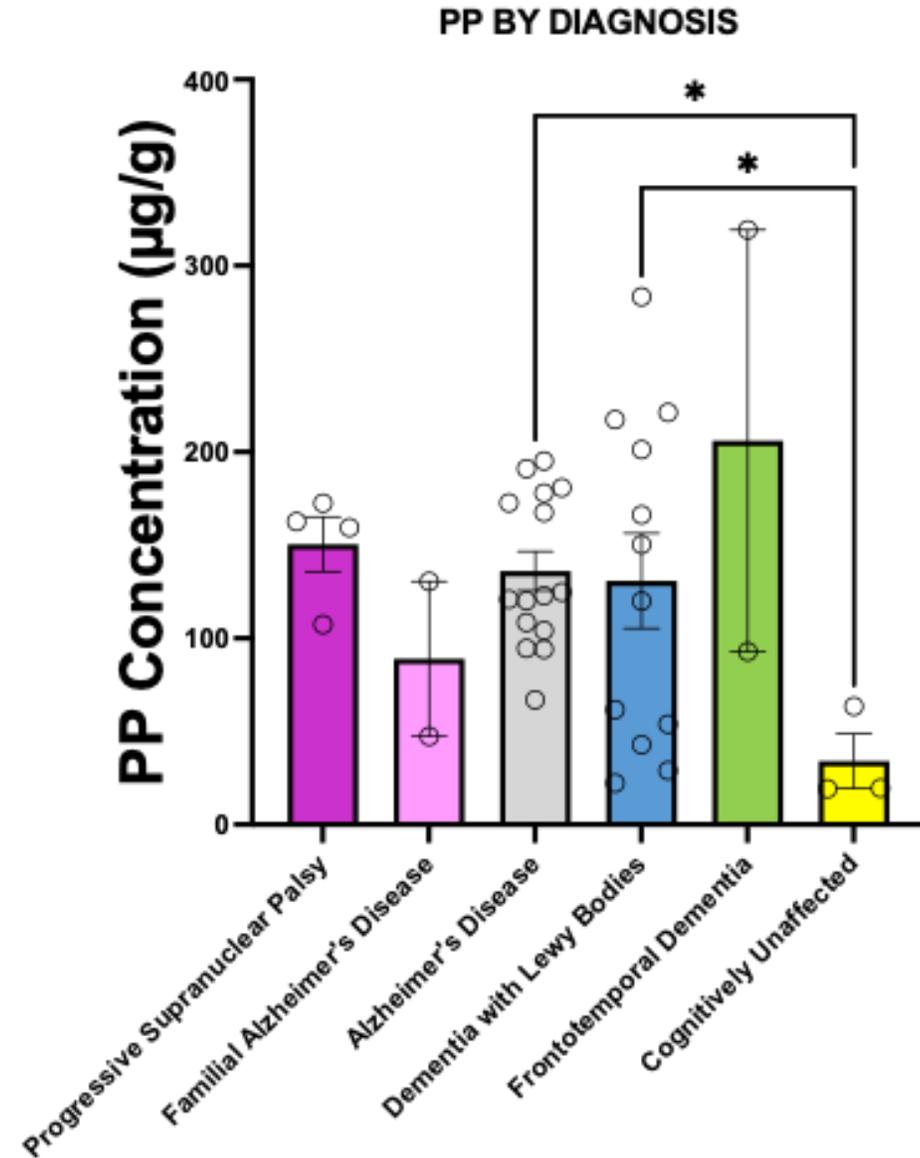
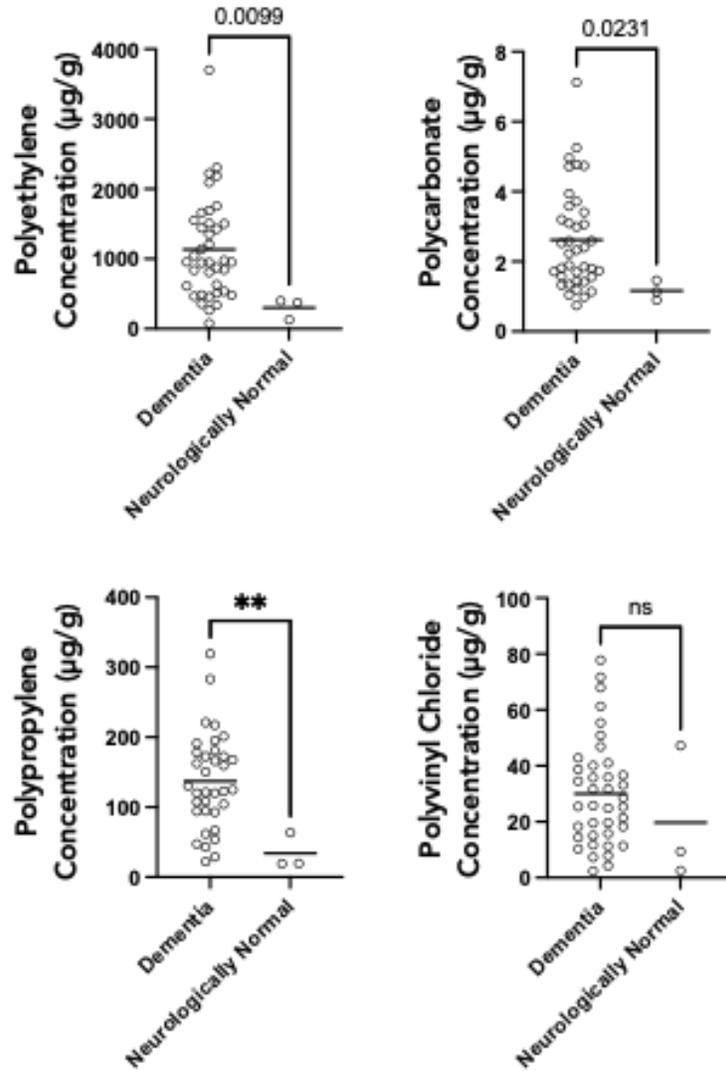


R^2 ranges from 0.25 to 0.48; all $p < 0.0001$

Improving the accuracy of Quantitation: 2nd Gen Isolation w/Organic Solvent



More aggressive digestion on a new cohort of **ADRD** samples reveals lower concentrations but consistent trends

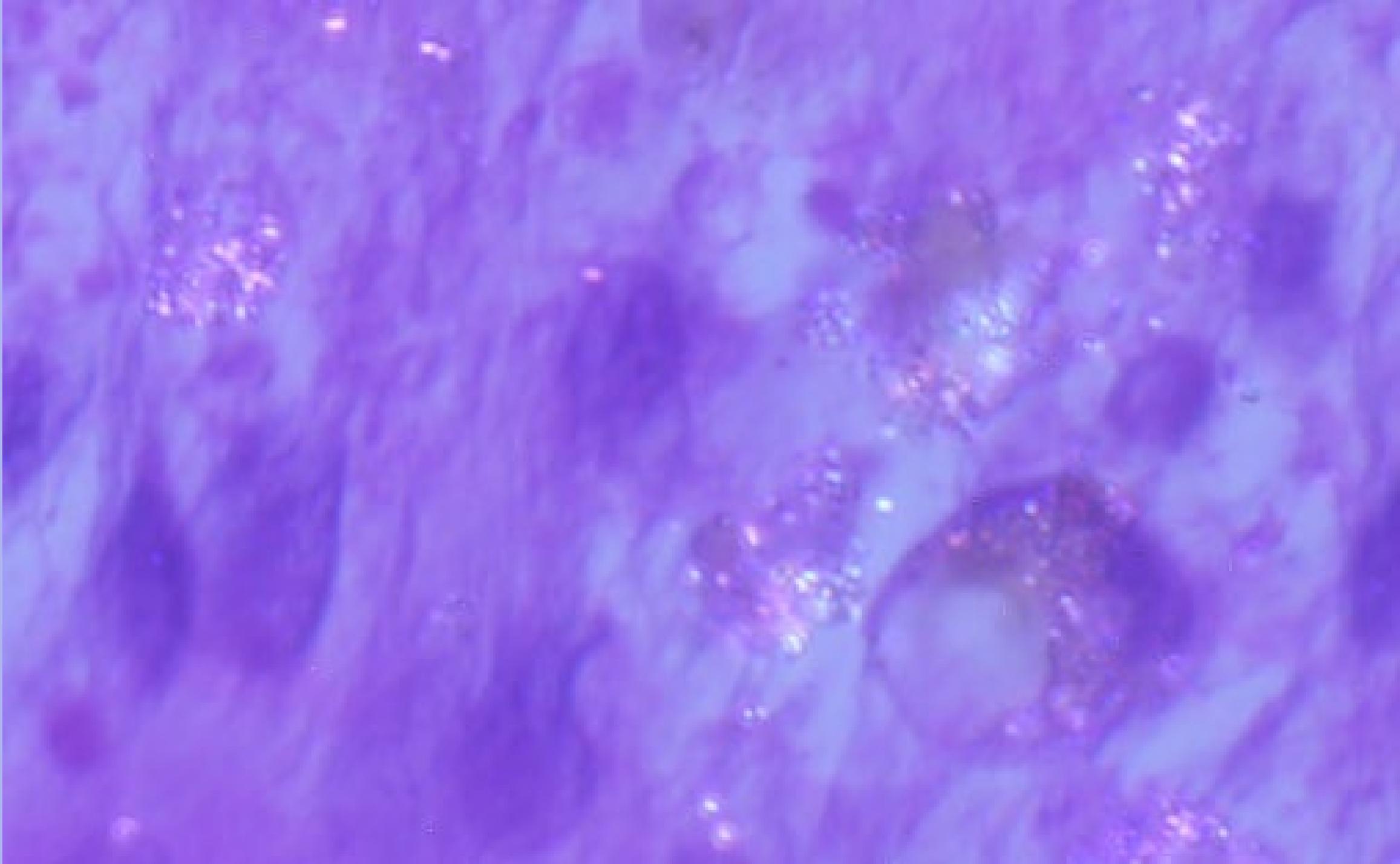


Mapping plastics in the human brain: Frontal Cortex has highest content

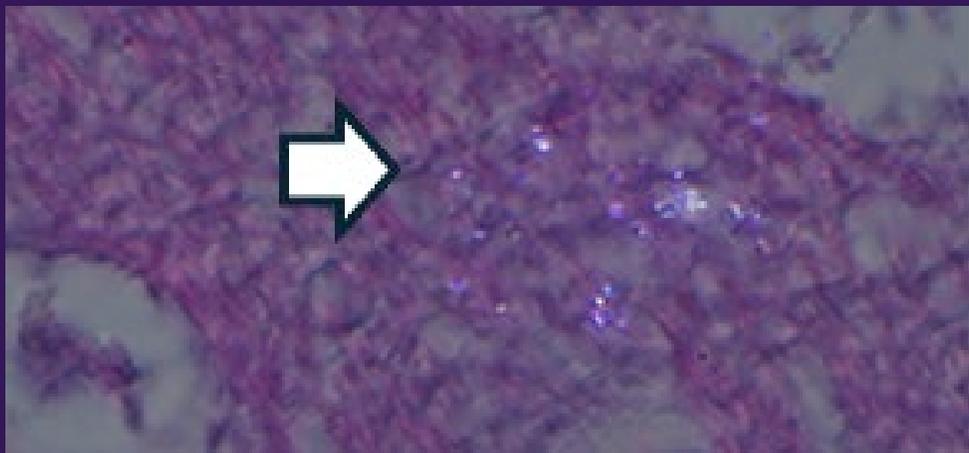
Laurissa
Barela



Polarization Wave Imaging

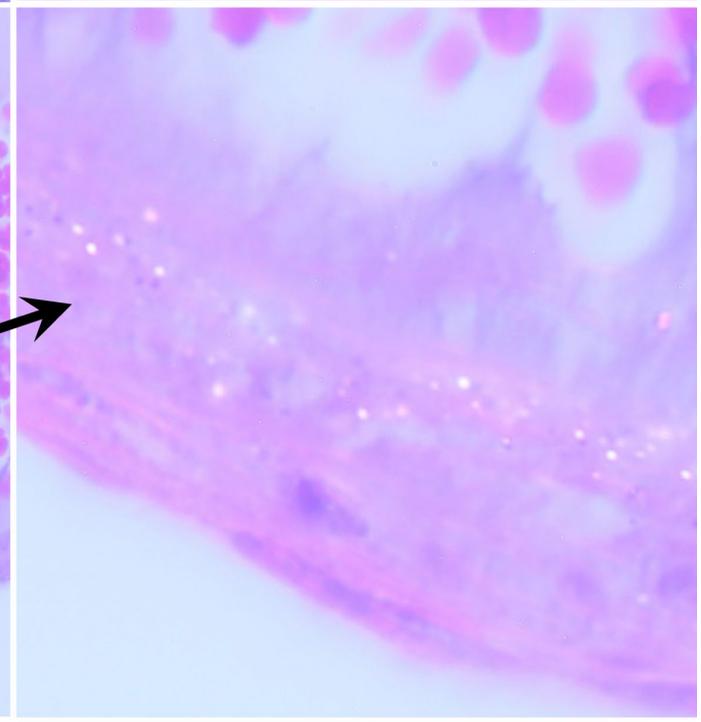
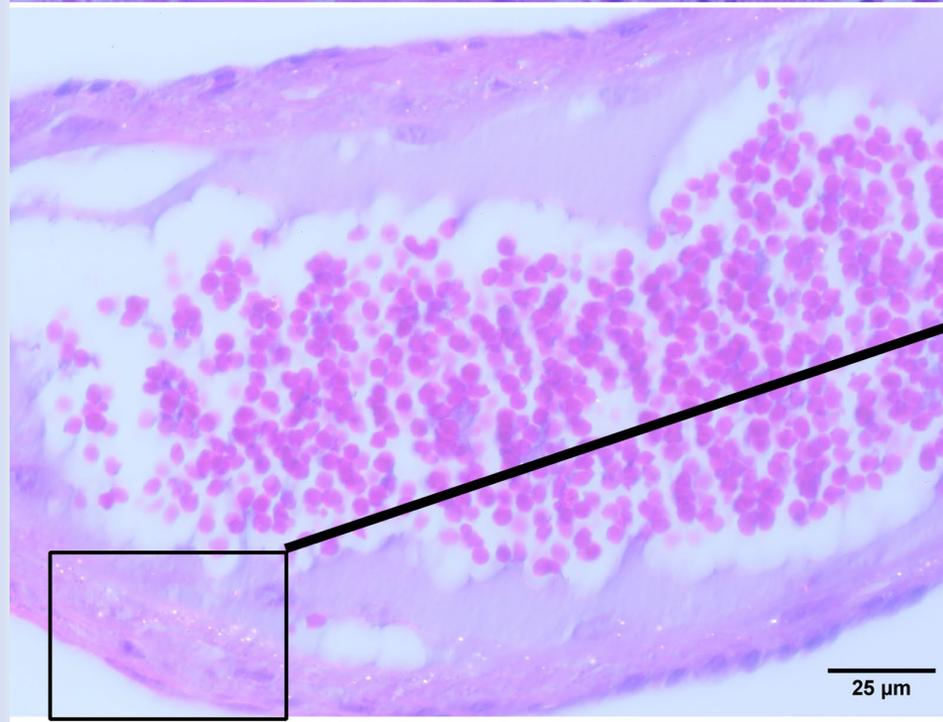
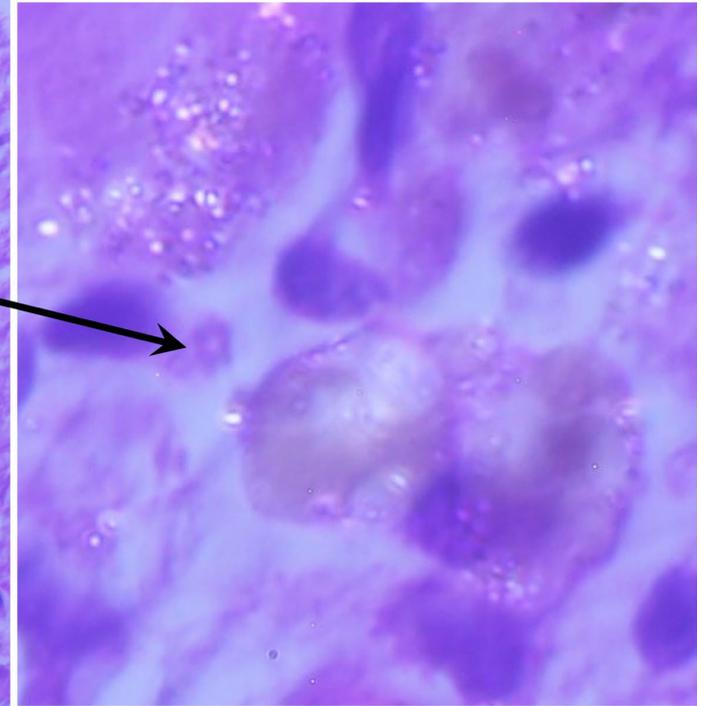
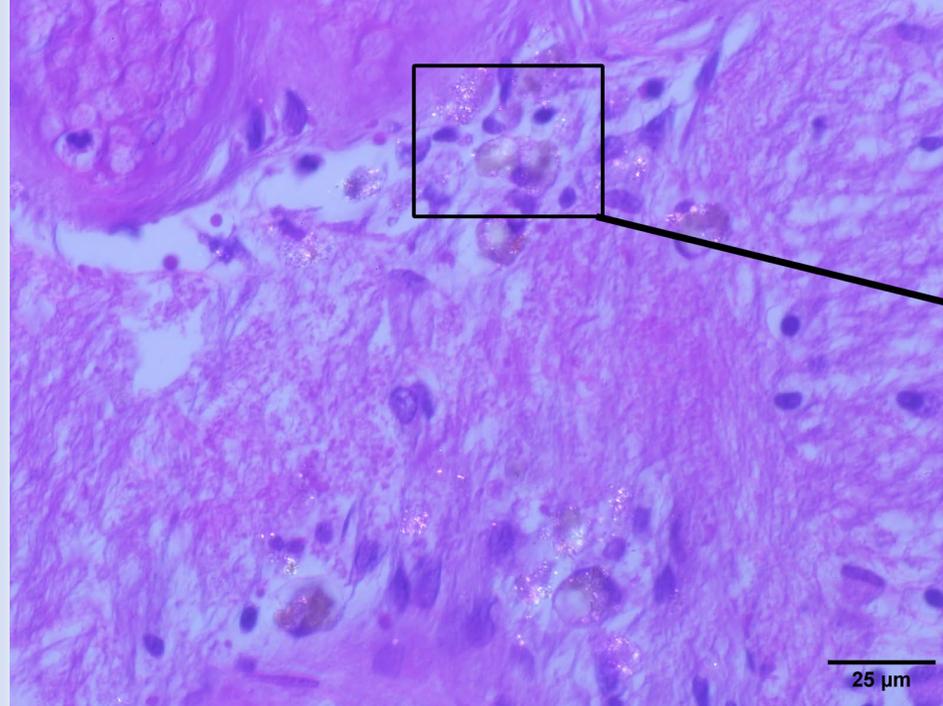


Brain

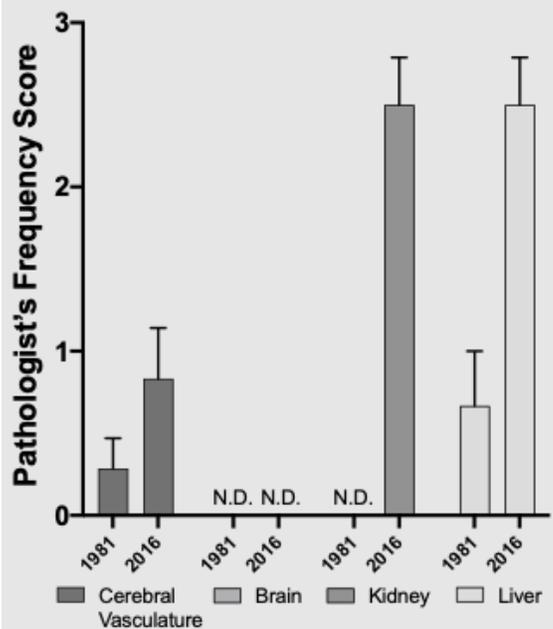


Plastics in dementia cases localized with vascular wall and immune cells in brain

Polarization wave microscopy on dementia cases from UNM OMI



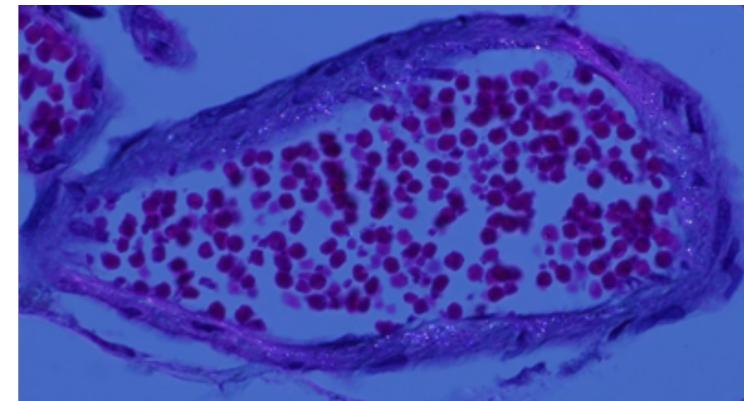
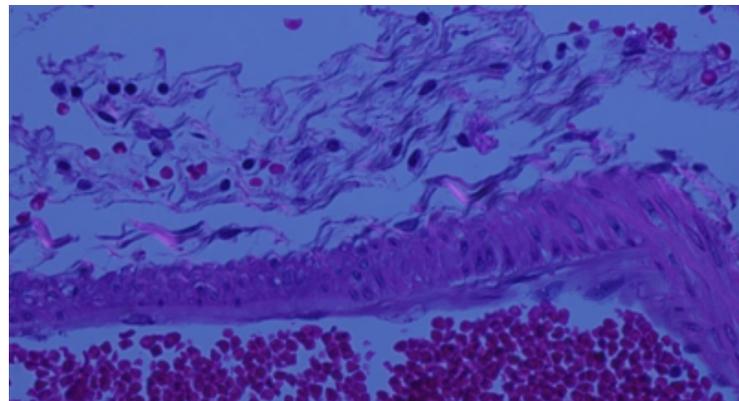
Historical Human Samples



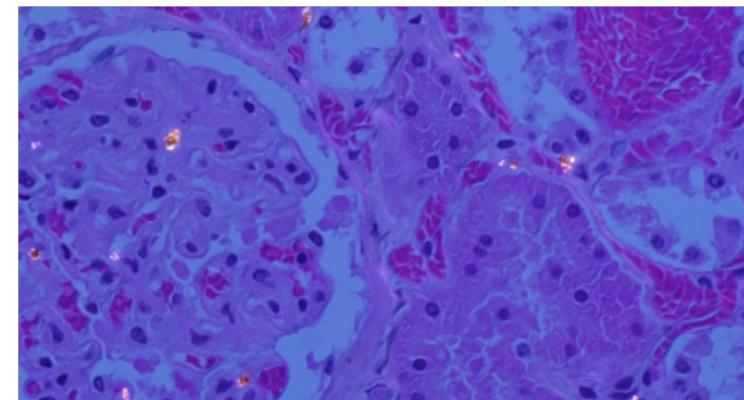
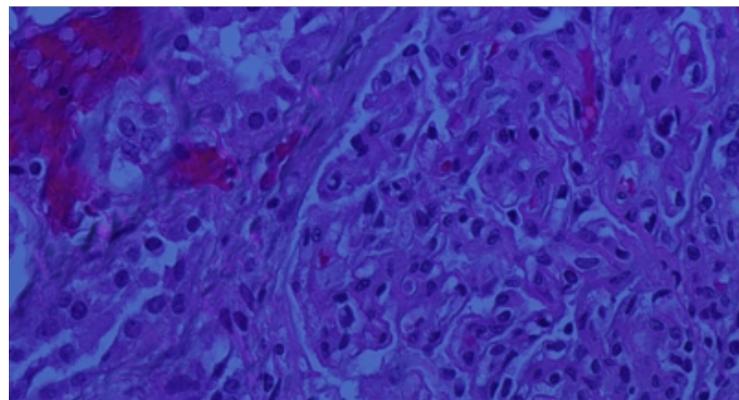
1981

2016-2023

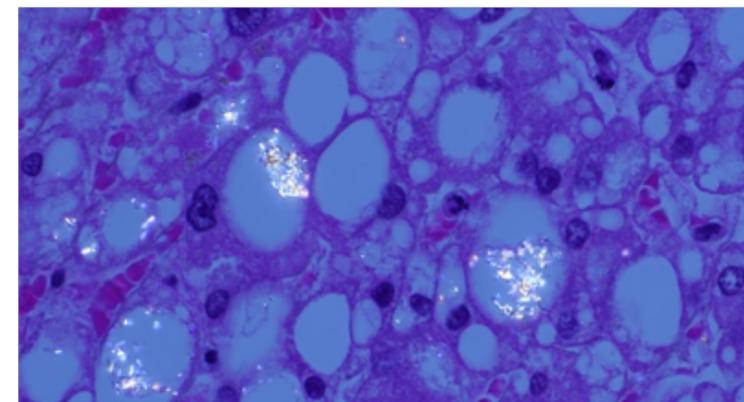
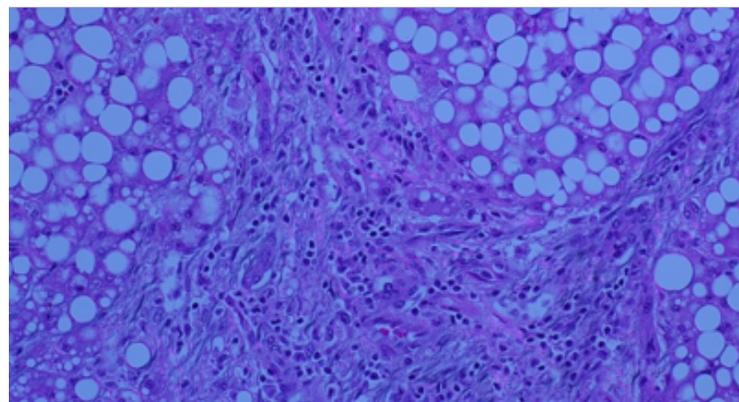
Brain



Kidney

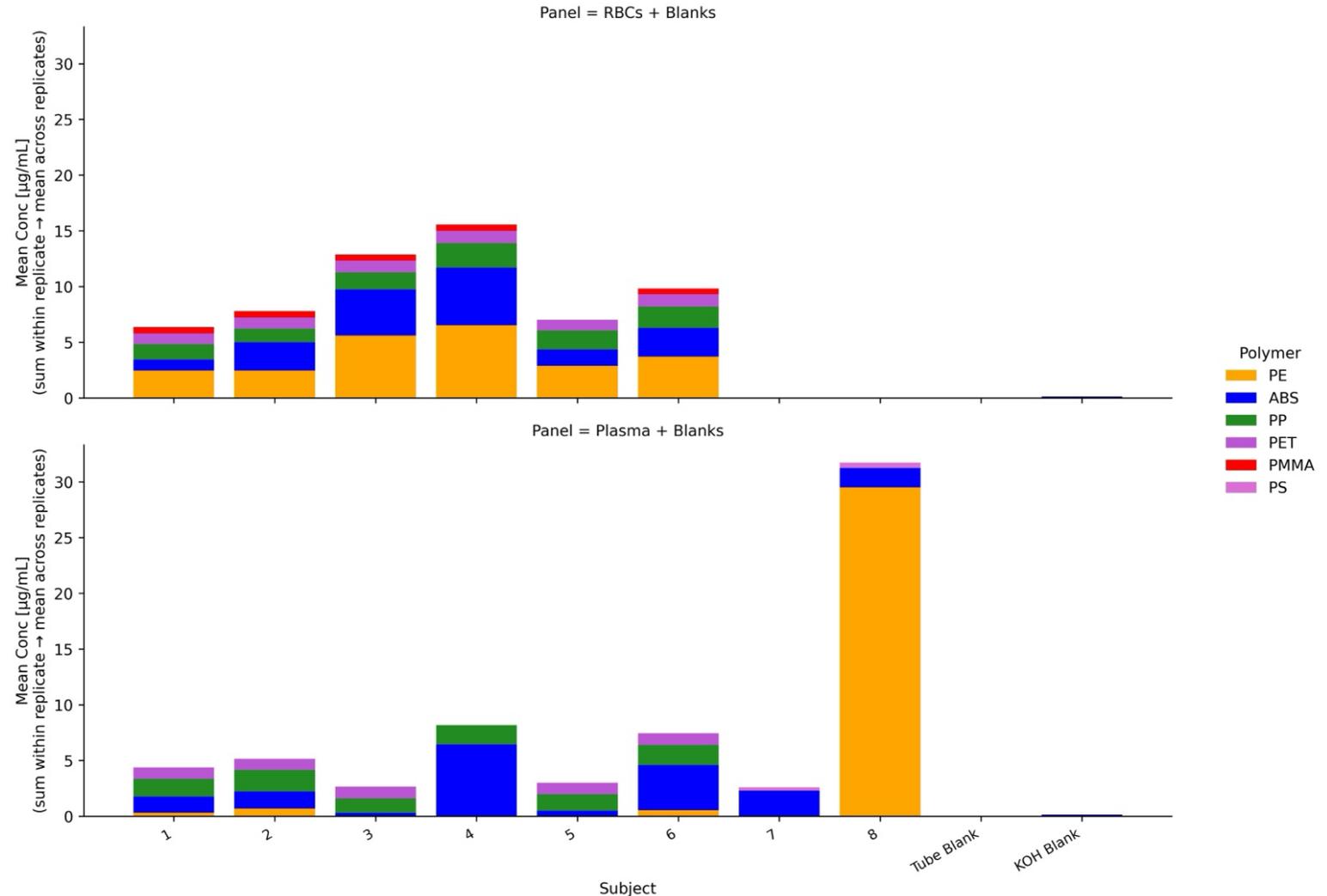


Liver



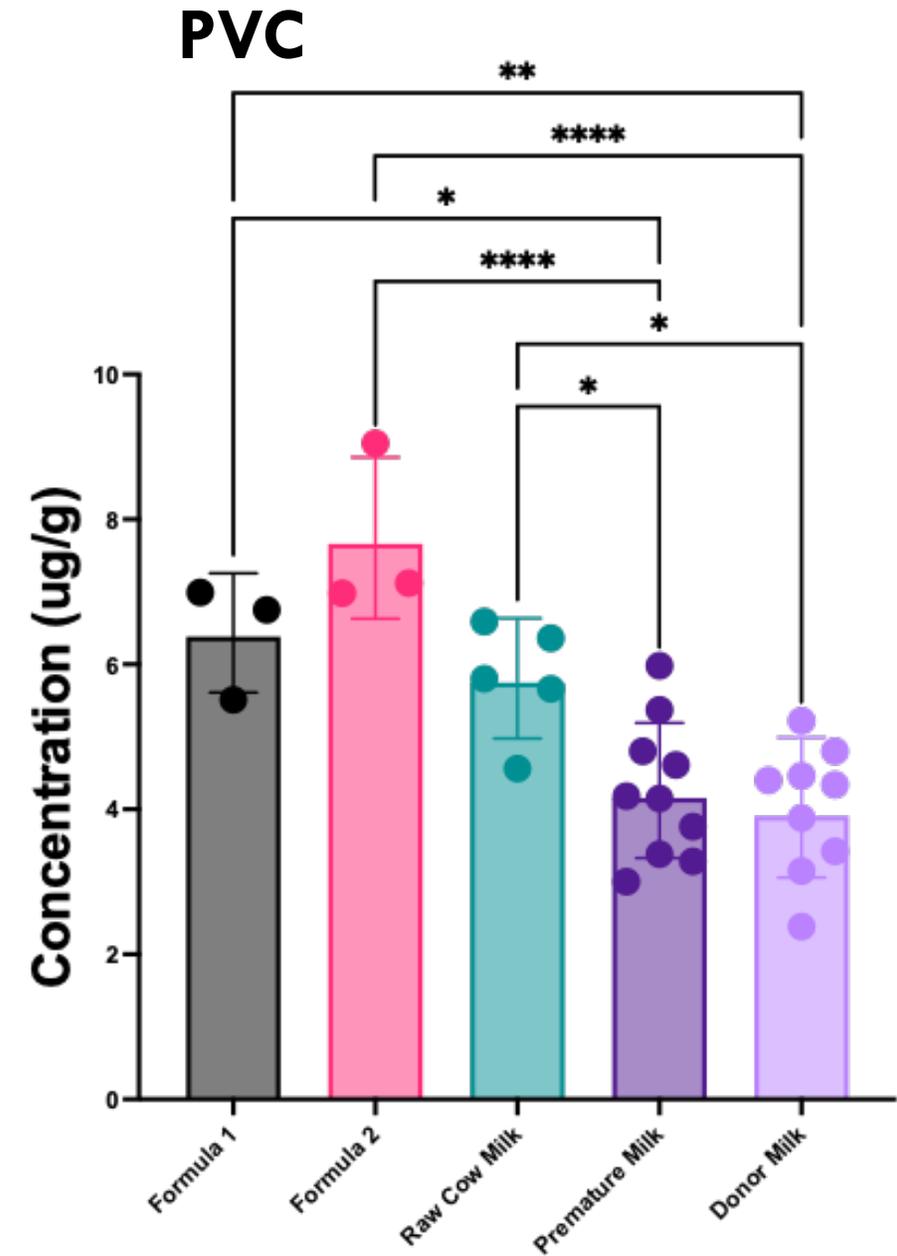
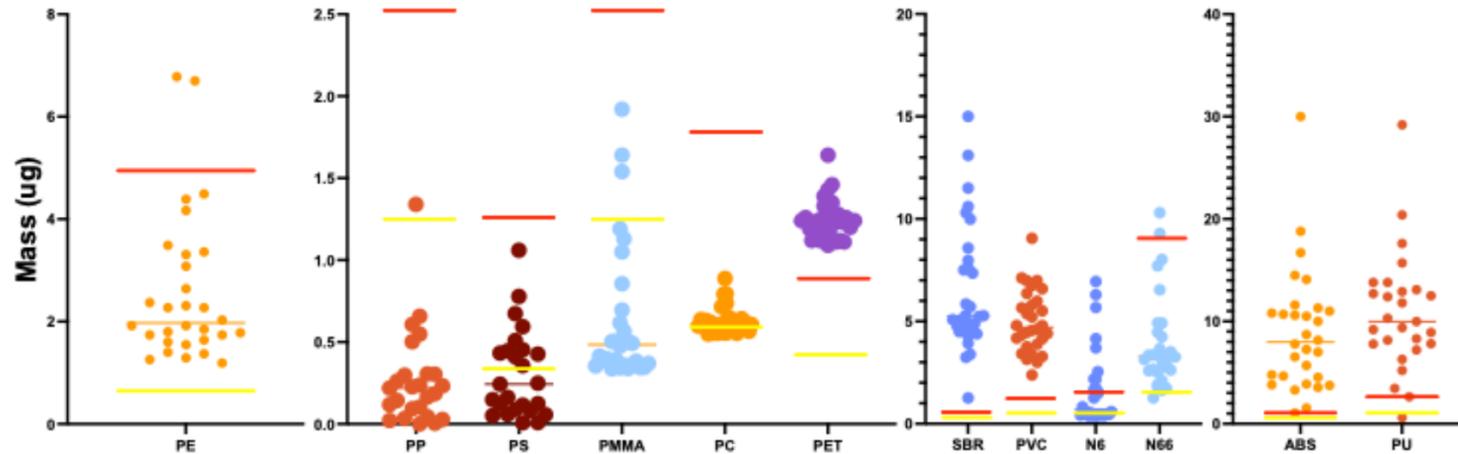
Measuring plastics in blood by PyGCMS

- Marja Lamoree (Netherlands) thinks it can be done
- Kevin Thomas (Brisbane) does not
- We think it can be done but the concentrations are too low for reliability
- Nanoflow cytometry may offer an opportunity



Measuring plastics in urine, breast milk, CSF

- Generally the same – matrix digestion must be optimized – but we are seeing promising results



Concluding thoughts: Are microplastics in the brain?

Human studies:

- Nihart et al., Nat Med 2025
 - Microplastics in the human [frontal cortex](#) with 4 methods (PyGCMS, FTIR, SEM/EDS, PWM)
- Amato-Lourenço et al., JAMA Network Open 2024
 - Used μ FTIR to show microplastics in the [olfactory bulb](#) of humans
- He et al., J Hazard Materials 2025
 - Showed microplastics in human [CSF](#) by Py-GC/MS
- Xie et al., J Hazard Materials 2024
 - Showed microplastics in human [CSF](#) by Py-GC/MS

Preclinical studies:

- Garcia et al., EHP 2024
 - Polystyrene and other polymer microspheres get to the brain
- Shan et al J Hazard Materials 2025
 - Polystyrene nanoplastics get to the brain
- **Dozens** of controlled exposure studies highlighting pathological and behavioral impacts of micro- and nanoplastics...

Plus...Unpublished studies at the Microplastics Exposure and Human Health Conference (Jan 11-14) made it abundantly clear that nano plastics get to the brain



Can we measure MNP accurately?

- PyGCMS may never get us where we need to go for clinical studies
 - Matrix digestion must be validated for different specimen types
 - Setting things on fire is difficult to control
 - Low-to-medium throughput
 - Batch variability
- We still “need” to see things – there is a fundamental concern for false positives that we need to visually ID particles in many situations
- Nano-scale flow cytometry or SRS (Wei Bin, Columbia) may be more rational approaches for serum/urine/etc



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Key Contributors: The real heroes of this story