Santa Fe, New Mexico, U.S.A. January 11 -14, 2026

Microplastics

EXPOSURE AND HUMAN HEALTH

FOSTERING COMMUNITY TO EXPLORE MICRO- AND NANOPLASTIC-INDUCED HEALTH EFFECTS

In this issue:

Keynote Speakers
Highlighted Research Seminars
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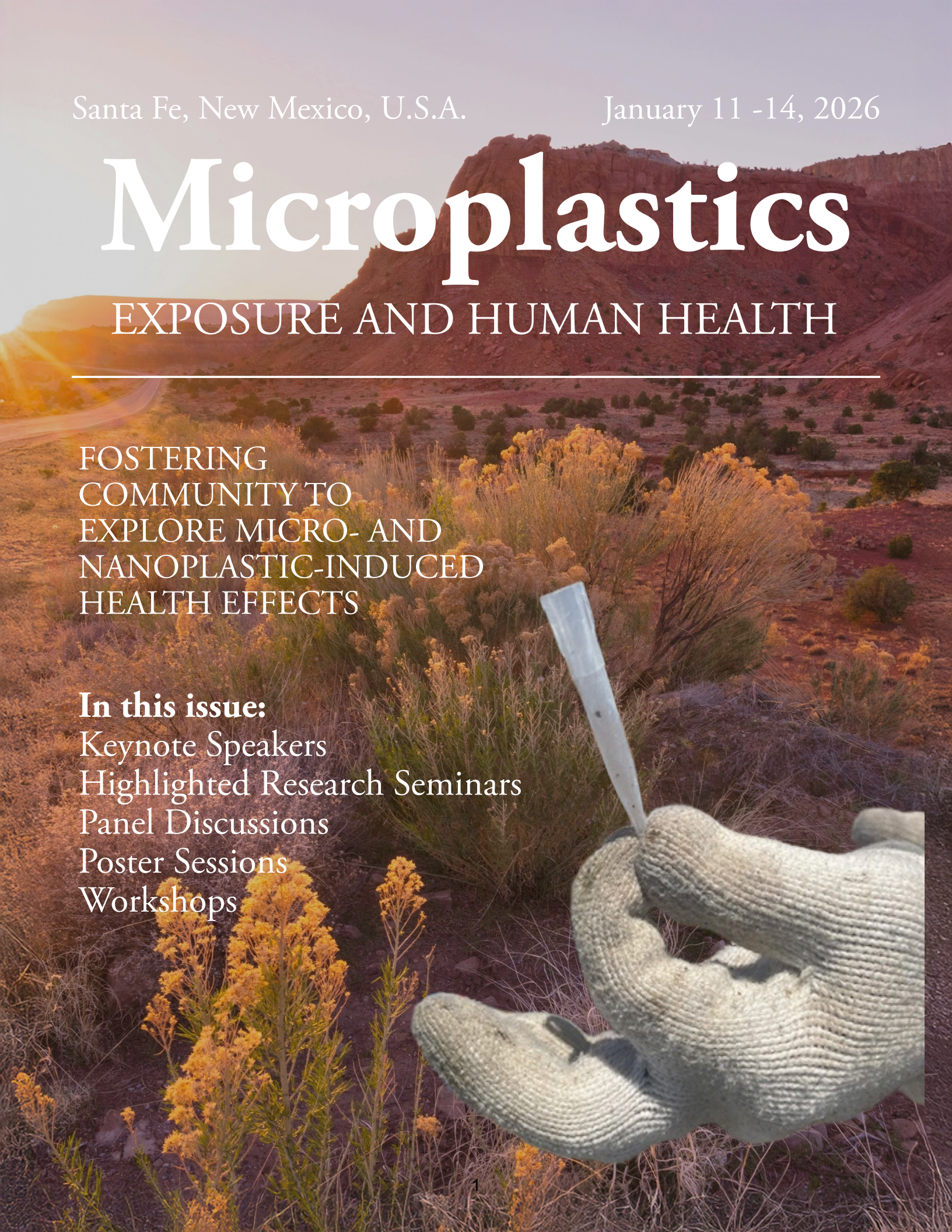
Poster Sessions
Workshops



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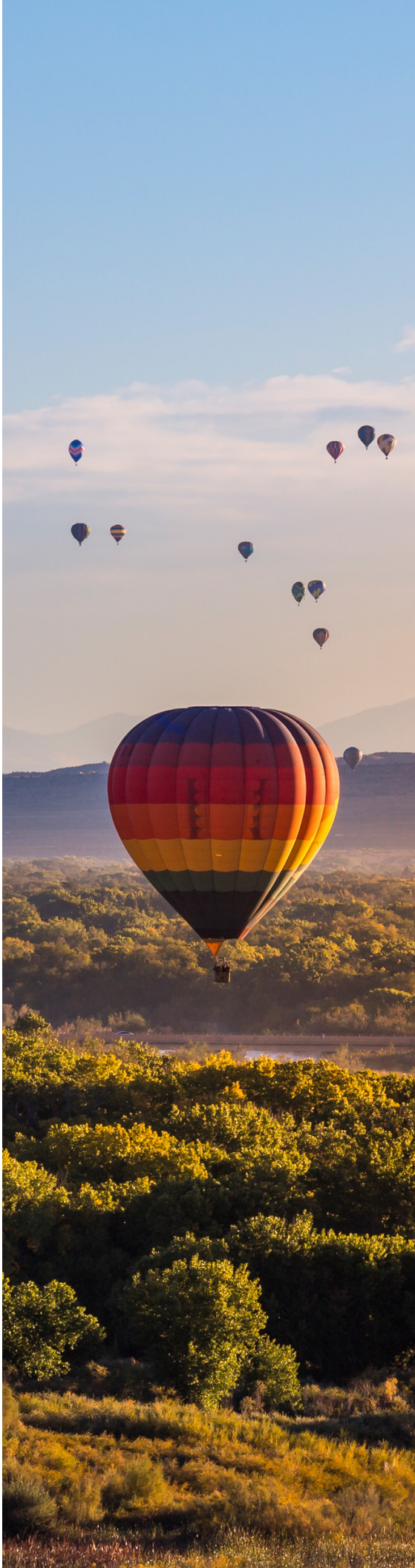


Welcome!

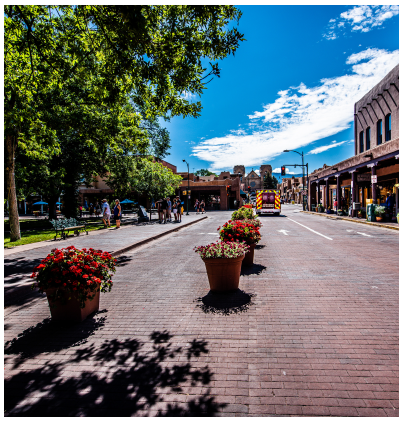
What is this conference about?

Microplastics and nanoplastics (MPs & NPs) are a growing environmental and human health concern. These tiny plastic fragments are ubiquitous, contaminating our food, water, and air. While research is ongoing, the potential health risks of human exposure to MPs & NPs remain largely unknown. This interdisciplinary international symposium aims to convene leading scientists, policymakers, and stakeholders to address this critical issue. Our focus is on the characterization of microplastics and nanoplastics, methods of measurement, exposure pathways, mechanisms of MPs & NPs-induced toxicity, risk assessment, strategies for intervention and prevention, and the potential for translation from basic bench science to population studies, or public policy. Our objective is to foster coordination, exchange, and disseminate information and to explore MPs & NPs-induced health effects.

Why Santa Fe, NM?

Santa Fe is an inspiring meeting destination that blends rich culture, creative energy, and natural beauty. Its walkable historic downtown, renowned cuisine, and vibrant arts scene foster meaningful connection, while the high-desert setting offers a refreshing change of pace that encourages focus and fresh thinking.

We hope you enjoy your time here!



Meet the Committee

John Yu	University of New Mexico
Matthew Campen	University of New Mexico
José Cerrato	University of New Mexico
Leo Trasande	NYU School of Medicine
Phoebe Stapleton	Rutgers University
Aaron Erderly	Editor in Chief, Particle and Fibre Tox.
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Marcus Garcia	University of New Mexico
Beizhan Yan	Columbia University
Susane Brander	Oregon State University
Katrina Korfmacher	University of Rochester
Jillian Kotulski	University of New Mexico
Jessica Begay	University of New Mexico

Reminder: Full program and abstracts are digital! See our website!

CONTACT US

Scan the code for detailed website information.
Should you need any assistance, please find one of our amazing committee members, or email us at **HSC-microplastics@salud.unm.edu**

Conference Day 0

Sunday, January 11

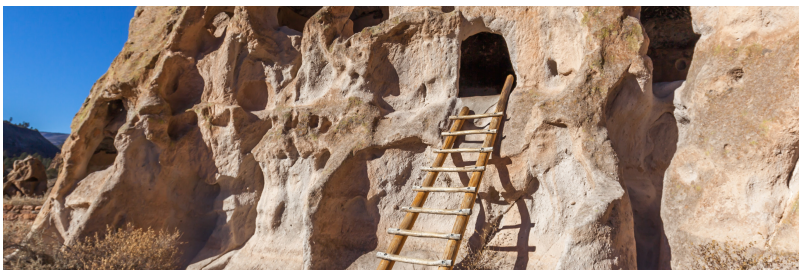
Welcome Reception

5-8pm

Please join us in the Santa Fe Meeting area for light snacks and refreshments! Meet us in the main lobby on the first floor of the Eldorado Hotel

A few tips and tricks!

- **Prepare for altitude:** Santa Fe sits around 7,200 feet, so stay hydrated, take it easy your first day, and limit alcohol initially.
- **Dress accordingly:** The high desert climate means warm days and cool mornings/evenings, even in summer.
- **Plan transportation ahead:** The historic downtown is very walkable, but renting a car is helpful for visiting nearby sites like Bandelier or Chimayó.
- **Make dining reservations early:** Popular restaurants and seasonal events can book up quickly, especially during peak travel months (see our suggestion on next pages!)
- **Embrace the local culture:** Check out local art markets, Pueblo sites, and regional cuisine to get the full Santa Fe experience



Code of Conduct Reminder

- **Professional conduct:** All participants are expected to engage in a professional, respectful, and collegial manner that supports scholarly exchange.
- **Inclusive environment:** The conference is committed to providing a welcoming and inclusive environment for all attendees, regardless of career stage, discipline, or background.
- **Respectful discourse:** Scientific discussion should be conducted thoughtfully and constructively, valuing diverse perspectives and evidence-based dialogue.
- **Zero tolerance for misconduct:** Harassment, discrimination, intimidation, or disruptive behavior will not be tolerated in any form.
- **Compliance with policies:** Attendees must adhere to conference policies, institutional standards, and venue rules.
- **Reporting and accountability:** ***Participants are encouraged to report concerns to or violations to conference organizers (or email HSC-microplastics@salud.unm.edu), who will address them promptly and confidentially.***

DINING IN SANTA FE:

RED OR GREEN?

Meals in Santa Fe range from established fine-dining restaurants where you can get dressed up, to leisurely spots where you can arrive in hiking shorts after a day in the Sangre de Cristo mountains. No matter where you go, though, the entire city is suffused with the laid-back, can-do attitude of the Southwest. Whether you're looking for iconic home-style New Mexican cuisine or a high desert take on global cuisine, the City Different has it.

Reminder: Don't forgot to Google before you go! Some restaurants may open certain hours/days.

DOWNTOWN

The Shed — 113½ East Palace Ave. — (505) 982-9030

As the sister restaurant to La Choza, this one's got a good 30 years on its sibling and has been a local fave for every moment of that time. One of the city's culinary treasures since 1953, the restaurant is renowned for their legendary red chile and blue corn enchiladas. Download your Santa Fe Margarita Trail App and save on the signature Roca Coin Margarita (and collect a free Margarita Trail T-shirt once you earn five passport stamps). We strongly recommend reservations.

Market Steer Steakhouse — 213 Washington Ave — (505) 365 -1010

For the purpose of this listing, it's all about the steak, but you can add lobster tail or crab Oscar to those orders and enhance it all with house-made truffle butter.

The Bull Ring — 150 Washington Ave. — (505) 983-3328

Since debuting La Boca in 2006 in downtown Santa Fe, chef James Campbell Caruso has merged regional Southwestern ingredients with methodical Spanish technique, transporting eaters from New Mexico to Spain. For example, Caruso pairs small plates like trio de califlor — roasted cauliflower with harissa barbecue sauce and manchego cream — with an impressive selection of Mediterranean and South American wines.

Il Vicino — 321 W San Francisco St. — (505) 986-8700

Leaning into the deep Neopolitan flavors, Il Vicino is a paradiso della pizza. There are classic options like margherita and simple pepperoni, or you can get nuts and go for the gorgonzola-goat cheese-portobello mixed Bianca.

Upper Crust Pizza — 329 Old Santa Fe Trail — (505) 982-0000

This place has a dedicated following that's pretty impressive. That sunny chicken pesto pizza is a delight, as is the red chile New Mexico mix.

La Boca — 72 W Marcy St. — (505) 982-3433

Since debuting La Boca in 2006 in downtown Santa Fe, chef James Campbell Caruso has merged regional Southwestern ingredients with methodical Spanish technique, transporting eaters from New Mexico to Spain. For example, Caruso pairs small plates like trio de califlor — roasted cauliflower with harissa barbecue sauce and manchego cream — with an impressive selection of Mediterranean and South American wines.

Cafe Pasqual's — 121 Don Gaspar Ave. — (505) 983-9340

Instead of being doused in green chile sauce, the handheld breakfast burrito contains minimalist strips of uncut, roasted green chile peppers. For those seeking a purer commune with the New Mexican green chile, this is a good way to go.

09

Sazón 221 Shelby St, (505) 983-8604

The signature mole negro is subtle and balanced; the pork belly tacos are divine; and the sweeter-than-normal chiles en nogada, made with a jalapeno balsamic reduction, offer a new take on a classic. It's cooking like this — which rivals anything you might find on a white tablecloth in Mexico City — that keeps tables at this adobe-walled restaurant in high demand.

Coyote Cafe & Rooftop Cantina 132 W Water St. (505) 954-0320

Sunday afternoons on the patio may as well be the official Santa Fe pastime. The patio at Coyote Cantina is a perfect place for Sunday Funday. Check out the green chile infused Norteño and collect another stamp on your Margarita Trail Passport.

Del Charro 101 W Alameda St. (505) 954-0320

From margaritas with a little extra in the shaker, to a good list of beer and plenty of spirits, this hotel bar is also a local haunt. Plus, great pub food with reasonable pricing despite being downtown.

CANYON ROAD

Geronimo 724 Canyon Road (505) 982-1500

Pan-seared Alaskan halibut, green miso sea bass, mesquite grilled Maine lobster tails...we'd say more, but there's a chance you'll keel over. Geronimo tops the BOSF list yet again as the reigning champ of local fine dining. Executive chef Sllin Cruz rotates his menu seasonally, so this Canyon Road haunt easily becomes a year-round experience with changing options. Don't say we didn't warn you about a Geronimo obsession, though. It's a thing.

The Compound 653 Canyon Road (505) 982-4353

Chef Mark Kiffin can cook a mean schnitzel, and that organic stone ground polenta has a bit of an attitude, too. Best to eat it slowly to punish it, knowing that a butterscotch budino is on the way for dessert.

The Teahouse 821 Canyon Road (505) 992-0972

With an endless list of fogs and blooming teas, plus a humongous collection of greens and many more steaming and iced options, The Teahouse is Santa Fe's favorite tea destination. We're talking premium Earl Greys, wellness teas and oolongs. Don't skip the food menu, either, but when you're looking for as many teas as possible in one place, this Canyon Road mainstay will simply not be beat.

THE RAILYARDS

Paloma Restaurant 401 S Guadalupe St. (505) 467-8624

This upscale Mexican restaurant makes its tortillas from local landrace blue corn that's nixtamalized in house. The result is a complex flavor that elevates Paloma's tacos — topped with carne asada, sea bass, or cauliflower — into some of the best in town.

Second Street Brewery - Rufina Taproom 2920 Rufina St. (505) 954-1068

With three locations around town, Second Street Brewery is a standby among locals for burgers, beers, and live music. The company's newest outpost is the spacious Rufina Taproom, conveniently located near the popular immersive art space Meow Wolf for pre- or post-visit refreshment. You'll find the brewery's bread-and-butter staples alongside Cajun-inspired dishes by chef Milton Villarubi

Tomasita's 500 S Guadalupe St. (505) 983-5721

Most enchiladas are rolled, but Tomasita's serves its enchiladas flat. Chicken, cheese, beef, shrimp, or vegetables are sandwiched between moist but sturdy layers of yellow corn tortillas, which are smothered with green chile sauce and cheese.

Andiamo! 322 Garfield St. (505) 995-9595

Start with prosciutto and fresh mozzarella, then hop into the penne arrabiata that's topped with chile flakes. Go for grilled trout or crispy duck leg. Just hurry.

Opuntia 1607 Alcaldesa St. (505) 780-5796

A cute little garden paradise in the Rail- yard might not've been what you were expecting the space to become five years ago, but, man, are you satisfied with these results. Look out from the second-story patio and marvel.

Radish & Rye 505 Cerrillos Rd. (505) 930-5325

The menu focuses on local sourced foods and simple dishes executed flawlessly. In other words, Radish and Rye takes the "farm-to-table" concept to a whole new level. Additionally, the restaurant runs a top bourbon program, an extensive whisky list and cocktails featuring hand-selected barrels of Buffalo Trace.

Boxcar Bar and Grill 530 S Guadalupe St. (505) 988-7222

We swear by sports in the daytime, live music in the night time, and great food all the time.

WORTH THE DRIVE

La Choza Restaurant 905 Alarid St. (505) 982-0909

You know these margs are worth the long wait. We've got no clue why drinks taste so different here, but there's a certain liveliness that must affect the mix at La Choza. Maybe it's just the atmosphere, that knowledge you're gonna have a good time and a great meal. We're fans of the fruity Choza Red, but if you want to give building your own marg a try you can do that, too. It's like an art project in a glass that goes well with chile.

Maria's New Mexican Kitchen 555 W Cordova Rd. (505) 983-7929

Flip to the classics menu if you're nervous (the Cheap Date has saved us so much deciding time), but have no fear —the list is so massive you'll find something to love.

Jambo Cafe 2010 Cerrillos Rd. (505) 473-1269

Chef Ahmed Obo combines the Swahili, Indian, Arabic, and European culinary influences of Kenya's Lamu Island, where he was raised, to provide a unique taste of East African fare. At Jambo Cafe, opened in 2009, check out the coconut pili pili shrimp, which features wild shrimp over spicy coconut tomato stew and basmati rice, alongside fan favorites like grilled jerk chicken and vegetarian dishes.

India House 2501 Cerrillos Rd. (505) 471-2651

Chef Kewal Singh Dhindsa took his love of classic South Indian food from Los Angeles to New York to the Caribbean before settling in Santa Fe. At India House, where the dining room is expansive and the service immaculate, try anything from the tandoor oven, like the chicken wings broiled over mesquite and mixed with yogurt, garlic, and ginger. Don't be shy if you like heat — ask for recommendations, or alter your favorite dishes with additional spice. India House will go above and beyond to make you sweat.

Pantry Restaurant 1820 Cerrillos Rd. (505) 986-0022

One of Santa Fe's most beloved breakfast hotspots since 1948, the restaurant touts itself as "Santa Fe's Meeting Place." The menu offers a healthy mixture of traditional breakfast favorites and New Mexican breakfast staples, usually smothered in the region's signature red or green chile (for a little of both, ask for "Christmas").

Back Road Pizza 1807 Second St., Ste. 1 (505) 955-9055

Thin-crust lovers know where the good stuff is: Spoiler alert, it's here. Piper Kapin, owner and operator of the joint, has created a well-known cool space in Midtown where the pizza is fab and you can even shoot a game of pool sometimes. Back Road also became a de facto grocery during the height of the pandemic and kicked off Santa Fe's love affair with Detroit-style pizzas. Thin crust or deep dish, the point remains the same—you love 'em, Santa Fe.

The Chocolate Maven 821 W San Mateo Rd. (505) 984-1980

Look, it's possible after going through Chocolate Maven's myriad bakery options you might find something that doesn't work for you. What we're saying is it takes ages to get to that point. I mean, Cape Cod cranberry orange cookies? Mocha peanut butter Oreo cake? Espresso brownie bars?! We're getting a sugar rush just from writing this. And oh no: Honey cakes and tea loaves? OK, Maven, we get it. We surrender. We'll keep coming back.

Clafoutis 333 W Cordova Rd. (505) 988-1809

Why our little desert town has so much French-ness we'll never know, but we aren't ones to complain. While you face a parking lot rather than the Champs-Élysées, never doubt the power of Clafoutis' croissants to fly you back to your French memories.

Santa Fe Bite 311 Old Santa Fe Trl (505) 982-0544

The green chile burger is the dish to get at Santa Fe Bite. It's the massive hunk of beautifully seared meat that really makes this dish, but the green chiles add a welcome bit of mild heat and help moderate the richness of the beef.

Shake Foundation 631 Cerrillos Rd. (505) 988-8992

Where fresh burgers come with shoestring fries and eating outside on long picnic tables is considered cool, Brian Knox's joint feels like we're in Austin, minus the dreadful heat.

Santa Fe Brewing Company

The facility has indoor and outdoor venues hosting several nationally touring arts throughout the year. Known for their flagship IPAs as well as rotating seasonal offerings, the brewery is New Mexico's original and most successful craft brewery.

Izanami 21 Ten Thousand Waves Way (505) 982-9304

Leaping from third place last year into first this year, Izanami has traditionally been the place we go for that higher-end Asian cuisine—literally and figuratively, as it's up in the mountains. Find sake in abundance, plus herbs grown on-site, meaning the food is as fresh as fresh can be. Ask anyone on staff and they can tell you where the restaurant sources its beef, fish and whatever else is on the menu. Try grilled miso bass or kurobuta pork belly tacos, then finish off the meal with a passion fruit tart. Staff won't even mind if you show up in a robe.

Conference Day 1

Monday, January 12 - Morning Sessions

8:00 AM	**Convene, Registration, Breakfast**	**Anasazi Room**
8:30 AM	Welcome in Eldorado A/B room, Opening Remarks, Video welcome from Senator Jeff Merkley, Oregon	Matthew Campen, Xiaozhong Yu
Keynote Seminar (Eldorado Ballroom)		
9:00-9:45 AM	**Stephanie Wright, PhD,** Associate Professor in Environmental Toxicology, Imperial College London	From inhalation to circulation: The past, present, and future of microplastics and human health research
Research Seminars (Eldorado Ballroom)		
9:45-10:30 AM	**Airborne Microplastics** Chaired by Aaron Erdely	**Athena Nguyen**, Frontier Lab America, “Pyrolysis-GCMS analysis of Microplastics in the air atmosphere”
		Sabina Halappanavar, PhD, Health Canada, “Challenges and Opportunities in the Toxicology of Microplastics in Ambient Air”
		Elise Granek, PhD, Portland State University, "Environmental microplastics - from our households to our rivers and oceans and back to our table"
10:30-10:45 AM	**Coffee Break**	
Research Seminars (Eldorado Ballroom)		
10:45 AM - 12:00 PM	**Maternal-Fetal and Reproductive** Health Effects, Chairs Genoa Warner, Marcus Garcia	**Genoa Warner, PhD,** NJIT, “Polystyrene and polyethylene terephthalate nanoplastics differentially impact mouse ovarian follicle function”
		Myla Stanford, Baylor University, “Polymer, Size, and Time Shape Microplastic Cytotoxicity Across Placental and Immune Cells with Links to Preterm Birth-Relevant Immune Microenvironments”
		Olga Khaybullina, PhD, University of Alabama-Birmingham, “Rethinking Fetal Risk: What 14C-Polystyrene Reveals About Nanoplastic Accumulation During Pregnancy
		Enrico Barrozo, PhD, Baylor College of Medicine, "Micro- and Nanoplastics (MNPs) in the Human Reproductive Tract: Blank-Corrected Polymer Burdens in Follicular Fluid and Endometrium Associate with IVF Endpoints and Path-Confirmed Polyps"
		Phoebe Stapleton, PhD, Rutgers University “Micro and nanoplastic inhalation throughout pregnancy disrupts placental invasion and morphology in Sprague-Dawley rats”
12 - 1 PM	**Lunch**	**Provided by Hotel (Anasazi Room)**

Conference Day 1

Monday, January 12 - Afternoon Sessions

Highlighted Research Seminar (Eldorado Ballroom)		
1:00-1:30 PM	**Cassandra Rauert, PhD**, The University of Queensland, Brisbane	Determining human exposures and internalisation of micro and nanoplastics, an update from the Minderoo Centre – Plastics and Human Health
Panel Discussion (Eldorado Ballroom)		
1:30 – 2:45 PM	**Communication of the global plastics problem**	**Becca Lauzon, PhD,** University of Rochester Medical Center, "Messaging about Microplastics and Human Health"
	Moderator, Katrina Korfmacher, PhD, University of Rochester Medical Center	**Katherine Pelch, PhD**, Natural Resources Defense Council, "Big conversations about tiny plastics: NGO communication strategies and public perceptions data on microplastics and health"
		Bethany Jorgensen, PhD, University of New Mexico, "Using narrative portraiture to understand experiences of plastics in the UNESCO Biosphere Reserve of Menorca (Spain)
		Megan J. Wolff, PhD MPH, "P-SNAP, Trusted Voices in a Turbulent Landscape: P-SNAP's Strategy for Communicating Microplastics Science"
2:45-3:00 PM	**Coffee Break (Concourse)**	
Research Seminars (Eldorado Ballroom)		
3:00 - 4:00 PM	**Methods for detection and quantitation**	**Alba Torrents de la Peña**,, PhD, Scripps Research, "p-CAPture: A novel method to identify and quantify micro- and nanoplastics"
	Chairs: Beizhan Yan, PhD and Jorge Gonzalez Estrella	**Sakshi Patil, PhD,** "Advancing the method for isolating and quantifying MNPs in human cerebrospinal fluid for Brain Waste Clearance Studies" **Justin Scott**, **PhD**, Cove Environmental, "Trace Level Quantitation of Micro- and Nanoplastics Utilizing Thermal Desorption and Pyrolysis–GC/MS Coupled with Selective Ion Monitoring: Development and Validation" **Yingyue Ni,** Boston University, "A machine-learning powered pipeline for microplastic quantification and classification using Py-GC/HRMS: Toward generalizable microplastic exposure assessment"
4:00 PM	**Poster Session 1 (Eldorado Ballroom)**	They will be displayed all day, but attended from 4-6 pm for a dedicated viewing and social networking opportunity.
6:00 PM	Dinner – free schedule	Santa Fe is a culinary gem in the U.S. with a variety of Southwestern restaurants and other diverse options within walking distance from the hotel. We encourage attendees from near and far to enjoy their visit!

Conference Day 2

Tuesday, January 13 - Morning Sessions

8:00 AM	**Breakfast**	**Light breakfast will be available for attendees, Anasazi Room**	
		Eldorado Ballroom A	**Eldorado Ballroom B**
8:45 AM	Reconvene, Introduction of Speaker	Matthew Campen	Xiaozhong Yu
9:00 AM	**Highlighted Research Seminar**	**Todd Gouin, PhD**, TG Environmental Research, "Plasticizers in microplastics, a critical view"	**Custodio Muianga, PhD**, "ATSDR Resources for Interactive Visualizations of Micro- and Nanoplastics and Human Health Research Data"
9:40 AM	**Research Seminar Blocks**	**Aquatic environments and species**: Chairs, Stacey Harper, PhD, Oregon State University	**Exposure science:** Chairs, Xiaozhong Yu, Jorge Gonzalez Estrella
		Susanne Brander, PhD, Oregon State University, "Similarities across responses in fish to diverse micro and nanoplastic particle types, informing common mechanisms of action across vertebrates"	**Britta Baechler, PhD,** Ocean Conservancy, "Exposure of U.S. Adults to Microplastics from Commonly-Consumed Proteins"
		Jacques Robert, PhD, University of Rochester, "Leveraging xenopus to assess the risks of microplastic exposure on development and immunity"	**Gaku Ichihara, MD, PhD,** Tokyo University of Science, "Assessment of occupational exposure to micro/nano particles generated from carbon fiber-reinforced plastic processing"
		Girija Prasad, CIPET:SARP-LARPM, Bhubaneswar, Odisha, India, "Spatial and Seasonal Patterns of Riverine Microplastics and Their Ecological Risks: A Case Study from the Cauvery River, India"	**Kazi Albab Hussain, PhD,** University of Nebraska-Lincoln, "From Packaging to Plate: Systematic Review and Meta-Analysis of Nanoplastics and Microplastics Release from Food Packaging"
		Karen McGuire-Diemer, Oklahoma State University, "Structural degradation of microplastics from thermal oxidation increases carbon leaching in aquatic environments"	**Nisarg Mehta,** Silesian University of Technology, "Microplastic Exposure in Indian Hospitals: Ingestion Risks from Settled Dust, Characterization, and Implications for Vulnerable Populations"
10:40 AM	**Coffee Break (Concourse)**		
11:00 AM - 11:30 AM	**Research Seminar Blocks**	**Cardiovascular health effects of plastics:** Chairs, Brian Kim and Barry Bleske	**Methods for plastics measurement and separation:** Chairs, Philip Demokritou and Beizhan Yan
		Tim O'Toole, PhD, University of Louisville "Microplastics consumption potentiates atherosclerotic lesion development in ApoE-/- mice"	**Kuanliang Shao, PhD,** Emory, "An exposomic analytical framework for measuring micro- and nano- plastic in human biospecimens"
		Changcheng Zhou, PhD, University of California at Riverside "Microplastic exposure elicits sex-specific atherosclerosis development in low-density lipoprotein receptor-deficient mice"	**Teagan Horan**, SIMpore, "Silicon Nanomembrane Analysis Pipeline (SNAP): A Flexible Workflow for the Multi-modal Analysis of Particulates from Varying Sample Types"

Conference Day 2

Tuesday, January 13 - Afternoon Sessions

		Eldorado Ballroom A	Eldorado Ballroom B
11:30 AM - 12:00 PM	**Research Seminar Blocks (cont.)**	**Cardiovascular health effects of plastics:** Chairs, Brian Kim and Barry Bleske	**Methods for plastics measurement and separation:** Chairs, Philip Demokritou and Beizhan Yan
		Ross Clark, MD, University of New Mexico, “Dietary Ocean Micronanoplastics are Associated Accelerated Atherosclerosis in ApoE-/- Mice”	**Ruben Trujillo, PhD,** University of New Mexico, "Positioning of Microstructures within Acoustic Waves Enhances Particle Trapping"
		Siwen Zheng, **PhD,** Stanford University “Deciphering the Causal Impacts of Polyethylene and Polyvinyl Chloride Nanoplastics on Vascular Remodeling and Atherosclerosis”	**Sanjay Giridharan**, Arizona State University, "Innovative Modelling Driven Membrane-Free Microfluidic Separation of Microplastics Model Optimized with Machine Learning"
12:00 PM	**Lunch (Anasazi Room)**		
1:00-1:40 PM	**Highlighted Research Seminar:**	**Yasue Mitsukura, PhD**, Keio University, Japan, “Unexpectedly High Accumulation of Nanoplastics in the Human Placenta: Higher Levels than in the Brain and Liver”	**Naixin Qian**, **PhD,** Columbia University, “Rapid Single-Particle Chemical Imaging and Analysis of Nanoplastics by Stimulated Raman Scattering Microscopy”
1:40-2:40 PM	**Research Seminar Blocks**	**Gastrointestinal and Hepatic Effects of Plastics:** Chairs, Rama Gullapalli, Robert Taylor	**Neurological health effects of plastics:** Chairs, Jamie Ross, Marcus Garcia
		Namrata Pandey, University of Plymouth, “Investigating the impact of Polystyrene Nanoplastics in liver using hepatic cell lines and human precision-cut liver slices”	**Huiping Deng, Columbia University,** "Accumulation of Micro- and Nanoplastics in Human Cerebral Spinal Fluid"
		Kyle Kim, University of Washington, “Elucidating the effects of environmental microplastics on the gut-brain axis of humanized ApoE3/E4 mice”	**Kyu-sung Kim, PhD,** KBRI “Inhaled Nanoplastics Drive PINK1/Parkin-Mediated Mitophagy and Metabolic Dysregulation, Compromising Neurovascular Integrity”
		Aaron Romero, University of New Mexico, “Chronic Dietary Microplastic Exposure Weakens Skeletal Integrity”	**Antara Verma**, Pennsylvania State University, "Axonal Transport of Nanoplastics by Kinesin"
		Lingjun Li, Arizona State University, “Metabolic Reprogramming in Gut Microbiota Exposed to Polystyrene Microplastics”	**Andrew Ortiz Balsero,** MS, University of Nebraska-Lincoln, "Benchmarking the Invisible: Modeling Neurotoxicity of Ingested Micro- and Nanoplastics Through Bayesian Dose–Response Analysis aided by systematic evidence integration"
2:40-3:00 PM	**Coffee Break (Concourse)**		

Conference Day 2

Tuesday, January 13 - Afternoon Sessions continued

		Eldorado Ballroom A	Eldorado Ballroom B
3:00-4:00 PM	**Research Seminar Blocks**	**Pulmonary Effects of Microplastics**: Chairs, Imari Walker-Franklin and Phoebe Stapleton	**Neurological health effects of plastics**: Chairs, Kiran Bhaskar and Shahani Noor
		Imari Walker-Franklin, PhD, Research Triangle Institute, "Multi-Omic Evidence of Respiratory Toxicity from Tire-Derived Microplastics"	**Jaime Ross, PhD,** University of Rhode Island, “Lifecyle of microplastics in the body and their contribution to Alzheimer’s disease”
		Cuizhu Ma, PhD, Columbia University, "Human Inhalation of Microplastic and Nanoplastic from E-cigs"	**Brandon Pearson, PhD**, Oregon State University, “Experimental models to test causal relationships between MNP exposure and Alzheimer’s disease pathology”
		Aerlin Decker, University of New Mexico, "Detection and Quantification of Microplastics in Human and Murine Lung Tissue"	**Dr. Fumihiko Maekawa**, Health and Environmental Risk Division, National Institute for Environmental Studies, Japan , “Neonatal Brain Exposure to Nanoplastics via Oral Route: Size-Dependent Uptake and Regional Localization”
		Ashish Jachak, PhD, RHP Risk Management, Inc, "Particle deposition in the human lung as a function of microplastics’ shape, size, orientation, and type"	**Marcus Garcia, PharmD**, University of New Mexico, Quantitative Mapping of Micro- and Nanoplastics Across the Hemisphere of a Human Brain
4:00-6:00 PM	**Poster Session 2**	They will be displayed all day, but attended from 4-6 pm for a dedicated viewing and social networking opportunity.	
4:30-5:30 PM	**Breakout 2 (in parallel with posters)**	***Microplastics Education Workshop (Devargas Room)*** “Exploring microplastics and human health with high school science classes” Katrina Korfmacher, PhD; Sami Romanick, PhD; Teagan Horan, PhD	
6:00 PM	**Dinner at Hotel (Anasazi Room),**	**All attendees welcome!** Southwestern-themed dinner for all attendees, award announcements	

Conference Day 3

Wednesday, January 14

7:45 AM	**Breakfast (Anasazi Room)**	
8:20 AM	Reconvene, Introduction of Speaker	
Keynote Seminar (Eldorado Ballroom)		
8:30-9:15 AM	**Mark Wiesner, PhD**, James B. Duke Distinguished Professor of Civil and Environmental Engineering, Duke University	Plastic aging and its impact on fragmentation and additive release
Research Seminars (Eldorado Ballroom)		
9:15-10:15 AM	**Nanoplastics origin, physicochemistry, and health risk**	**Sanat Kumar, PhD,** Columbia University, "Mechanism of Quiescent Nanoplastic Formation from Semicrystalline Polymers"
	Chair, Matthew Campen, PhD, and Eliane El Hayek, PhD, University of New Mexico	**Aaron Erdely, PhD,** Editor in Chief, Particle and Fibre Toxicology**,** "Morphological and chemical characterization of nanoplastics in human tissue"
		Eve Rowland, PhD, UNM "Visualization of putative nanoplastic particles within historical and modern tissue samples of kangaroo rats"
10:15-10:30 AM	**Coffee Break (Concourse)**	
Panel Discussion (Eldorado Ballroom)		
10:30-11:30AM	**Microplastics and human health translation to policy and action**	**Paulita Bennett-Martin**, 5 Gyres Institute "#MicroplasticFreeUS: a comprehensive policy approach to addressing microplastic pollution by the 5 Gyres Institute"
		Julia Cohen, Plastics Pollution Coalition **Susanne Brander, PhD,** Pew Charitable Trust and Oregon State
Highlighted Research Seminar (Eldorado Ballroom)		
11:30 AM - 12:00 PM	**Scott Coffin, California Office of Environmental Health Hazard Assessment**	Advancing Microplastic Risk Assessment: The ToMEx 2.0 Database, Quality Evaluation, and Probabilistic Modeling Framework
12:00 PM	Concluding remarks, Adjournment	

From inhalation to circulation: the past, present, and future of microplastics and human health research

Stephanie Wright, PhD.

Associate Professor in Environmental Toxicology, Imperial College London

Micro- and nanoplastics (MNPs) are emerging as complex particulate pollutants in indoor and outdoor air with potential impacts on respiratory and systemic health. Yet exposure assessment remains uncertain due to analytical constraints and non standardised dosimetry. Experimental models demonstrate oxidative stress, inflammation, and epithelial barrier disruption in the lung microenvironment, but cross MNP comparisons and real world extrapolation are restricted because deposition, doses, and responses vary with particle size, morphology, and polymer chemistry. Evidence indicates that plastic particles can traverse epithelial interfaces and enter circulation; synthetic polymer signatures detected in human blood and distal organs emphasise the need for mechanistic clarity on translocation and robust measurements.

This keynote will synthesise past and present advances in MNP inhalation exposure, toxicity, dosimetry, and blood detection, highlighting mass spectrometric and vibrational spectroscopic analytics, while confronting limitations, artefacts, and contamination risks. To establish an MNP–disease link, we set the evidentiary bar: unequivocal tissue detection, rigorous contamination control, credible exposure and dose estimates, mechanistic pathways, and reproducible associations with pathology. From a critical reviewer's standpoint, persuasive evidence might include direct, repeatable in situ visualisation of MNP in diseased tissues, co localised with injury or immune markers and validated by orthogonal methods and longitudinal data. The talk will thus also explore the value of pathology specimens and tissue banks, and survey cutting edge technologies, their limitations, and opportunities to harmonise policy-relevant research.

Plastic aging and its impact on fragmentation and additive release

Mark Wiesner, PhD.

James B. Duke Distinguished Professor of Civil and Environmental Engineering, Duke University

Plastics often contain a wide variety of chemical additives as well as non-intentionally added substances such as degradation products, reaction by-products and/or impurities. Since these other chemicals are not generally covalently bound to the polymer matrix, they may leach out of the plastic. These leached chemicals include bisphenol A, phthalates, nonylphenols, brominated flame retardants, to name a few. Also, nanomaterials are sometimes incorporated as nanofillers into polymer formulations to enhance existing properties or to add new properties of interest in the products made from these plastic composites.

This presentation presents a modeling framework for describing additive release from plastics that considers the role of plastic fragmentation in increasing surface area and release rates over time and methods for parameterizing the models from plastic abrasion and additive leaching experiments. Derivations of mechanical stresses on plastics as a function of power input are related to rate constants in a population balance on plastic particle number distributions. The leaching of additives from homogeneous plastic spheres is estimated as function of fragment size and environmental conditions and the implications for exposure to additives are discussed. Data of weathering of plastics will be summarized and a framework for modeling weathering and its impact on fragmentation rate will be presented focusing on the impact increased fragmentation rate on additive release.

Highlighted Reseach Seminars

Determining human exposures and internalization of micro and neoplastic, an update from the Minderoo Centre – Plastics and Human Health

Cassandra Rauert, PhD

The University of Queensland, Brisbane

Cassandra Rauert (1,2,4), Elvis Okoffo (2,4), Nathan Charlton (1,2), Angus Bagley (1,2), Laura Puente De La Cruz (1,2), Honglin Chen (1,2), Yufei Pan (1,2,4), Coral Jeffries (2), Stacey O'Brien (2), Sarah Dunlop (1,3), Christos Symeonides (1,3), Kevin V. Thomas (1,2,4)

1.Minderoo Centre – Plastics and Human Health, The University of Queensland, 20 Cornwall Street, Woolloongabba, 4102 QLD, Australia.
2.Queensland Alliance for Environmental Health Sciences (QAEHS), The University of Queensland, 20 Cornwall Street, Woolloongabba, 4102 QLD, Australia.
3.Minderoo Foundation, Perth, Western Australia, 6009, Australia
4.ARC Training Centre for Hyphenated Analytical Separation Technologies (HyTECH), Woolloongabba, Queensland 4102, Australia

It is globally recognised that micro and nanoplastics (MNPs) are pervasive in the environment and that we are continually exposed to these contaminants. Whilst inhalation and ingestion are considered our key everyday exposure routes, there are still gaps in our understanding on the extent of exposure from various sources and subsequent fate of these particles within the body. This presentation will provide an update on recent research activities from the Queensland Alliance for Environmental Health Sciences (QAEHS) and the Minderoo Centre – Plastics and Human Health that are aiming to address these knowledge gaps. Key results that will be presented include a recent Australian food diet survey, demonstrated that our key ingestion exposures are beverages rather than food with up to 12 µg/L (primarily polypropylene) detected in beer, wine, bottled and tap water. Additionally shedding of plastics from consumer items such plastic kettles, food storage containers or baby milk bottles can release up to 25 µg/L or 2 µg/bottle during their first use. The release follows first order kinetics and reduces with each wash of the product. Inhalation exposure in a number of laboratory environments demonstrated that the human traffic within that environment was the key determinant of how 'contaminated' it was. Additionally, challenges with currently available analytical techniques will be discussed including quantifying small MNPs in complex matrices (biological samples) and difficulties with developing realistic in vitro models to investigate NPs migration across biological barriers. In summary, the presentation will highlight progress that is being made to fill knowledge gaps in this challenging field but will also suggest priority areas for future research and the need for more interdisciplinary collaborations.

Plasticizers in microplastics, a critical view

Todd Gouin , PhD

TG Environmental Research,

Plastic represents an important material used in a broad range of applications. Increasing demand for plastic is a direct result of its ability to support the production of high performance products that meet or exceed consumer expectations. Increasing demand for plastic, however, has also been shown to be correlated with an increase in the generation of plastic waste. Concerns regarding plastic pollution, as well as the presence of nano- and microplastic particles (NMPs) in environmental systems, could thus be perceived as an unintended consequence of a material that has been too successful at supporting innovation in a variety of commercial applications. Over the last several years there has been significant investment in scientific research aimed at assessing the implications that exposure to NMPs in the environment represent to both human health and environmental systems. Various concerns have been communicated in the scientific literature, including studies that report relatively large numbers of NMPs in various foods and beverages, as well as in human biological tissues. These same studies, however, have also been challenged with respect to the reliability and relevance of the data generated. Common concerns raised include questions regarding the robustness of quality assurance and quality control protocol adopted by researchers, as well as the adoption of ad hoc, non-standard, analytical methods. Numerous

groups have thus recommended the need for the development of standard and/or harmonized methods, which would help support inter-laboratory comparison of data generated by different groups. The adoption of standard methods, therefore, represents a key research need that is urgently required in order to increase the relative level of confidence of the data generated. This presentation aims to reflect on this challenge. Importantly, there is a need to recognize the non-trivial complexity of the issue, which cannot be addressed by researchers working independently or within a relatively narrow range of expertise. The complexity of the issue can only best be addressed through multidisciplinary expertise, and which should include polymer chemists, material scientists, mechanical engineers, exposure and life-cycle assessment scientists, toxicologists, microbiologists and analytical chemists, needed to provide leadership and guidance.

Agency for Toxic Substances and Disease Registry Resources for Interactive Visualizations of Micro- and Nanoplastics and Human Health Research Data

Custodio Muianga, PhD

CDC-Agency for Toxic Substances and Disease Registry (ATSDR)

1 Agency for Toxic Substances and Disease Registry (ATSDR), Office of Innovation and Analytics, Atlanta, GA. 2 CDC- ATSDR ORISE Fellowship.

Micro- and nanoplastic research is rapidly expanding, producing a volume of literature that makes it difficult to synthesize findings and identify gaps. To address this challenge, the Agency for Toxic Substances and Disease Registry (ATSDR) Microplastic and Human Health workgroup has developed multiple data visualization tools to provide streamlined access to rigorously evaluated data. Hubs for Interactive Literature (HILs) compile literature used to produce the corresponding workgroup review articles. HILs filter and offer easy access to the original references. These visualizations allow rapid review of microplastics research data and isolate specific subtopics of interest to generate new ideas and quickly identify data gaps. HILs incorporate a novel world map to explore global microplastics data and related public health issues and enable targeted exploration of specific themes within the literature. Currently, there are four HILs that, collectively, have been viewed over 1,300 times. The Plastics Related Toxicological Profile Tool organizes health endpoint data extracted from 98 ATSDR toxicological profiles representing over 400 chemicals related to plastics production. It integrates ATSDR Substance Priority List rankings and polymers use information, helping contextualize chemical hazards within plastics production. The tool has been accessed approximately 940 times. Additionally, the ATSDR Microplastics and Human Health workgroup website features two interactive maps. A world references map sortable by broad categories: environmental, chemistry, guidance, and human body/cellular exposure and additional subcategories. A human body map links references to specific organs and systems by study type. The interactive human body map features the broad categories of disease, animal study, cell study, model study, and tissue study as well as several more specific organ categories. Together, these ATSDR tools enhance the ability of public health professionals to navigate the expanding literature, synthesize findings, and identify priorities. This represents the first initiative to consolidate global microplastics research into interactive, publicly accessible tools, advancing collaboration and generating ideas in the important micro- and nanoplastic research field.

Disclaimer: The findings and conclusions in this presentation have not been formally disseminated by the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.

Unexpectedly High Accumulation of Nanoplastics in the Human Placenta: Higher Levels than in the Brain and Liver

Yasue Mitsukura, PhD

Keio University, Japan

Yasue Mitsukura, Hayato Ikeda, Akiko Suganuma, Toshihiko Nishimura, and Ron Yasue Mitsukura, Hayato Ikeda, Akiko Suganuma, Toshihiko Nishimura, and RRonald G. Pearl

Nanoplastics (NPs), plastic particles smaller than 1 μm, have become a major environmental and public health concern. They can enter the human body through food, air, and water, yet direct evidence of their biodistribution, particularly across maternal and fetal organs, remains scarce. This study investigated the distribution of fluorescently labeled polystyrene nanoplastics (100 nm) in pregnant rats, focusing on their presence in the placenta, fetal liver, and brain.

Pregnant rats on gestational day 15 received intravenous injections of fluorescent nanoparticles. After 48 hours, placental and fetal tissues were collected, fixed, and analyzed by confocal fluorescence microscopy under standardized conditions. Quantitative image analysis revealed strong NP fluorescence in the placenta and lower

but detectable signals in the fetal liver and brain. The fluorescence intensity in the placenta was about 2.5 times higher than in the liver and 3.1 times higher than in the brain, indicating that the placenta serves not only as a semipermeable barrier but also as a major accumulation site.

These findings provide direct evidence that nanoplastics can cross the placental barrier and reach fetal organs. Two mechanisms may explain this transfer: (1) endocytic uptake by trophoblast cells followed by accumulation, and (2) transcytosis-mediated transport into the fetal circulation. The detection of NPs in both fetal liver and brain implies systemic distribution after transplacental passage, suggesting that prenatal exposure could cause long-term developmental or immunological effects.

The pronounced accumulation of NPs in the placenta highlights its dual role as both a filter and a reservoir. The higher concentration compared to fetal tissues may reflect its active uptake and limited clearance capacity. These results agree with previous findings on microplastics in human and animal placentas but provide the first microscopic evidence at the nanoscale level.

As environmental nanoplastic pollution continues to increase, understanding maternal–fetal transfer is crucial. Further studies should address chronic low-dose exposure, developmental toxicity, and the physicochemical factors affecting placental permeability. Improved analytical methods such as Raman or FTIR spectroscopy will be essential for accurate particle identification and contamination control.

In conclusion, nanoplastics penetrate the rat placenta and accumulate in fetal tissues, with the placenta showing the highest concentration among examined

Rapid Single-Particle Chemical Imaging and Analysis of Nanoplastics by Stimulated Raman Scattering Microscopy

Naixin Qian, PhD

Columbia University

Steven C. Sutton (UNE), Ronald D. Hills Jr (UNE)

Nanoplastics represent an emerging class of environmental contaminants with the potential to cross biological barriers and impact human health. However, their small size and chemical diversity have made accurate identification and quantification at the single-particle level particularly challenging. Here, we present a stimulated Raman scattering (SRS) microscopy platform that achieves rapid, chemically specific imaging of individual nanoplastics down to 100 nm. By combining a comprehensive spectral library with data-driven polymer identification algorithms, our method recovers chemical specificity beyond conventional spectral-matching approaches. We apply this workflow to bottled water, quantifying thousands of individual micro- and nanoplastics with multidimensional statistical profiling, including number- and mass-based abundance, polymer-specific size distribution, and particle morphology. This single-particle approach reveals tremendous heterogeneity in nanoplastic populations and uncovers previously inaccessible exposure information. Beyond environmental monitoring, our framework provides a broadly applicable strategy for imaging nanoplastics in biological matrices, laying the foundation for mechanistic studies of biodistribution and toxicity

Advancing Microplastic Risk Assessment: The ToMEx 2.0 Database, Quality Evaluation, and Probabilistic Modeling Framework

Scott Coffin

California Office of Environmental Health Hazard Assessment

Scott Coffin 1, Leah M. Thornton Hampton2 , Dana Briggs Wyler2, Bethanie Carney Almroth3 , Win Cowger4 , Darragh Doyle3, Eden K. Hataley5, Sara J. Hutton6 , Magdalena M. Mair7 , Ezra L. Miller8 , Laura Monclús9, Emma E. Sharpe10, Siddiqui Samreen11 , Kazi Towsif Ahmed12, Quinn P. V. Allamby13, Ana L. Antonio Vital14, Davide Asnicar15 , Jennifer L. Bare16 , Andrew Barrick17 , Katherine Berreman11,Lidwina Bertrand18, Virginia Boone19, Agathe Bour20
Julian Brehm14, , Victor Carrasco-Navarro21, Travis Cook22 , Garth A. Covernton23, Patricia Cubanski1 , Pedro M. C. Da Silva19, Luan de Souza Leite24 , Sam M. Gene25 , Ludovic Hermabessiere23 , Asta Hooge20 , Yuichi Iwasaki26 Natasha Klasios27 Christine M. Knauss28 Azora König Kardgar3 Philipp Kropf29 Isaac B. Kudu30 Anna Kukkola31 Christian Laforsch14 Stephanie B. Kennedy16 Frederic D. L. Leusch32 Lucy Wei Li33 Hsuan-Cheng Lu32Judd Mahan34 Uddin Md Saif35 Simona Mondellini14 John P. Norman36 Zacharias Pandelides37 Tove Petersson3 Danielle A. Philibert15 Elina Kvist3 Anja F. R. M. Ramsperger7 Gabrielle Rigutto38 Sven Ritschar14Monica H. Sandgaard20 Jona Schmitt14 Matthias Schott14 Michael Schwarzer14 Katryna J. Seabrook25 Teresa M. Seifried27 Rohan Sepahi39 Mariella Siña40 Alex N. Testoff41 Maaike Vercauteren42 Colleen M. Wardlaw13 Andrew Yeh43 Rachel Zajac-Fay37 Alvine C. Mehinto2
1 California State Water Resources Control Board
2 Southern California Coastal Water Research Project Authority
3 University of Gothenburg
4 Moore Institute for Plastic Pollution Research
5 University of Toronto Scarborough
6 GSI Environmental Inc.
7 University of Bayreuth
8 San Francisco Estuary Institute
9 Norwegian Geotechnical Institute
10 Western Washington University
11 Oregon State University
12 Bangladesh Agricultural University
13 McMaster University
14 University of Bayreuth
15 Huntsman Marine Science Centre
16 ToxStrategies, LLC
17 Auburn University

18 CIBICI-CONICET & FCQ-UNC
19 Potomac-Hudson Engineering
20 Roskilde University
21 University of Eastern Finland
22 Beiersdorf, Inc.
23 University of Toronto
24 University of Campinas
25 Queen's University
26 National Institute of Advanced Industrial Science and Technology
27 University of British Columbia
28 University of Maryland Center for Environmental Science
29 University of Leiden
30 Ghana Atomic Energy Commission
31 University of Birmingham
32 Griffith University
33 Metropolitan Water District of Southern California
34 Tetra Tech
35 The Education University of Hong Kong
36 American Chemistry Council
37 Geosyntec Consultants
38 University of California Berkeley
39 Environmental Sustainability Works; MAIVO Repair Network LLC
40 National Taiwan University
41 Montrose Environmental Solutions
42 Ghent University

The Toxicity of Microplastics Explorer (ToMEx) is a hazard database and toolkit designed to enable quantitative risk assessment, quality evaluation, and more. Through a collaborative effort of > 75 volunteers from 14 countries, ToMEx just underwent a massive update - aggregating ~13,000 toxicity records from ~ 300 studies across freshwater and marine taxa. While this expansive dataset enables finer ecotoxicological hazard assessment – including the separation of freshwater and marine environments – unfortunately, 88% of studies still failed minimum quality criteria, emphasizing the urgent need for standardized, fit-for-purpose ecotoxicity testing.

Assessing risks to ecosystems from microplastics requires modelling that accounts for the diverse, continuous nature of the unique contaminant suite. California previously developed and applied a quantitative risk assessment framework to handle the diverse nature of microplastics using ecologically relevant metrics, data alignments, and bioaccessibility modelling in combination with species sensitivity distributions (SSDs). However, uncertainties due to the modelling process were not fully accounted for. We expanded upon our previous methodology to holistically account for uncertainties through the development of a novel framework combining data alignments, Monte Carlo uncertainty propagation technique, and a Probabilistic Species Sensitivity Distribution Plus (PSSD+) model. We applied this approach to marine and freshwater ecosystems and performed sensitivity analyses to shed insights on the model and underlying data. Compared to conventional aligned SSDs, our probabilistic approach produced more precautionary but more uncertain thresholds - up to two orders of magnitude more variable - revealing that data alignment uncertainty and bioaccessibility dominate overall risk uncertainty.

In addition to updating the database and developing and applying an updated risk assessment framework, our workgroup performed an in-depth assessment of their quality and associated trends and built machine learning-based models to predict toxicity. This presentation will highlight significant findings from these sub-projects.

Note that the presenter (Dr. Scott Coffin) is employed at California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA). The views are those of his and do not necessarily reflect the views or policies of OEHHA or California Environmental Protection Agency. Furthermore, the workgroups and projects presented in this presentation were conducted during Scott's previous employment with the California State Water Board to fulfill legislative requirements of Senate Bill 1263.

Airborne Microplastics

Pyrolysis-GCMS analysis of Microplastics in the air atmosphere

Athena Nguyen
Frontier Lab America

Microplastics are now a global problem. They are tiny fragments shed during the degradation of larger pieces of plastic. They are light enough to be transported by the wind over large distances. Due to their small size, Microplastics (MPs) end up in all sorts of places, including the air we breathe and the water we drink.

In this presentation, we demonstrate the study of microplastics (MPs) in the air atmosphere. The method requires very little sample preparation. The MPs were collected by passive sampling method in three different rooms. After 30 days, the analysis was carried out using the micro-furnace pyrolyzer to perform Flash Pyrolysis-Gas chromatography/ Mass spectrometry (Py-GC/MS).

Micro-furnace Py-GC/MS is an easy solid sample introduction technique that expands the application areas of GC/MS. It is easy to use and simple to operate. The solid samples can be analyzed as is without going through any solvent extraction steps. This fastens the workflow and reduces labor intensive.

The data obtained were analyzed by using the F-search MPs library. The software created the calibration curve automatically, and quantification was done within minutes.

Challenges and Opportunities in the Toxicology of Microplastics in Ambient Air

Sabina Halappanavar, PhD
Health Canada

Sabina Halappanavar (Environmental Health Science and Research Bureau, Health Canada; Department of Biology, University of Ottawa. Ottawa, Canada)
Luna Rahman (Environmental Health Science and Research Bureau, Health Canada)

Human health effects of microplastics/nanoplastics (MP/NP) remain unclear due to a lack of systematic studies. Reference MP/NP reflective of real-world exposures are not available for toxicological testing, and there are currently no standardized protocols for isolating sufficient quantities of MP/NPs from complex environmental samples. In this study, ambient air samples were analyzed to identify the types of MP/NP present. Subsequently, standard operating procedures were developed for the laboratory-scale generation of well-characterized MP/NP representative of environmental exposures. The potential of these particles to induce lung injury or toxicity was assessed using human lung epithelial cells.

Commercially available PS beads of various sizes, nylon powder, PMMA, and polyethylene MP/NPs were purchased. Additionally, respirable size MP/NP of different shapes were generated in-house using plastic water bottles, storage containers, and nylon tea bags, abundant sources of MP/NP pollution in the air, using different methods, and weathered using a solar box. Both the purchased and in-house generated MP/NPs were characterized for dry size, shape, size distribution in the exposure medium, and chemical composition. Toxicity was evaluated using lung cells. Endpoints assessed included cell viability, immune and inflammatory responses, gene expression changes, genotoxicity, and particle uptake. The gene expression profile induced by the most toxic MP/NP was compared to previously generated gene expression data from nanomaterial exposure in these cells.

The study successfully established several methods, including methods for isolating, weathering and characterizing MP/NP from plastics used and abandoned every day. Exposure of cells to the collection of individual MP/NP resulted in dose, time and MP/NP type-dependent reductions in cell viability. Commercially available 100 nm PS, PMMA and in-house generated polyethylene terephthalate MP from plastic water bottles induced secretions of inflammation associated proteins and the

formation of micronuclei, a marker of genetic damage. The smaller size fractions of MP/NP types were more genotoxic compared to their larger counterparts. Weathering impacted MP characteristics of some and influenced their toxicity. Gene expression analysis revealed pathways associated with pathogen response in MP-induced toxicity.

In the absence of information on effects of real-world MP/NP exposures, the methods developed and insights gained in this study are valuable. Preliminary results indicate that exposure to MP/NPs can be harmful to cultured cells. Although some apical responses are similar to those observed in cells exposed to nanomaterials, the molecular-level responses differ. Overall, these findings highlight the need for further research to fully understand the human health effects of environmental MP/NP exposure.

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Environmental microplastics - from our households to our rivers and oceans and back to our table

Elise Granek, PhD
Portland State University

Granek, E.F. (Portland State University); Traylor, Summer (NOAA Corps); Duncan, Marilyn; Talbot, Becky (ODEQ), Baechler, B. (The Ocean Conservancy), Brander, S. (Oregon State University); Baird, Kervelle (Portland State University); Evans, Katherine (Portland State University)

Sources of environmental microplastics into urban environments include washing machines, and dryer vents. However, the extent to which these various sources contribute microplastics into our air and water have not been explicitly compared. To assess whether washing machines or dryer vents are greater contributors of environmental microplastics, we

simultaneously installed and sampled filters on household washing machines and dryers across two coastal communities for a 30 day period. We quantified the dry weight of the microparticles in each of the filter types and compared within and between households. We also surveyed users about the ease of use of each filter type. Washing machine and dryer type and age affected the amount of microparticles collected in the filters. The efficacy of the washing machine and dryer vent filters at trapping microplastics and the user experience can inform policy for wider application to minimize environmental microplastics from laundry. Reductions in microfibers entering the environment is essential to reducing exposure by organisms, including humans.

Maternal-Fetal and Reproductive Health

Polystyrene and polyethylene terephthalate nanoplastics differentially impact mouse ovarian follicle function

Genoa Warner, PhD

New Jersey Institute of Technology

Genoa R. Warner, Hanin Alahmadi, Maira Nadeem, Alixs M. Pujols, Raulle Reynolds, Mohammad Saiful Islam, Indrani Gupta, Courtney Potts, Allison Harbolic, Gania Lafontant, Somenath Mitra (Department of Chemistry and Environmental Science, New Jersey Institute of Technology, Newark, NJ)

Exposure to micro- and nanoplastics is unavoidable. Foods and beverages contain plastic particles from environmental contamination and processing and packaging materials, which are frequently made of polyethylene terephthalate (PET). Micro- and nanoplastics have been detected in human tissues such as the brain, liver, and placenta, as well as in ovarian follicular fluid, but little is known about the effects nanoplastics have on the female reproductive system. In addition, few studies on the health impacts of nanoplastics have been performed using environmentally relevant plastic types and concentrations. Thus, this research tested the hypothesis that nanoplastics made of spherical polystyrene (PS), a common model nanoplastic, would have different effects on cultured mouse ovarian follicles compared to secondary PET nanoplastics at environmentally relevant doses. The ovary is a highly sensitive reproductive organ responsible for the development of follicles, which contain the oocyte, and production of steroid hormones. Follicles were harvested from adult mouse ovaries and cultured for 96 h with vehicle, spherical commercially available 220 nm PS nanoplastics (1–100 µg/mL), or lab-generated 240 nm PET nanoplastics (0.1–10 µg/mL). PS and PET nanoplastic exposure inhibited follicle growth and altered expression of genes related to steroid synthesis, cell cycle, and oxidative stress. PET nanoplastics increased levels of pregnenolone and decreased expression of Cyp17a1. Overall, both plastic types altered ovarian function, but they impacted different genes in similar pathways. These findings suggest that nanoplastic exposure at environmentally relevant concentrations may pose a risk to female reproductive health by disrupting hormonal and molecular pathways. In addition, environmentally relevant plastic types and doses are necessary for studying health impacts of nanoplastics.

Polymer, Size, and Time Shape Microplastic Cytotoxicity Across Placental and Immune Cells with Links to Preterm Birth-Relevant Immune Microenvironments

Myla Stanford

Baylor University

Myla C. Stanford, B.S. (Baylor College of Medicine & Texas Children's Hospital, Department of Obstetrics & Gynecology, 1 Baylor Plaza, Houston, TX 77030), Jacquelyne C. Howell (Baylor College of Medicine & Texas Children's Hospital, Department of Obstetrics & Gynecology, 1 Baylor Plaza, Houston, TX 77030) , B.S., Cynthia Shope, M.S. (Baylor College of Medicine & Texas Children's Hospital, Department of Obstetrics & Gynecology, 1 Baylor Plaza, Houston, TX 77030), Enrico R. Barrozo, Ph.D. (Baylor College of Medicine & Texas Children's Hospital, Department of Obstetrics & Gynecology, 1 Baylor Plaza, Houston, TX 77030)

Background. . Micro- and nanoplastics (MNPs) are increasingly detected in human tissues; however, there is limited quantitative toxicity data for placental and immune cell types. Understanding when and where different cell types are most vulnerable can help guide mechanistic research.

Objective. Test whether MNP exposures create cell-type–specific susceptibility windows aligned with preterm birth (PTB)-relevant immune microenvironments. We hypothesized that smaller particles and more reactive chemistries (e.g., those releasing additives) would reduce CC50 values, particularly in macrophages compared to trophoblasts and T cells, with peak effects at 24–48 hours. These windows were expected to mirror pro-inflammatory niches observed via spatial transcriptomics at the maternal–fetal interface.

Methods. CC50 values were measured across three polymers (PE, PS, PVC), two sizes (Small, Large), and four timepoints (3, 6, 24, 48 h) in human trophoblasts (BeWo, HTR8, JEG3), T cells (Jurkat), and macrophages (THP-1). Replicate-level dose-response data were modeled using a mixed-effects framework: cc50 ~ cell_line Size + cell_line Timepoint + cell_line*Treatment + (1|Replicate).

Contrasts referencing Jurkat were obtained using emmeans. To control for multiple testing while maintaining power, we applied weighted Benjamini–Hochberg FDR (weights $1/SE^2$, mean-normalized) within biologically relevant families (e.g., Timepoint × Treatment × Size). Sensitivity analyses included hierarchical FDR and cell-type–specific family groupings. Inference was based on q-values.

Results. Jurkat cells showed the highest resistance (reference CC50) and were used to assess differential susceptibility. After weighted FDR correction, responses varied by condition and did not follow global trends across polymers or cell types. A notable susceptibility window appeared in trophoblasts at 24 h with PS–Small: BeWo (Δ CC50 = −84; 95% CI −126, −42; q=0.042) and JEG3 (Δ = −99; 95% CI −141, −56; q=0.042) were significantly more sensitive than Jurkat. In contrast, PVC–Small at 48 h showed no FDR-significant differences (all q≥0.05), despite small nominal p-values, supporting a context-dependent, rather than universal, cytotoxicity profile. Interaction summaries highlighted additional condition-specific effects: at 24 h with PE/Mix, BeWo (Δ ≈ −96; 95% CI −153, −40; q≈0.001) and HTR8 (Δ ≈ −59; 95% CI −102, −16; q≈0.003) were sensitive; size-specific effects were seen in JEG3 Small/PE (Δ ≈ −62; q≈0.03) and HTR8 Large/PE (Δ ≈ −63; 95% CI −111, −15; q≈0.009). No broad, polymer-independent differences remained after correction.

Conclusions. MNP cytotoxicity in pregnancy-relevant systems is context-dependent, shaped by polymer, size,

Rethinking Fetal Risk: What 14C-Polystyrene Reveals About Nanoplastic Accumulation During Pregnancy

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Micro- and nanoplastic exposure is now a certainty; what remains uncertain is how particles distribute and translocate during pregnancy. We propose a quantitative, artifact-resistant framework for tracking nanoplastic accumulation using carbon-14-labeled polymers. 14C-radiolabeling has become a valuable technique for understanding the in vivo behavior of various compounds while preserving their original composition and properties. Here, we have synthesized 14C-labeled polystyrene particles of three different sizes (33 ± 11 nm, 246 ± 81 nm, and 1052 ± 189 nm) and tracked their translocation in pregnant mice. In late-gestation mice, we compared two exposure routes – repeated intranasal administration and single intravenous injection – and then performed whole-organ radioassay across maternal tissues, placentae, fetuses, blood, and excreta. Biodistribution and excretion of the polystyrene particles followed patterns observed with other nanoparticles: pulmonary retention and excretion through the GI tract after intranasal administration (0.5 mg per mouse on GD12, GD14, and GD16, n = 7), and accumulation in liver, spleen, and lungs after intravenous injection (1.5 mg per mouse on GD16, n = 7). We did not detect 14C in placentae or fetuses after intranasal administration. After intravenous administration, around 0.10-0.15% of the injected polystyrene particles were detected in the placentae with all particle sizes. Our results indicate that a small number of polystyrene particles in the blood flow may accumulate in the placenta. However, the portion of plastic particles in the blood flow remains low due to the efficient clearance mechanisms of nanoparticles in mammalian systems. The polystyrene particles used here had the radiolabel covalently incorporated into the backbone of the material. This allows for the tracking of unmodified polystyrene particles, preserving their intrinsic behavior. Importantly, the use of radiolabeled particles avoids the confounding issue of background signal; any radioactivity detected in tissues can be confidently attributed to the administered dose. The use of 14C-labeled particles can be extended to other polymer materials and chronic exposure investigations that are required to fully recapitulate the real-world human exposure.

Micro- and Nanoplastics (MNPs) in the Human Reproductive Tract: Blank-Corrected Polymer Burdens in Follicular Fluid and Endometrium Associate with IVF Endpoints and Path-Confirmed Polyp

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Structured Abstract (2,881 of 3,000 Characters)
Objective: To quantify micro- and nanoplastic (MNP) polymers in follicular fluid (FF, µg/mL) and endometrium (µg/g tissue) using blank-corrected pyrolysis-GC/MS, and to examine associations with IVF outcomes and endometrial pathology.
Design: Cross-sectional analyses of prospectively collected FF and clinically indicated endometrial specimens from a single academic center.
Materials and Methods: Twelve polymers were quantified using Py-GC/MS. QC/contamination control included specimen collection procedural blanks, 0.2-µm filtered solvents, polymer-specific calibration curves, and a positive-pressure hood. Blank subtraction was performed for each batch on a polymer basis; negative values were set to zero and flagged. LOD/LOQ were estimated from blank distributions (LOD≈mean_blank+3SD; LOQ≈ mean_blank+10SD). Exposures were log10(x+1)-transformed and scaled by IQR. Outcomes included fertilization and blastulation rates (%) and pathologist-confirmed endometrial polyps (yes/no). Models involved beta regression (logit link) for rates and logistic regression (Firth when needed) for binary variables, adjusted for maternal age and BMI at retrieval (centered), as well as male-factor infertility; race/ethnicity were assessed in sensitivity analyses. Multiplicity was controlled through permutation-FDR (q_perm<0.10 as primary) within outcome families; BH-FDR and nominal p-values are presented additionally.
Results: FF cohort (n=40 fertilization; n=39 blastulation). Higher nylon-6 (N6) was associated with lower fertilization (Δ=−6.29 percentage points (pp) per IQR, 95% CI −11.3 to −1.3; p=0.0168; q_perm=0.033) and lower blastulation (Δ=−7.71 pp, 95% CI −14.3 to −1.1; p=0.0228; q_perm=0.085). Higher polyethylene terephthalate (PET) was linked to lower fertilization (Δ=−12.16 pp, 95% CI −22.2 to −2.1; p=0.0200; q_perm=0.033). Endometrium cohort (n=26; 11 path-confirmed polyps/15 controls). Polyvinyl chloride (PVC) burden was tied to path-confirmed polyp (ORIQR=2.80, 95% CI 1.03–7.61; p=0.043; q_perm=0.011). PU (ORIQR=3.50; q_perm=0.066) and styrene-butadiene rubber (SBR) (ORIQR=3.67; q_perm=0.069) were flagged by permutation-FDR. Findings remained consistent after subtracting blanks, handling LOQ, and using different covariate sets.
Conclusions: After thorough blank correction and permutation-FDR control, FF PET and N6 are linked to reduced fertilization rates (with N6 also associated with lower blastulation), and endometrial PVC is connected to path-confirmed polyps. Results support a comprehensive, polymer-specific exposure framework for REI outcomes.
Impact Statement: To our knowledge, this is the first REI study to combine blank-corrected, polymer-resolved Py-GC/MS with outcome-focused modeling across both FF and endometrium. Using contamination control and permutation FDR provides a rigorous framework for future human MNP health outcome research.

Micro and nanoplastic inhalation throughout pregnancy disrupts placental invasion and morphology in Sprague-Dawley rats

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Micro- and nanoplastic particles (MNP) are a ubiquitous environmental contaminants. Multiple studies have shown that MNP translocate to and deposit within human placental tissues. Central to placental function is appropriate uterine invasion and the adequate development of maternal-fetal blood spaces for nutrient and waste exchange. Impaired to placental invasion and morphological development have been associated with decreased maternal health and poor fetal outcomes. To date, placental development has not been assessed following maternal exposure to MNP throughout pregnancy. Pregnant Sprague-Dawley rats were exposed to polyamide-12 (nylon) MNP from gestational day (GD) 5 through GD 19. Gross and histological analysis of placental morphology, invasion of spiral arteries, and angiogenic signaling were evaluated on male and female placentas at GD 20. Maternal MNP inhalation reduced the relative distance of trophoblast invasion into the uterus and limited spiral artery remodeling as evidenced by residual staining of smooth muscle actin. Moreover, MNP inhalation significantly altered the size and number of maternal and fetal blood spaces collectively reducing surface area for maternal-fetal nutrient/waste exchange. Lastly, there were key changes in the enrichment and spatial distribution of angiogenic and antiangiogenic mRNA transcripts that regulate branching and surface area for maternal-fetal exchange in the placenta. Placental invasion, development, and

morphology are necessary for a successful pregnancy and the maintenance of maternal-fetal health. Disrupted development can have severe consequences for the mother and developing fetus. Future studies are required to assess the influence of MNP exposure on generational health.

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Methods for detection and quantitation

p-CAPture: A novel method to identify and quantify micro- and nanoplastics

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The ubiquitous existence of micro- and nano-plastics (MNPs) raises concerns associated with their potential impact on human and planetary health. However, while mapping MNPs has been conducted in various environmental settings, including marine, freshwater, terrestrial, and atmospheric systems, and, more recently, in human tissues, the low throughput, a lack of standardized protocols and sparse sampling density hinder the development of comparable maps. As a result, while environmental and human microplastic mapping has begun, scalable, sensitive, and cross-validated techniques are still needed to accurately assess distribution, exposure, and risk. For instance, FTIR and Raman spectroscopy allow for non-destructive chemical identification but can only analyze particles larger than 10 µm. Py-GC/MS, while capable of detecting a broad range of polymer types and particle sizes (from nanometers to micrometers), relies on mass-based detection rather than size resolution. The need for large sample together with the slow/laborious processing time (a few hours to days) poses barriers to widespread monitoring and exposure assessment.

Our lab has developed p-CAPture (plastics – Color and Photographs Capture), with the aim to standardize and increase the sensitivity and throughput of the current techniques to detect and quantitate MNPs in environmental and human matrices. p-CAPture is a dye-based and machine learning-based technology that uses Fluorescent Activated Cell Sorting (FACS) and trained neural networks with images from a high throughput bright field camera to characterize MNPs (type, size and amounts). A 50-200 µL aliquot of each sample is incubated with a panel of eight fluorescent dyes. This thermal dye incubation enhances the generation of distinct fluorescence signatures that aid in polymer-type identification. Flow cytometric data is acquired, capturing quantitative fluorescence signals across nine fluorescent detectors. These multichannel signatures enable the generation of unique spectral profiles corresponding to specific polymer classes. In addition, the cytometer collects up to 30,000 brightfield images per sample of the dye-labeled MNPs. These images are curated and pre-classified and then undergo detailed analysis using our neural network-based classification model (model 8). This integrated approach enables polymer identification and quantification, providing detailed information on both the types, relative size abundance and shape of MNPs present in each sample.

Our current technology processes 50–200 µL per sample in 4–9 minutes, with a size detection limit down to 300 nm. This capability enables the analysis of at least 90 samples per day, substantially surpassing the throughput of current methods, while offering the potential to expand the detectable range of MNP monitoring. These advancements position the platform as a powerful tool for environmental surveillance, and public health applications.

Advancing the method for isolating and quantifying MNPs in human cerebrospinal fluid for Brain Waste Clearance Studies

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MNPs have been detected in human feces, urine, blood, and various organs, raising concerns about human exposure and potential health implications. However, isolating and quantifying MNPs from complex biological matrices remains a major analytical challenge. Our team has made significant development by developing a novel approach to isolate and quantify MNPs from human tissues using advanced spectroscopic and microscopic techniques. The findings show significant MNPs accumulation in the human brain compared to the liver and kidney, raising concerns about brain waste management and potential toxic effects on the central nervous system (CNS) function. Here, we assess the quantity and physicochemical properties of MNPs in human cerebrospinal fluid (CSF) using pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS). The initial quantitative measurement was conducted on CSF samples (n=14) collected from a brain injury cohort. Polymer concentrations ranging between 13.3 and 82.8 µg/ml were detected, with a mean of 22 µg/ml for the summed polymer concentrations. To validate our experimental approach, artificial cerebrospinal fluid (aCSF) spiked with known polymer standards is analyzed to assess matrix interference removal and recovery efficiency. This will help us advance the methodological precision to facilitate the implementation of accurate correlation studies with brain waste clearance and CNS pathologies.

Trace Level Quantitation of Micro- and Nanoplastics Utilizing Thermal Desorption and Pyrolysis–GC/MS Coupled with Selective Ion Monitoring: Development and Validation

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Micro- and nanoplastics (MNPs) are now ubiquitous across atmospheric, aquatic, terrestrial, and biological systems, creating urgent challenges for environmental monitoring and risk assessment. Conventional techniques such as ATR-FTIR and SEM are constrained by particle size limits and surface dependence, while existing pyrolysis–gas chromatography mass spectrometry (py–GC/MS) workflows suffer from matrix-driven interferences, co-elution, signal inflation, and unstable detection limits. These limitations undermine reproducibility and routine trace-level monitoring, particularly in studies with limited sample mass such as bioaccumulation in tissues where trace level analysis is required for high-throughput routine analysis. We present an enhanced thermal desorption-pyrolysis-GC/MS (TD-py-GC/MS) workflow explicitly designed to stabilize performance and improve sensitivity and resolution for MNP analysis. A dual stage thermal desorption (TD) sequence removes volatile and semi-volatile interferences prior to pyrolysis, yielding cleaner chromatograms, reduced false positives, and additive-specific profiles that support source attribution to quality control. To streamline calibration, we developed a microwave-assisted digestion protocol for preparing multi-polymer standards, allowing trace level measurements aimed at creating high throughput calibration resources while reducing the reliance on current labor-intensive microbalance methods. Using selective ion monitoring (SIM) to target diagnostic fragments, we achieved approximately 6-10 times lower method detection limits relative to full-scan acquisition across ten environmentally relevant polymers (PE, PET, PVC, PS, PP, PMMA, ABS, SBR, N6, and N66). The combined strategy mitigates matrix effects, improves quantitative robustness, and supports standardized, scalable deployment in environmental screening, regulatory monitoring, and mechanistic studies of plastic occurrence. Overall, Dual TD-py-GC/MS with SIM offers a practical, reproducible, and trace-sensitive solution to advance analytical quantitation of MNP research.

A machine-learning powered pipeline for microplastic quantification and classification using Py-GC/HRMS: Toward generalizable microplastic exposure assessment

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Ubiquitous microplastic exposure raises concerns for human health. However, the exposure assessment of microplastics continues to be a formidable challenge, with over 2,400 substances exhibiting potentially toxicity. Existing analytical methods remain limited in identifying signals from complex mixtures, with

traditional approaches primarily focusing on quantitative analysis of target polymers and relying on manual compound annotations. Our team established a pipeline to quantify and classify microplastic polymers based on Pyrolysis–GC/High-resolution MS (Py-GC/HRMS) total chromatogram full-scan mode data. Further, it validated the additivity of the full-spectrum signal matrix. We proposed and implemented a novel framework with the ability to deconvolute mixture microplastic signals, which was constructed through random linear addition of signal matrix from different polymers and concentrations in our experimental dataset. This method effectively identifies major components and their absolute concentrations. Capable of automated and reproducible processing of high-throughput data. With the establishment of a comprehensive polymer reference database, this framework demonstrates significant potential for scalable human exposure assessment.

Aquatic Environment and Species

Similarities across responses in fish to diverse micro and nanoplastic particle types, informing common mechanisms of action across vertebrates

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Micro and nanoplastics (MNPs) are ubiquitous in the environment and have been detected in most ecosystems, including those that are relatively isolated. The class of contaminants categorized as MNPs are quite broad and encompass variable polymer types, shapes, and sizes. Few studies have compared responses between varied particle types. Fibers are the most frequently detected in the environment, followed by fragments, but also represent a relatively small number of studies. Additionally, most research is conducted using virgin particles when the majority of MNP pollution is from secondary microplastics, which have weathered and broken down over time, modifying surface properties and density. To address these data gaps, we exposed the model fish Inland Silverside, Menidia beryllina, for 21-days to micro and nano cryo-milled tire particles, micro and nano polylactic acid, and polyester microfibers, with both weathered and unweathered treatments included in testing. We evaluated the impacts of these particles on growth, behavior, and gene expression to compare the relative toxicities of the different particles. Overall, the nanoparticles (both PLA and TP) and weathered fibers had the greatest effect on behavior and gene expression. Gene ontology analysis revealed strong evidence suggesting MNP exposure affected pathways involved in both muscle contraction and function, with overlap between NPs and weathered fibers, which we confirmed were breaking down into nano-sized fragments. Similar responses have been observed in other vertebrates. Only unweathered microfibers significantly decreased growth which is likely a result of food dilution. Our results also suggest that under weathering conditions polyester microfibers breakdown into smaller sizes and induce toxicity similar to nanoparticles. This has implications for vertebrate and for human health, given that we are exposed to new textiles and other products that shed fiber in our homes. This study highlights the variable effects of MNPs in fish and emphasizes the importance of considering particle shape and size in toxicity studies. We will discuss the findings of this study and how they align with research on other species.

Leveraging xenopus to assess the risks of microplastic exposure on development and immunity

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Microplastics (1µm-5mm) are ubiquitous in the environment and possess a variety of different shapes and compositions. While bioaccumulation and biological effects of pristine microspheres at high concentrations have been extensively investigated, less is known about effects of low concentration of more realistic microplastics with variable sizes (1-20 um) and irregular shapes (I-MPs). To investigate the immunotoxicology and longterm developmental perturbations of exposure to I-MPs, we have leveraged a comparative biology approach using the amphibian Xenopus. Fully aquatic tadpoles are ideal experimental organism because their post-embryonic development including the immune system is external and not protected by the maternal environment, which make them are especially sensitive to perturbations by water pollutants. Furthermore, the development and physiology of Xenopus are remarkably similar to those of humans. Accumulation rate in tadpole of two types of I-MPs (Polyethylene terephthalate [PET] and Nylon) fluorescently labeled with Nile red was evaluated by fluorescence microscopy on whole mounted tissues and by situ enzymatic digestion followed by filtration using silicon nanomembranes. Upon exposure at concentrations as low as 0.1 mg/L, I-MPs rapidly accumulated within tadpole

intestine, liver, kidneys, and brain, persisting over a week. Furthermore, this accumulation led to macrophages disfunction, compromised antiviral immunity and diminished resistance against infections by the ranavirus FV3, but did not induce marked inflammation. Our data also suggest that a brief developmental exposure to I-MPs results in long-term fitness defects such as, weight gain and delay in metamorphosis completion, whereas chronic immune deficits is currently investigated. Finally, we found that mycobacteria pathogens detected in biofilms associated to environmental MPs, can tightly bind to I-MPs in vitro, which may promote their colonization into tadpoles. These findings carry substantial significance, raising developmental immunotoxicity (DIT) concerns not only for aquatic vertebrates but also for human health.

Spatial and Seasonal Patterns of Riverine Microplastics and Their Ecological Risks: A Case Study from the Cauvery River, India

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Microplastic (MP) pollution in freshwater ecosystems poses a growing global concern due to its persistence, ecological risks, and potential for long-range transport. This study assessed the abundance, characteristics, polymer composition, and ecological risks of MPs in surface water from 19 sites along the Cauvery River, Tamil Nadu, India, during the dry (February) and wet (November) seasons. MP concentrations ranged from 0.52 to 6.16 particles L^{-1}, with higher values observed during the wet season, highlighting seasonal influences on transport and accumulation. Identified morphotypes included fibers, films, fragments, pellets, and beads, with fibers dominating. Most particles ranged between 500–1000 µm in size. Scanning electron microscopy indicated advanced weathering features such as cracks, fibrils, and surface pitting. Polymer analysis using µ-FTIR, Raman spectroscopy, and pyrolysis-GC/MS confirmed the presence of polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), and polyamide (PA). The polymer hazard index (PHI) varied from 20.2 to 29.65, classifying all sites as moderate hazard (Class III). Comparative insights with other Indian and international freshwater systems suggest that urban, industrial, and agricultural activities significantly influence MP pollution in the Cauvery River. These findings emphasize the importance of region-specific monitoring and management strategies to mitigate both point and non-point sources of MP contamination in riverine environments.

Structural degradation of microplastics from thermal oxidation increases carbon leaching in aquatic environments

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This study aims to quantify and compare the leaching potential of polyvinyl chloride (PVC) and polyethylene terephthalate (PET) microplastics (MPs) after exposure to thermal oxidation. The rising global incidence of wildfires along with the frequency of open burning makes the thermal oxidation of MPs an emerging environmental concern. Although this process alters the chemical structure of MPs and may alter their behavior in the environment, the specific impacts of thermal oxidation on MP leaching mechanisms remain poorly understood. We quantified total carbon (TC) and dissolved organic carbon (DOC) in MP leachates using a total organic carbon (TOC) analyzer to compare release behavior differences between thermally oxidized MPs and non-thermally oxidized MPs when exposed to freshwater and DI water. To track chemical and physical changes before and after thermal oxidation and leaching, we analyzed MPs using attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectroscopy, scanning electron microscopy (SEM), elemental analysis (EDS), and zeta potential (ZP) measurements. These characterization techniques showed changes to elemental composition, increased carbonyl index, and decreased ZP attributed to burning, proving that thermal oxidation alters the chemical structure of MPs. Our results showed an increase in TC leaching as a result of thermal oxidation, with 100°C burned PVC leaching 1.3x more and 250°C PVC leaching 8.9x more TC into water compared to non-oxidized PVC. PET showed limited leaching across all oxidation conditions. Current work focuses on in-depth kinetic modeling of DOC release, particularly in thermally oxidized PVC, investigating the role of temperature, agitation, and concentration on leaching mechanisms. These findings highlight the distinct chemical fingerprint and unique leaching behavior of thermally oxidized MP to help better understand their reactivity in the environment.

Exposure Science

Exposure of U.S. Adults to Microplastics from Commonly-Consumed Proteins

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This research, published in 2024, investigated microplastic (MP) contamination in 16 commonly-consumed protein products (seafoods, terrestrial meats, and plant-based proteins) purchased in the United States (U.S.) with different levels of processing (unprocessed, minimally-processed, and highly-processed), brands (1 – 4 per product type, depending on availability) and store types (conventional supermarket and grocer featuring mostly natural/organic products). Mean (±stdev) MP contamination per serving among the products was 74 ± 220 particles (ranging from 2 ± 2 particles in chicken breast to 370 ± 580 in breaded shrimp). Concentrations (MPs/g tissue) differed between processing levels, with highly-processed products containing significantly more MPs than minimally-processed products ($p = 0.0049$). There were no significant differences among the same product from different brands or store types. Integrating these results with protein consumption data from the American public, we estimate that the mean annual exposure of adults to MPs in these proteins is 11,000 ± 29,000 particles, with a maximum estimated exposure of 3.8 million MPs/year. These findings further inform estimations of human exposure to MPs, particularly from proteins which are important dietary staples in the U.S. Subsequent research should investigate additional drivers of MPs in the human diet, including other understudied food groups sourced from both within and outside the U.S.

Assessment of occupational exposure to micro/nano particles generated from carbon fiber-reinforced plastic processing

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Carbon fiber-reinforced plastics (CFRP) are leading functional materials with superior strength and low mass density compared to metal. Our previous factory site analyses found that CFRP processing generates fibrous debris and fine micro/nano-sized particles of various shapes. The present interventional study was conducted at a factory located in Japan and evaluated debris consisting of various-sized particles generated during the industrial processing of CFRP, such as cutting, grinding, and turning of CFRP pipes, using real-time particle monitoring devices of the following: PM4 Digital Dust Monitor (DDM), handled Optical Particle Counter (OPC), Condensation Particle Counter (CPC), and Scanning Mobility Particle Sizer (SMPS). In addition, personal exposure of workers was evaluated using a novel wearable PM2.5-compatible device (P-sensor). First, we confirmed the presence of micro/nano particles in the dust generated during industrial processing of CFRP. Finer CFRP-generated particles were detected by the nanoparticle-compatible devices; CPC and SMPS, but not by OPC or DDM. The dynamic detection pattern of the P-sensor resembled that recorded by the nanoparticle-compatible devices. The novel wearable P-sensor can be used to measure finer particles generated by CFRP processing in occupational settings. Second, the exposure assessment was conducted twice and the levels of the micro/nano particles in the second survey were significantly (less than half) lower than that in the first survey. By avoiding immediate power-off of the exhaust system after operations, the scattering of particles was effectively reduced. Our results indicate that effective use of local exhaust ventilation system improves the workplace environment for particle exposure.

From Packaging to Plate: Systematic Review and Meta-Analysis of Nanoplastics and Microplastics Release from Food Packaging

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Increasing evidence indicates that nanoplastics (NPs) and microplastics (MPs) are released from plastic packaging into food, raising concerns about human exposure to these particles. This systematic review and meta-analysis explores the occurrence and release of NPs and MPs from plastic food packaging into food. Our analysis revealed significant variation in reported occurrence and release of NPs and MPs across studies for different packaging types. For example, paper cups were found to release the highest number concentration of particles, up to 5.4 trillion particles per liter, with sizes ranging from 15 nm to 325 nm. In contrast, fish packaging released the lowest concentration, with only 7 particles per liter, ranging from 50 to 500 μm. Interestingly, we found that studies using methods capable of detecting smaller particles reported higher concentrations of NPs and MPs, regardless of the packaging or material types, release conditions, or study location. NPs and MPs detected in plastic packaging predominantly originate from the packaging materials themselves, although airborne sources or chemicals and simulants used in the studies can also contribute. Elevated temperatures consistently increased the release of NPs and MPs from plastic packaging. Longer contact times were also associated with increased NMP release. However, studies limited to detecting only larger NPs and MPs often observed a decrease in release with extended exposure possibly due to particle sedimentation or degradation into smaller, undetectable sizes over time. Repeated use generally reduced NP and MP release as the dominant release mechanism shifts from detachment of loosely attached particles to degradation.

Microplastic Exposure in Indian Hospitals: Ingestion Risks from Settled Dust, Characterization, and Implications for Vulnerable Populations

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Microplastics (MPs) in indoor environments represent an emerging pollutant with significant human health implications, particularly through ingestion and inhalation pathways. In healthcare settings, where vulnerable populations such as infants and immunocompromised patients spend extended periods. Despite global concerns, data on MP contamination in Indian hospitals remain scarce, limiting evidence-based mitigation. This study provides the first insights into MP exposure in public and private hospitals in Rajkot, India, emphasizing ingestion as a primary route and its potential links to inflammation, endocrine disruption, and respiratory issues. Settled dust samples were collected from diverse zones in two Rajkot city, India hospitals. Samples underwent organic digestion, density separation, and filtration. MPs were quantified and morphologically classified via optical microscopy. Polymer identification used FTIR spectroscopy. Estimated Daily Intake (EDI) via ingestion was modeled using EPA equations. Result shows mean MP concentrations were 65.0 ± 20.3 MPs/g (Hospital 1) and 80.0 ± 38.5 MPs/g (Hospital 2), with fibers dominating (52–69%) and red/blue particles (22–54%) prevalent, linked to PET (dominant polymer) and PE from textiles and disposables. Sizes peaked at 200–500 μm (27–37%), though <50 μm fractions were underrepresented. EDI values highlighted stark risks: infants faced up to 0.82 MPs/kg/day in high-traffic OPDs/corridors—exceeding adult levels (0.02–0.04 MPs/kg/day) by 20–40-fold—due to higher hand-to-mouth behavior and lower body weights. PCA revealed institution-specific patterns, with high-traffic zones driving elevated exposure via homogenized fiber distribution. These levels suggest chronic ingestion could amplify health burdens, including oxidative stress and pollutant bioaccumulation in patients. This baseline reveals substantial MP ingestion exposure in Indian hospitals, disproportionately affecting infants and underscoring the need for urgent interventions like synthetic material substitution, enhanced filtration, and single-use plastic regulations. Future work should integrate inhalation modeling and advanced techniques (e.g., pyrolysis-GC-MS) to refine risk assessments and safeguard healthcare environments.

Cardiovascular Health Effects of Plastics

Microplastics consumption potentiates atherosclerotic lesion development in ApoE-/- mice

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Vast amounts of plastic materials are produced in the modern world and despite recycling efforts, much of this material is disposed in water systems and landfills. In these conditions, physical weathering and photochemical processes break down these polymers into smaller particles of the micro- and nano-scale. In addition, ecosystems can be contaminated with plastic particles which are manufactured in these size ranges for commercial purposes. Independent of source, micro- and nano-plastics (MNP) are abundant in the environment and humans are exposed to these materials through consumption, inhalation, or absorption. Indeed, MNP have now been identified in multiple human tissues. Nevertheless, the health consequences of MNP exposure are largely unknown. Given reports of MMP accumulation in human cardiovascular tissues and some associations with adverse outcomes, we examined if MNP consumption might directly contribute to atherogenesis using a mouse mice. For this study we supplied disease prone, ApoE-/- mice with normal chow and either normal drinking water or that containing polystyrene beads (PS: 0.5□m, 1□g/ml) for 20wk. At the end of this time period, we observed significantly increased lipid accumulation (1.3-fold) in the heart valves of mice consuming the PS-containing water compared to that in mice consuming normal water. These PS-exposed mice also demonstrated increased levels of fasting plasma glucose, but lower levels of plasma insulin. There were no differences in HOMA-IR scores nor in plasma lipids or cytokines between the groups. An aortic transcriptomic analysis revealed that the top pathways upregulated in the PS-consuming mice consisted largely of those impacting immune cell function (T-cell/leukocyte activation, regulation of T-cell/lymphocyte activation, leukocyte proliferation, regulation of cell adhesion). Changes in these pathways are consistent with a pro-inflammatory, atherosclerotic phenotype. Minor changes in the levels of short chain fatty acids were also observed. In a second experiment, we supplied ApoE-/- mice with a Western diet and either normal drinking water or that containing a mixture of two of the most abundant MNP in human cardiovascular tissues, polyethylene and polyvinyl chloride (PE+PVC: PE: 0.065□m, 2.5ng/ml; PVC: 0.25□m, 200ng/ml) for 6wk. Likewise, at the end of this exposure we observed hyperglycemia, hyperinsulinemia and a 1.5-fold increase in lipid accumulation in the heart valves of mice consuming the PE+PVC-containing water. These results suggest that consumption of MNP promotes

Microplastic exposure elicits sex-specific atherosclerosis development in low-density lipoprotein receptor-deficient mice

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Microplastics (MPs) are small plastic particles emerging as significant environmental pollutants and humans are ubiquitously exposed to microplastics. MPs can be detected in human atherosclerotic plaques and have been associated with a higher risk of cardiovascular disease (CVD) and stroke in humans. However, the impact of MP exposure on the cardiovascular system remains elusive. In the current study, we investigated the effects of MP exposure on atherosclerosis development in low-density lipoprotein receptor-deficient (LDLR-/-) mice. Male and female LDLR-/- mice were fed a semi-synthetic low-fat diet and exposed to MPs via daily oral gavage for 9 weeks. We found that exposure to MPs did not affect body weight and circulating lipid profiles in both male and female LDLR-/- mice. Intriguingly, MP exposure led to significantly increased atherosclerosis in male but not female LDLR-/- mice. Single-cell RNA sequencing analysis of the whole aorta revealed that exposure to MPs affected the proportions and cellular processes of key atherogenesis-related cell types, especially endothelia cells. Consistently, MP exposure elicited pro-atherogenic gene expression in murine primary endothelia cells in

vitro. Our findings reveal the atherogenic effects of MPs in vivo and contribute to our understanding of the association between MP exposure and increased CVD risk in humans.

Dietary Ocean Micronanoplastics are Associated Accelerated Atherosclerosis in ApoE-/- Mice

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Introduction: Micronanoplastics (MNPs) are a recently recognized ubiquitous environmental contaminant linked to atherosclerotic and cardiovascular disease outcomes in humans. The mechanisms by which MNPs may affect the pathophysiology of atherosclerosis remain obscure. Animal models of atherosclerosis development, such as the ApoE-/- mouse, may permit the study of MNP-atheroma interactions in a controlled setting. We aim to investigate the effects of dietary ocean-derived MNPs on atherosclerosis development.
Methods: Adult male and female ApoE-/- mice (n=5-7/group) were fed standard or Western diet (WD) with and without 1% (w/w) added ocean MNPs milled into the chow. After 6 or 12 weeks of exposure, animals underwent aortic pulse wave velocity (PWV) recordings using the transit time method. Whole aortas were used to measure atheroma development using Oil Red O (ORO) assay and aortic root histologic analysis by H&E. Ex vivo pin myography of 5 mm aortic rings evaluated wall stiffness by collagen and elastin modulus. Bulk RNAseq of dissociated aortic tissue compared differential gene expression between MNP exposures.
Results: Animal weights did not differ between MNP-fed and control (non-MNP) animals within diet groups. WD-fed animals had mean weight of 29 g at week 6 compared to 25 g in standard chow group (P=0.02). Aortic PWV was 307 cm/s in MNP-fed animals eating a WD compared to 263 cm/s in non-MNP group (P=0.01), suggesting increased aortic stiffness. ORO disclosed significantly greater aortic atheroma area in MNP-fed animals eating a WD (0.66 mm2) versus non-MNP group (0.19 mm2, P=0.007). Aortic root atherosclerotic area was 2.8-fold greater in MNP-fed animals (16.4 um2) compared to control (5.8 um2, P=0.008) with MNP-fed animals demonstrating mean 6 hemosiderin-laden macrophages per high-power field compared to 1.9 in control (P=0.03). Myography confirmed greater elastin modulus in MNP-fed animals (660 vs 587 AU, P<0.05) with a strong trend toward greater collagen modulus (21162 vs 16892 AU, P=0.06) as well. Bulk RNAseq disclosed significant upregulation of several pro-atherogenic genes known to be expressed in vascular smooth muscle cells (VSMC) and macrophages including Slc2a5 (10.5 fold), Acly (3.7 fold), Lep (2.0 fold), and Me1 (2.1 fold), (all P<0.01).

Deciphering the Causal Impacts of Polyethylene and Polyvinyl Chloride Nanoplastics on Vascular Remodeling and Atherosclerosis

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Plastic degradation generates micro- and nanoplastics (MNPs), which are now detected in drinking water, food sources, and air, raising concerns about their cardiovascular effects. Nanoplastics (NPs) are particularly worrisome due to their ability to penetrate biological barriers, circulate systemically, and interact with vascular and immune cells. Recent human studies have revealed accumulation of polyethylene (PE) and polyvinyl chloride (PVC) MNPs in atherosclerotic plaques, correlating with elevated cardiovascular risk. However, the causal and mechanistic links between NP exposure and atherosclerosis remain unclear. Here, we investigated polymer-specific effects of chronic waterborne PE and PVC NPs on atherosclerosis using ApoE□/□ mice fed a high-fat diet (HFD) for 16 weeks. Both polymers accumulated in aortic plaques and resulted in an increased plaque burden. However, scRNA-Seq analyses revealed that PE and PVC induced distinct transcriptional effects in mature and modulated smooth muscle cells (SMCs) within the aorta, suggesting a polymer type-specific mechanisms contributing to SMC phenotypic modulation and plaque progression. PE exposure induced a pronounced shift toward chondromyocytes, characterized by upregulation of

Ibsp, and enrichment of endochondral ossification and biomineralization pathways, suggesting accelerated vascular calcification. In contrast, PVC exposure primarily affected fluid shear stress–related signaling. In vitro exposure of human coronary artery SMCs (HCASMCs) further demonstrated polymer-specific intracellular interactions. PE preferentially associated with mitochondria, while PVC localized to the endoplasmic reticulum. Bulk RNA-Seq further revealed divergent immune and signaling responses in HCASMCs. PE primarily enriched TGF-β and Hippo signaling, indicating a more restricted response centered on cellular reprogramming, whereas PVC broadly activated MAPK, PI3K-Akt, ECM-receptor, and shear stress pathways, consistent with amplified inflammation and vascular remodeling. Collectively, these results support a model in which nanoplastic exposure accelerates atherosclerosis progression through polymer-dependent SMC–immune crosstalk, providing new mechanistic insight into how environmental nanoplastics may contribute to cardiovascular disease.

Methods for Plastics Measurement and Separation

An exposomic analytical framework for measuring micro- and nano- plastic in human biospecimens

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Objectives: Micro- and nanoplastics (MNPs) are an emerging concern for human health that have been reported in a wide range of human tissues and biological fluids. Despite growing evidence of their exposure in human populations, standardized methods for detecting MNPs are still lacking. Existing detection strategies typically focus on a limited set of polymers or additives, failing to capture the full diversity of nanoplastics and associated compounds, and are limited by throughput and sensitivity for detecting a wide range of particle sizes. **Materials and Methods:** In this work, we present a comprehensive analytical framework for MNP biomonitoring in human specimens that integrates sample pretreatment, microplastic separation and enrichment, and MNPs measurement using Pyrolysis-GC/HRMS. This framework enables a detailed and reliable characterization of polymers present in biological samples. **Results:** Three major highlights of this work are: (1) Exposomic analytical framework: Established a comprehensive framework for measuring MNPs in human biospecimens. Method validation confirmed reliable recovery of MNPs at various analytical stages, providing a robust basis for improving and quantitatively evaluating MNP measurement in human samples. (2) Quantitative accuracy and efficiency: Achieved accurate and efficient detection and quantification of 12 types of MNPs: PMMA, N66, PP, PVC, PE, N6, PET, PU, PC, ABS, PS, and SBR, with corresponding limits of detection of 0.005, 0.020, 0.048, 0.255, 0.337, 0.007, 0.013, 0.009, 0.156, 0.016, 0.020, and 0.020 μg, respectively. (3) Comprehensive chemical monitoring: Demonstrated the ability to simultaneously monitor and detect more than 10,000 plastic-associated additives and chemicals. **Conclusions:** This platform represents a significant advancement in the detection of MNPs and offers a scalable solution for assessing plastic exposure in human populations.

Keywords: Microplastics, Exposome, Assay Development, Biomonitoring, Reproductive Health.
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Silicon Nanomembrane Analysis Pipeline (SNAP): A Flexible Workflow for the Multi-modal Analysis of Particulates from Varying Sample Types

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A significant hurdle in microplastics analysis lies in effectively capturing and analyzing the particles of interest, as the most commonly available filters are not designed with microplastics analysis in mind. These filters may have pores of inconsistent sizes, shapes, and porosities. More concerning, they are made of polymers which complicate sample analysis. All of these drawbacks increase analysis costs and lengthen time to results.
Here, the Silicon Nanomembrane Analysis Pipeline (SNAP)

will be presented as a means for addressing these challenges. SNAP is an analytical workflow utilizing novel Silicon nitride nanomembranes to capture, characterize, and enumerate microplastics and other microparticles of interest. The consolidated capture of particulates onto one non-polymeric, planarized observation area enables the direct multimodal analysis of particulates in an efficient manner. The highly conserved pore geometry and consistent background of silicon nanomembranes eliminates the need for error-prone transfers between substrates and improves automated particle recognition and analysis routines. The step-by-step methods for SNAP will be presented and its utility and advantages heuristically demonstrated through the analysis of model particles, biological aggregates, and consumer beverage products. The morphology, composition, and quantity of microplastics and other particulates were respectively determined in these samples, using optical and scanning electron microscopy (SEM), and Raman spectroscopy.

Positioning of Microstructures within Acoustic Waves Enhances Particle Trapping

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Introduction: Ultrafiltration, nanofiltration, and ultracentrifugation are popular techniques for separating microparticles and nano particles (MNPs), but are time intensive and do not operate as a continuous process. The separation of MNPs and biologics have been explored by applying acoustophoretic techniques. Particles in the presence of acoustic waves move due to their relative densities (primary acoustic force) and adsorb to structures based on their proximity (secondary acoustic force) (Laurell +, 2017). Successful acoustic trapping of microparticles flowing through a random mesh structure has been shown (Gupta +, 1997). We explore the acoustic focusing and trapping of microparticles in a novel device, strategically positioning a stainless steel through wire axially within a microcapillary. We designed devices using a cylindrical microcapillary with i) no through wire, ii) a centered through wire and iii) an offset through wire to evaluate acoustic focusing and trapping efficiency.

Methods: A custom cylindrical microcapillary was designed to allow axial placement of a stainless steel through wire (50 μm diameter). Experiments were conducted using high intensity fluorescent Nile red polystyrene microspheres at ~150,000 particles/mL (10-14μm) at a flow rate of 200 μL/min. The acoustic field was applied perpendicular to flow in the borosilicate capillary (1.12 mm ID, 2 mm OD) by a ceramic transducer (PZT). Videos were taken via a CMOS camera mounted to a fluorescence microscope. Videos were analyzed using MATLAB®. COMSOL was used to model flow and pressure profiles using system material properties, dimensions, and experimental conditions.

Results: The presence and positioning of the axial stainless steel through wire affected the flow profiles based on COMSOL simulations. The device with no through wire exhibits maximum flow at the center of the microcapillary, and a minimum flow at the tube walls due to no-slip boundary conditions. Devices with the through wire had minimum flow at the tube walls, as well as at the interface of the steel wire. The predicted pressure profiles for all three devices were nearly identical, suggesting that both the presence and positioning of the wire do not impact the acoustic pressure profiles. Particle trapping to the stainless steel through wire due to secondary acoustic forces occurred for both the centered and offset wire devices. Specifically, the device with the centered through wire achieved 3.3 times greater increase in particle concentration than the device without the wire, highlighting effective particle trapping.

Discussion: Precise positioning of microstructures within acoustic waves leads to optimal acoustic trapping via secondary acoustic forces. This work demonstrates the proof-of-concept that placing microstructures at the pressure node of an acoustic field does not hinder particle focusing, but rather enhances particle trapping, and is a novel approach for acoustophoretic separation techniques.

Innovative Modelling Driven Membrane-Free Microfluidic Separation of Microplastics Model Optimized with Machine Learning

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The pervasive presence of microplastics (MPs) in drinking water poses significant health risks, yet current removal technologies particularly membrane-based filtration are costly, prone to fouling, and energy-intensive. This study proposes an innovative, cost-effective, membrane-free microfluidic device for

MP separation based on size and shape, leveraging fundamental physical principles such as Reynolds number, inertial lift, and drag forces. The device features a specially engineered microchannel that generates targeted flow profiles, enabling precise particle separation through the interplay of inertial and drag forces influenced by channel geometry, flow rate, and particle characteristics. A Multiphysics computational model will simulate particle trajectories and optimize channel design, while a machine learning model trained on simulation data will predict optimal operating conditions for diverse MP types. This integrated approach aims to develop a passive, low-energy device capable of achieving >95% removal efficiency across a wide range of microplastics. By combining Multiphysics modeling with adaptive machine learning control, the system offers a scalable, sustainable, and low-cost alternative to conventional filtration methods. The proposed strategy not only enhances water treatment efficiency but also addresses global challenges in providing safe drinking water, presenting a practical solution for microplastic mitigation in environmental and public health contexts.

Keywords: Microplastics; Membrane-free Filtration; Microfluidics; Multiphysics Modeling; Machine Learning; Water Treatment

Gastrointestinal and Hepatic Effects of Plastics

Investigating the impact of Polystyrene Nanoplastics in liver using hepatic cell lines and human precision-cut liver slices

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Large plastic products degrade during use and after disposal into small particles described as microplastics (<5 mm, MP) and nanoplastics (<1µm, NP). These MP/NPs accumulate in the environment and can enter the human body via ingestion, inhalation or dermal contact. Several studies have reported MP/NP in human tissue, raising concerns about potential adverse health outcomes. Existing research on NP toxicity is variable and lacks sufficient understanding of the liver-associated pathophysiology. To understand the impact of NP on the liver, we determined the uptake and effects of commercially available carboxylate-modified 20 nm polystyrene nanoparticles (PS NPs) in three hepatic models: human carcinoma hepatocytes (HepG2), immortalised human hepatocytes (IHH), and human precision-cut liver slices (hPCLS). We visualised and quantified PS NPs uptake using confocal microscopy and flow cytometry, and analysed cytotoxicity post-exposure. Further, we examined the subtle physiological effects of PS NPs on the redox state and mitochondrial respiration in HepG2 cells.

Exposure experiments show a model and dose-dependent uptake of PS NPs after 24 and 48 hours of exposure in all three hepatic models. 63.0 ± 31.5% IHH cells showed PS NPs uptake at a concentration of 0.1 µg/mL, which is considerably lower than the measured plastic concentration in human blood (1.8 -4.7 µg/mL). Cell viability of IHH cells decreased from 95.2 ± 2% in the control group to 9.7 ± 7.1% at 100 µg/mL after 48 hours of exposure. Early signs of cell injury were observed with high levels of AST enzyme in the media of IHH and hPCLS at high PS NPs concentrations. Additionally, HepG2 cells showed no changes in cell viability, redox state, or mitochondrial respiratory parameters after exposure to PS NPs. In conclusion, the study demonstrates that PS NPs can readily accumulate in hepatocytes, even at a concentration as low as 0.1 µg/mL in IHH cells, and cause cell damage and a decrease in viability at a high dose of 100 µg/mL. The effect of PS NPs is model-dependent, highlighting the need for physiologically relevant toxicity models to study the underlying mechanisms of NP cytotoxicity. These findings emphasise the urgent need to investigate the health effects of NP pollution on human health, utilising environmentally relevant plastic particles and humanised toxicity models.

Elucidating the effects of environmental microplastics on the gut-brain axis of humanized ApoE3/E4 mice

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Microplastics are emerging environmental contaminants due to the rise in their global plastic production. Most common sizes microplastic particles detected in the environment range from 4-15 um in diameter. Their

pervasive presence in various settings—including soil, household dust, and aquatic environments—raises significant environmental and public health concerns. Previous studies detected 5µm plastic microspheres in human gastrointestinal tract, blood, and brain, and the gut-brain axis is increasingly recognized as a key player for neurotoxicity. Microplastics are known to significantly change the gut microbiome composition in wildtype mice; however, very little is known regarding how microplastics modulate the gut-brain axis.

Eight-week-old male and female C57BL/6 mice were orally gavaged vehicle (0 mg/week), a low dose (2 mg/week) of a microplastic mixture (MPs), or a high MPs dose (4 mg/week), twice a week for 4 weeks (n = 4/sex/exposure). The MPs include 5 um polystyrene (PS), polyethylene (PE), and the biodegradable medical plastic congener poly-lactic-co-glycolic acid (PLGA). At the end of the exposure, fecal samples were collected. Total microbial DNA was extracted and subjected to metagenomic shotgun sequencing (MGS). Serum was subjected to both untargeted and targeted short-chain fatty acid (SCFA) metabolomics. TMM normalization followed by Bonferroni's p-value correction looking at a p-value of 0.05- and 1.2-fold change was done on the microbiome data.

MPs in wild-type mice differentially regulated 14 microbial species in males and 18 in females. The high MPs dose decreased the neuroprotective SCFA-producing Akkermansia muciniphila and Bacteroides thetaiotaomicron in males. The high MPs dose increased opportunistic pathogens such as Enterococcus faecalis and Stenotrophomonas pavanii in females. Untargeted metabolomics showed that the MPs altered pathways involved in amino acid metabolism/biosynthesis, anti-inflammatory pathways, and mitochondrial function, with more prominent effects observed at the low MPs dose and in females.

A subsequent in vivo project was conducted on humanized ApoE3/E4 mice to observe the gene-environment interaction of MPs within a humanized Alzheimer's model. Eight-week-old male and female mice were orally gavaged vehicle (0mg/week) or an MPs mixture (2mg/wk) twice a week for 4 weeks (n = 8/sex/genotype/exposure). Total microbial DNA was extracted and subjected to nanopore metagenomic shotgun sequencing (N-MGS). Serum was subjected to both untargeted metabolomics and lipidomics. Left-hemisphere brain sections were prepared for immunohistochemistry (n = 4/sex/genotype/exposure).

In conclusion, the present study shows that MPs altered the mouse fecal gut microbiome in a sex and dose-dependent manner associated with altered serum metabolomes within wild-type mice. Future studies will determine the potential long-term gene-environment interactions of MPs on the gut-brain axis.

Chronic Dietary Microplastic Exposure Weakens Skeletal Integrity

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Humans are estimated to ingest up to 5 grams of microplastics (MPs) weekly through diet, yet the physiological consequences of chronic exposure remain poorly understood. Emerging evidence suggests MPs can disrupt endocrine function and accumulate in various systemic tissues, but the effects on the skeletal system remain unclear, particularly regarding the gut–bone axis. To investigate this, we exposed C57BL/6J mice to polystyrene MPs (0.5–5 µm) incorporated into standard diet pellets for 12 weeks. Although no significant differences were observed in body weight, fat mass, energy intake, or inflammatory markers (serum TNFα, fecal LCN-2 and sIgA) compared to controls, microCT analysis revealed sex- and site-specific skeletal changes following chronic MP exposure. In females, MP exposure reduced spinal trabecular thickness without altering connectivity density and caused reductions in femoral cortical area, cortical thickness, trabecular bone volume fraction (BV/TV), along with increased trabecular separation. In males, spinal BV/TV was preserved, but trabecular thickness increased while connectivity density declined. Male femurs showed reduced BV/TV and increased trabecular separation. Interestingly, serum serotonin levels were elevated in exposed mice. In vitro, serotonin as well as MP exposure significantly reduced osteoblast mineralization, indicating a direct cellular mechanism underlying the in vivo bone loss. Lastly, MPs were detected in human femoral bone tissue supporting a role for hormonal and environmental factors in disrupted bone homeostasis. These findings suggest chronic MP exposure induces skeletal degradation in a sex- and site-dependent manner. The architectural pattern observed, particularly reduced connectivity with compensatory thickening in male spines, resembles osteoporotic bone. Our findings highlight dietary MPs as a novel risk factor for compromised skeletal integrity, with implications for

long-term musculoskeletal health in exposed populations.

Metabolic Reprogramming in Gut Microbiota Exposed to Polystyrene Microplastics

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Background: Microplastics (MPs) are small plastic fragments with diameters less than 5 mm in size and are prevalent in everyday essentials and consumables. Large global plastic production has now led to a flooding of MPs in our natural environment. Due to their detrimental impacts on the planet's ecosystems and potentially our health, MPs have emerged as a significant public health concern. In this pilot study, we hypothesize that MPs exposure will negatively affect gut microbiota composition and function, in which metabolic reprogramming plays an important role. **Methods:** Using in vitro experiments, three bacterial strains (Escherichia coli MG1655, Nissle 1917, and Lactobacillus rhamnosus) were selected to investigate the impacts of MPs exposure. The bacterial strains were individually cultured in an anaerobic chamber and exposed to 1 μm polystyrene MPs at various concentrations (0, 10, 20, 50, 100, and 500 μg/mL) in the culture medium. Results: MPs exposure reduced the growth of all three bacterial strains in a dose-dependent manner. Liquid chromatography mass spectrometry (LC-MS)-based untargeted metabolomics revealed significant differences in multiple metabolic pathways, such as sulfur metabolism and amino sugar and nucleotide sugar metabolism. In addition, we extracted gut microbiota from C57BL/6 mice, and16SrRNAsequencingresults showed a significant upregulation of Lactobacillales and a significant reduction in Erysipelotrichales due to MPs exposure. Furthermore, targeted and untargeted metabolomics corroborated the in vitro results and revealed alterations in microbial tryptophan metabolism and energy producing pathways, such as glycolysis/gluconeogenesis and the pentose phosphate pathway. **Conclusions:** These findings provide evidence that MPs exposure causes comprehensive changes to healthy gut microbiota, which may also provide insights into the mechanistic effects of MPs exposure in humans.

Keywords: gut microbiota; microplastics; mass spectrometry; metabolomics; 16S rRNA

Neurological Health Effects of Plastics (Part 1)

Accumulation of Micro- and Nanoplastics in Human Cerebral Spinal Fluid

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Plastics are emerging pollutants of growing concern due to their ubiquitous presence and potential toxicity to human health, but remain poorly understood. As plastics degrade, they release microplastics (<5 mm) and nanoplastics (<1μm), collectively referred to as MNPs, which can enter the human body through ingestion, inhalation, and dermal contact. Recent studies suggested that MNPs may have the ability to cross biological membranes such as the blood–brain barrier (BBB). A recent study detected MNPs in the cerebrospinal fluid (CSF) of 28 participants using pyrolysis-gas chromatography mass spectrometry (Py-GC/MS) and laser direct infrared imaging (LDIR), confirming that PS, PE, PP, and PVC can reach the central nervous system (CNS). Participants with CNS infections had elevated interleukin-6 (IL-6) and interleukin-8 (IL-8) levels, suggesting a connection between MNPs accumulation and BBB integrity. We used stimulated Raman spectroscopy (SRS) to quantify MNPs and identify plastic types. Compared to LDIR's detection limit (10 μm), SRS' greater sensitivity (0.2 μm) allows the quantification of not only micro, but also nanoplastics. Particle size plays a crucial role in toxicity since smaller particles may have a greater ability to cross biological barriers. Our preliminary data from 10 participants without biomarkers of BBB disruption showed that MNP concentrations in CSF increased with age, but this trend may not persist with a larger sample size. Participants over 70 had an average of ($1.04 \times 10^6 \pm 4.77 \times 10^5$), while those under 70 had ($2.42 \times 10^5 \pm 4.72 \times 10^4$) MNPs per mL. Both groups had higher levels than artificial CSF controls, which averaged ($3.68 \times 10^4 \pm 1.29 \times 10^4$ MNPs/mL). Detected polymers included PVC, PE, PMMA, PA66, PP, and PS, with PVC being most abundant. Nanoplastics accounted for 88% of the total particles with the remaining (12%) being microplastics. Further research is needed to understand MNP accumulation, entry pathways, and neurotoxic effects.

Inhaled Nanoplastics Drive PINK1/Parkin-Mediated Mitophagy and Metabolic Dysregulation, Compromising Neurovascular Integrity

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The global plastic production has resulted in widespread human exposure to airborne nanoplastics (NPs), creating an urgent need to understand their neurotoxic potential. Here, we demonstrate that short-term inhalation of polystyrene NPs causes significant neuropathological changes in the murine brain. Our findings show that NPs exposure induces notable neuronal loss in the cerebral cortex, characterized by dendritic degeneration and mitochondrial pathology, through disruption of neuronal and vascular integrity, ultimately leading to cellular metabolism. Furthermore, we observed significant NP accumulation not only within neuronal and cerebrovascular endothelial cells but specifically concentrating in the mitochondrial compartment of these cell types. Importantly, initial NP accumulation was also evident in the synaptic cleft before major damage. Mechanistically, we identify the PINK1/Parkin-mediated mitophagy pathway as a central driver, not only of neuronal injury but also of concurrent endothelial cell dysfunction. This disruption leads to the breakdown of the blood-brain barrier (BBB) and subsequent perivascular hemorrhage. These structural and functional deficits were

accompanied by a neuroinflammatory cascade, highly characteristic of early-stage neurodegenerative processes. Through integrated in vivo and in vitro analyses, we define a mechanistic pathway by which nanoplastics compromise neuronal and vascular integrity. Finally, bulk RNA sequencing of brain tissue revealed significant alterations in transcriptionally related gene pathways, correlating with the observed neuroinflammatory cascades. This study underscores the potential of airborne nanoplastics to accelerate or contribute to pollution-associated brain disorders and highlights the urgent need for environmental policy and targeted therapeutic interventions.

Axonal Transport of Nanoplastics by Kinesin

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Nanoplastics (NPs), defined as plastic particles <1000 nm, are ubiquitous in our environment, but their impacts on human health are poorly understood. Several studies report NP accumulation in the central nervous system of fish, rodents and flies, and recent work has shown the uptake of different NPs in various neuronal cell types. Furthermore, there is growing evidence that exposure to NPs is a strong risk factor in the development of neurodegenerative disease like Alzheimer's and Parkinson's. NPs enter the body through ingestion or inhalation, and may reach the brain via the circulatory system, the olfactory route, the trigeminal pathway or the vagus nerve. While there are ongoing efforts to study the uptake mechanisms of these NPs, there is little investigation into their post-internalization transport in neurons. Given our increasing exposure and the potential toxicity of NPs, understanding their transport inside our brains is a pressing need.

In neurons, intracellular cargo are transported at millimeters per hour speeds by the molecular motors kinesin and dynein along microtubules- the cytoskeletal filament tracks found throughout axons and dendrites. Kinesin-1, 2 and 3 are fast axonal transport motors, and their tail domains allow specific cargo binding. We hypothesize that these inherently "sticky" tails enable NPs to bind kinesins and hijack the axonal transport system. This would allow internalized NPs to be rapidly transported along axons to vital parts of the central nervous system, driving neurotoxicity and neurodegeneration.

To test this hypothesis, we incubated 50-nm diameter fluorescent plastic nanospheres with Drosophila kinesin-1 and visualized motility along immobilized microtubules in vitro using Total Internal Reflection Fluorescence Microscopy. We found that kinesin-1 can bind and transport polystyrene (PS), carboxyl modified polystyrene (c-PS), polyethylene terephthalate (PET), polyvinyl chloride (PVC), and polyethylene (PE) nanoparticles at speeds ranging from 200-900 nm/s, close to wild-type transport speeds of kinesin-1. Our binding assays indicate that different NPs have varying affinities for kinesin-1 which may be due to differences in surface chemistry. c-PS particles bind more tightly to kinesin-1 compared to PS particles, which we hypothesize is due to electrostatic interactions between the positively charged kinesin tail and negatively charged carboxyl group. PS, PET, PVC and PE particles, which are more hydrophobic, bind less tightly to kinesin.

Our results suggest that kinesin-based cytoskeletal transport may serve as a mechanism by which NPs spread through the brain, which may contribute to neurotoxicity and neurodegeneration. Because kinesin-based transport exists in all cells, our results may be generalized to other tissues and organs in the body.

Benchmarking the Invisible: Modeling Neurotoxicity of Ingested Micro- and Nanoplastics Through Bayesian Dose–Response Analysis Aided by Systematic Evidence Integration

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Despite growing evidence of micro- and nanoplastics (MNP) ingestion through food, no reference doses (RfDs) currently guide human-health risk assessment. To address this, we conducted a systematic review of mammalian oral exposure studies using the PRISMA framework and PICOS model to derive points of departure (PODs) and propose RfDs for MNPs,

establishing a transparent framework for regulatory evaluation of emerging hazards.

From 35,046 articles retrieved from seven databases, we removed duplicates, screened titles with a fine-tuned Large Language Model (LLM) model, and manually reviewed abstracts and full texts, yielding 165 eligible studies across multiple biological systems. Due to the volume and complexity of the data, our detailed analysis in the present study focused on neurological outcomes.

Twenty-two studies addressed neurotoxicity. From these 132 statistically or biologically significant dose–response endpoints, spanning behavioral performance, neuroinflammatory cytokines, oxidative stress markers, and neurodevelopmental or structural measures, models and calculations were developed for the Benchmark Dose Lower Confidence Limit (BMDL) in Phase 1 of a three-tiered pipeline. In Phase 2, each paper was reanalyzed by selecting two representative endpoints based on BMDL, precision, biological relevance, and coherence with related endpoints. Phase 3 will integrate expert consensus to identify the most suitable endpoint and BMDL for deriving final POD and RfD values.

Preliminary results indicate that polystyrene NP consistently exhibit lower BMDLs than MPs across sub-chronic and chronic exposure periods, suggesting greater nanoscale toxicity. MPs BMDLs (95%CrI) ranged from $0.3–2.8\times10^{2}$ mg $kg^{-1}day^{-1}$ (sub-acute), 2.5×10^{-2}–0.25 (sub-chronic), and 5.5×10^{-3}–4.8×10^{-2} (chronic), whereas NP values were 0.22–35.6, 9.0×10^{-3}–0.29, and 3.0×10^{-3}–2.3×10^{-2} mg $kg^{-1}day^{-1}$, respectively. Comparable sub-acute BMDLs were observed for other MP polymers, including polyethylene terephthalate (4.7–10.6mg $kg^{-1}day^{-1}$), polypropylene (2.1–22.5), polylactic acid (0.23–6.98), and low-density polyethylene (0.10–0.84mg $kg^{-1}day^{-1}$). These estimates should be interpreted with caution while Phases 2 and 3 are completed, as this initial analysis is purely statistical and may change with expert inputs.

In addition, consistent with our second objective, these findings demonstrate that study design, specifically exposure duration, dose spacing, and endpoint selection, can significantly impact BMDL values and, consequently, influence POD and RfD estimates, underscoring the importance of an evidence-synthesis approach rather than reliance on individual studies and the need for ongoing evidence collection to keep risk assessments current and robust for decision-making. Together, these efforts provide an essential first step toward establishing science-based regulatory thresholds for MNP ingestion and demonstrate a scalable framework for future risk assessment and policy development.

Pulmonary Effects of Microplastics

Multi-Omic Evidence of Respiratory Toxicity from Tire-Derived Microplastics

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Microplastics (MPs) have become a pervasive and persistent contaminant across freshwater, marine, soil, and atmospheric environments. Humans rely on these resources for clean food, water, and air, yet they now contribute to increased MP exposure. Due to the increasing studies demonstrating MPs in various compartments of the body (lung, brain, heart, placenta, etc.), the need to understand the human health effects of microplastics is imperative. Health concerns from MPs include their ability to transport to different parts of the body, physical characteristics, potentially toxic chemical additives released, and ability to harbor bacteria and viruses that may evade immune defenses. One of the largest but often overlooked sources of MPs is tire wear particles from automotive vehicles, estimated to contribute 26–74% of total global MP pollution. Recycled tire crumbs used in athletic fields, recreational areas, and playgrounds also represent an important exposure source. Tire particles contain additives such as carbon black, plasticizers, vulcanizers, antioxidants, and activators—many with poorly

In this study, we applied a multi-omic approach to investigate the impacts of tire-derived microplastics (MPs) in two upper-respiratory human cell models. Tire particles (<45 μm) were leached in culture media for 24 hours and subsequently administered at concentrations of 0, 50, 100, and 150 μg/mL to human alveolar carcinoma cells (A549) and human bronchial epithelial cells (BBMs). Over a three-day period, we assessed cell proliferation, viability, and reactive oxygen species (ROS) generation using live-cell imaging, as well as inflammatory cytokine release using a multiplex assay. Exposure to tire particle leachates induced concentration- and cell type–dependent increases in proliferation, ROS production, and cytokine release. Furthermore, Media and cell extracts were analyzed using a Thermo Fisher Scientific Vanquish Flex UHPLC coupled to an Exploris 480 Orbitrap High Resolution Mass Spectrometer. Non-targeted analysis revealed cellular uptake of diverse tire additives, including corrosion inhibitors, process regulators, antioxidants, adhesives, and transformation products. Notably, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine quinone (6PPD-quinone)—a toxic environmental transformation product of a common tire antioxidant—was detected in exposed cells. Additional structurally annotated chemicals were linked to hazards such as acute toxicity, skin irritation, and reproductive harm. In addition to upregulation of specific cellular metabolites with tire leachate dosing, bottom-up proteomic analysis identified a novel protein biomarker of airway exposure to quinone-derived tire-associated chemicals. Collectively, these findings underscore the potential human health risks posed by tire-derived microplastics as an emerging global and regional air pollutant.

Human Inhalation of Microplastic and Nanoplastic from E-cigs

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Electronic cigarettes (e-cigs), which heat liquids to generate inhaled aerosol vapors, have become increasingly popular worldwide, particularly among younger populations. While plastics account for up to 80% of the device's main material besides metal, the potential release and inhalation of microplastics (MPs) and nanoplastics (NPs) during e-cig use remains poorly understood. Inhalation exposure is especially concerning, as the respiratory tract may serve as a direct entry pathway for these small plastic particles into the human body, raising potential health risks. In this study, we

systematically investigated the occurrence and characteristics of MPs and NPs released from aerosols of different commercial e-cigarette brands (e.g., Vuse and Eleaf) under varying heating conditions. Aerosol samples were collected and analyzed using a combination of stimulated Raman scattering (SRS) microscopy and pyrolysis–gas chromatography–mass spectrometry (py-GCMS), providing complementary information on particle morphology and polymer composition. Prior to analysis, aerosol aliquots (200 µL) were dispersed with Milli-Q water (900 µL) and menthol (900 µL), then filtered through 0.2 µm Anodisc or silver membranes. Our results revealed that the abundance of NPs in Vuse aerosols was approximately three times higher than in Eleaf aerosols, highlighting brand-specific differences in material release. In agreement with previous studies showing the use of polycarbonate in casings and nylon in wicks (Turner et al., 2024), we identified PA66, PMMA, and PE as the dominant polymer types among the detected NPs. Moreover, more than 90% of the particles detected across all brands were smaller than 1 µm, underscoring the predominance of nanoscale plastics in the inhalable fraction. These findings provide the first detailed evidence that e-cigarettes can be a significant source of inhaled NPs. Given their small size, such particles may penetrate deep into the respiratory system, potentially exerting toxicological effects. This study highlights the urgent need for further toxicological evaluation and regulatory attention to assess the implications of e-cigarette-derived NP exposure on human health.

Detection and Quantification of Microplastics in Human and Murine Lung Tissue

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Micro and Nanoplastics (MNPs) are a persistent environmental pollutant which have been detected in several human tissue types, and notably, in the human lungs (Amato-Lourenço et al., 2021). Rising concentrations of these polymers suggest new concerns for human health outcomes considering the increase in chronic pulmonary disease diagnoses (Boers et al., 2023). Due to the extremely expansive surface area and large air volume expected to be filtered by the lungs, pulmonary MP accumulation remains a highly interesting and understudied topic (Ananda Rao & Johncy, 2022). A variety of quantitative and qualitative methods have demonstrated the presence of MNPs of varying polymer types, with the largest fraction typically being polyethylene (Nihart et al., 2025). While qualitative methods allow for rapid identification of individual fibers, Py-GC/MS specifically allows for total-tissue MNP recovery, as many of the suspected particles are below the size of detection for µFTIR/Raman spectrometry. Questions remain regarding the relative accuracy of Py-GC/MS data, given the potential difficulty in matrix-plastic separation. Several steps are taken to validate the prescence of MNPs, as well as establishing novel benchmark polymers which are resistant to lipid-polymer contamination. Among lung tissue, relative concentrations of Styrene-Butadiene Rubber (SBR) appear to be higher compared with findings of other tissue types, suggesting an alternative uptake mechanism. SBR may also serve as a benchmark polymer for lung analysis, due to its persistence throughout lipid-eliminating procedures. In comparing 2016 (x=143.3 µg/g) and 2024 (x=287.5 µg/g), Polyethylene remains the most abundant polymer, which was significantly higher in 2024, compared with 2016 (95% CI, 32.14–256.3; P=0.0133). Relative to other human tissue types (brain, kidney, liver), lung tissue has a higher percent SBR by mass when compared with the brain and kidney (mean difference 4.044, 4.149; 95% CI, 1.395–6.692 and 1.379–6.920; P = 0.0009, 0.0012). Mouse lung samples demonstrated similar concentrations by mass of SBR compared with human lungs, with a greater proportion in human lungs (95% CI, -3.887–-0.08832; P = 0.0405). Polyvinyl Chloride (PVC) was found to be significantly elevated in mouse lungs compared with human lungs (95% CI, -17.12 – -13.57, P<0.0001). Finally, Cyclohexane, a nonpolar solvent is introduced with the intent to remove any lipid matrix interference. Post-solvent extraction demonstrated significant reduction only with polyethylene, with all other polymers remaining as non significant reductions after filtration (95% CI, 222.7–343.6, P<0.0001).

Particle deposition in the human lung as a function of microplastics' shape, size, orientation, and type

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Ashish Jachak (RHP Risk Management, Inc.), Frank Pagone (RHP Risk Management, Inc.)

The widespread use and poor end-of-life management of single-use plastics has created a global pollution problem with emerging health concerns. Weathering produces micro- and nanoplastics that become airborne and can be inhaled. Some are cleared; others persist, provoke inflammatory or oxidative responses, and carry intrinsic additives or adsorbed or absorbed pollutants creating combined particle–chemical hazards. Because airborne microplastics are often fibrous with non-spherical aerodynamics, we examined how fiber size, shape (aspect ratio), density, and orientation govern regional lung deposition. We estimated deposition in the nasopharyngeal, tracheobronchial, and alveolar regions using the ICRP respiratory tract model with fiber-specific corrections. Fiber length and diameter were converted to aerodynamic-equivalent diameters via dynamic-shape-factor adjustments that incorporate density and orientation. We evaluated fibers 10–50 μm long and 0.75–5 μm in diameter under parallel, perpendicular, and random orientations to bound realistic inhalation. Under random orientation, nasopharyngeal deposition peaked at ~0.87 for fibers with aerodynamic diameters ~5–7 μm, where inertial impaction dominates. Alveolar deposition peaked at 0.13 for ~0.75 μm diameter fibers up to ~35 μm long, where low inertia permits deep penetration and sedimentation competes with diffusion. Tracheobronchial deposition was intermediate; parallel alignment favored deeper penetration, whereas perpendicular alignment increased proximal capture. We provide predictive curves and closed-form relationships linking geometry, density, and orientation to regional deposition, enabling scenario-specific exposure estimates. Implications are twofold: elongated microplastics in the 5–7 μm aerodynamic range are efficiently intercepted in the upper airways, while small-diameter elongated fibers can reach the alveoli, where clearance is slower and tissue interactions may be more consequential; orientation and flow regime strongly modulate both outcomes. Limitations include reliance on a modified ICRP framework not yet validated experimentally for microplastic fibers; idealized assumptions about orientation and density; a restricted size window (10–50 μm length; 0.75–5 μm diameter); and omission of hygroscopic growth, electrostatics/aggregation, co-contaminants, and post-deposition clearance/translocation. Future work should pair harmonized field measurements with controlled inhalation and air–liquid-interface studies to validate deposition and clearance, extend models to nanoplastics and realistic breathing patterns, incorporate polymer aging and additive, absorbed or adsorbed-chemical release, and generate dose–response data for quantitative risk assessment.

Neurological Health Effects of Plastics (Part 2)

Lifecyle of microplastics in the body and their contribution to Alzheimer's disease

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Nano- and microplastics (NMPs) exposure represents a new health concern for the human population, but their lifecycle in the body after ingestion and their potential impact on human health, including their possible contribution to disease, remain poorly understood. My group has shown that acute (3 week) exposure to 0.1 and 2 µm pristine, spherical polystyrene (PS) NMPs via drinking water induced marked neurobehavioral effects in both young and aged healthy female C57BL/6J mice with NMPs translocating into intracellular compartments of all major tissues, including parenchyma of brain. Importantly, we found that exposure induced alterations in inflammatory processes in the body, with a striking decrease in glial fibrillary acidic protein (GFAP) expression in brain. Using cellular models, we also found that PS-NMPs readily enter the cell and surround the nuclear envelope and that exposure negatively affects cellular homeostasis and viability. Building on these findings, we then investigated the interplay between NMPs exposure and genetic susceptibility for neurological disease development by exposing mice carrying the largest known risk factor for developing Alzheimer's disease (AD) in humans, apolipoprotein E (APOE) ε4 allele (APOE4). Surprisingly, we found that short-term (3 weeks) exposure to 0.1 and 2 µm PS-NMPs via drinking water significantly affected spontaneous locomotor activity and recognition memory in a sex-dependent manner in humanized knock-in APOE4 mice, but not in APOE3 controls. Additionally, we again observed a decrease in GFAP expression as well as a decrease in ionized calcium-binding adaptor molecule 1 (IBA1) expression, a marker for microglia, in brain. Ongoing work of the lab aims to elucidate the bioaccumulation, lifecycle, and long-term health effects of NMPs and their contribution to disease onset and progression.

Experimental models to test causal relationships between MNP exposure and Alzheimer's disease pathology

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Emerging research demonstrates that micro- and nanoplastics (MNP) are abundant in human tissues including the brain. Plastics levels were shown to be higher in post-mortem tissue from dementia patients. However, it is not clear if MNP causally contribute to dementia and Alzheimer's and if so, whether it is through actions on core pathological AD features such as amyloid beta plaques and tau tangles or through upstream or generic cellular toxicity pathways. Enhanced Alzheimer's disease (AD) like pathology was elicited with oral administration of MNP in transgenic AD mouse models. MNP facilitate the fibrillization of amyloid beta in vitro. Thus, there is suggestive experimental support that MNP may act on core pathological features of AD. Existing experimental systems almost exclusively rely on pristine polystyrene spheres which limits interpretation and translational relevance relative to environmental MNP made up of other polymers, shapes, adsorbed chemical mixtures and co-exposures, and weathering states. Since many environmental neurotoxicants show low oral bioavailability, we have investigated the potential of nanoplastics to act as carriers to increase their brain bioavailability. We contrasted four neurotoxic pesticides varying in their lipophilic properties (LogP -0.5 – 4.9) and showed that the most liphophilic (rotenone and fenpyroximate) show synergistic toxicity with co-exposure to 50 nm PS spheres as measured by cell death in primary embryonic mouse cortical cells. In contrast, paraquat and endothall did not show synergistic cytotoxicity. Finally, while we have shown that 50 nm PS and PMMA spheres both accelerate beta amyloid fibril formation in cell free assays, we are investigating this phenomenon in cortical cell-based preparations to determine if MNP influence amyloid beta aggregation in more physiological conditions and under in vitro conditions that polymer screening and evaluations of various mixtures, polymers, and particle shapes and sizes.

Neonatal Brain Exposure to Nanoplastics via Oral Route: Size-Dependent Uptake and Regional Localization

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Environmental nanoplastics (NPs; diameter <␣1␣µm) are increasingly recognized for their ability to traverse biological barriers—such as the intestinal epithelium, placenta, and blood–brain barrier—and accumulate in sensitive tissues, including the brain. During neonatal development, when these protective structures are not fully formed, NPs may gain access to the brain, raising critical concerns about early-life exposure and its potential to disrupt neurodevelopmental processes. To address this, we employed advanced imaging techniques to investigate the size-dependent accumulation of polystyrene NPs (PS-NPs) in neonatal mice, with a particular focus on brain accumulation following oral exposure. Neonatal mice (P0) received a single oral gavage of 30 µl fluorescent yellow-green (excitation/emission: 441/486␣nm) labeled PS-NPs (PS-YG) at varying diameters (50 nm, 500 nm) and concentrations (2.5-12.5 mg/ml), alongside double-distilled water as a control. Oral administration was selected to reflect a plausible environmental exposure route, particularly relevant to early-life ingestion scenarios. Fluorescence stereomicroscopy revealed distinct PS-YG distribution across multiple organs—including intestine, liver, kidney, and brain—within 24 hours post-administration. Notably, 50 nm PS-YG demonstrated significantly higher tissue uptake than the 500 nm group, underscoring the critical role of particle size in bioavailability and translocation. To resolve regional localization within the brain, we applied tissue-clearing and lightsheet microscopy. This approach allowed for intact volumetric imaging without sectioning, preserving spatial context and minimizing distortion. High-resolution 3D visualization revealed PS-YG distribution in the cortex, thalamus, hindbrain, and cerebellum. These observations suggest that neonatal biological barriers exhibit increased permeability to nanoscale particles, potentially heightening susceptibility to neurodevelopmental perturbation. This study demonstrates the utility of advanced imaging techniques for tracing NP accumulation. The observed rapid and region-specific accumulation of PS-NPs in neonatal brains provides foundational evidence for potential long-term neurotoxic outcomes. These findings support the urgent need for precautionary regulatory frameworks to mitigate environmental NP exposure during early life and inform future risk assessment strategies targeting vulnerable developmental stages.

Quantitative Mapping of Micro- and Nanoplastics Across the Hemisphere of a Human Brain

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The ubiquitous presence of micro- and nanoplastics (MNPs) brings concern for environmental and human health conditions. While MNPs have been observed and categorized throughout the body, no studies have successfully mapped and quantified the specific accumulation and distribution of MNPs within singular organs. This study focuses on MNPs found in the human brain, specifically the right cerebral hemisphere's white and grey matter. This area includes the olfactory, optic, cranial nerves, cerebral artery, corpus colosseum, basal ganglia, hippocampus, occipital cortex, medulla, pons, cerebellum, and brainstem. For analysis, autopsy samples were obtained in 2024 from the Office of the Medical Investigator in Albuquerque, New Mexico. Using a digestion protocol and Pyrolysis Gas Chromatography/Mass Spectrometry (Py-GC/MS), results showed the highest average concentration of MNPs in the white matter (WM) (3605 ug/g). In contrast, the grey matter (GM) (1,485ug/g), arteries, and nerves (2,501ug/g) showed a significantly lower concentration. Of the 12 polymers scr eened for, polyethylene (PE) showed the highest prevalence (WM:1178ug/g, GM:512ug/g), followed by polypropylene (PP) (WM:1079ug/g, GM:344ug/g) polyethylene terephthalate (PET) (WM:225ug/g, GM:86ug/g), and polyvinyl chloride (PVC) (WM:216ug/g, GM:87ug/g), in the basilar artery (PE: 2111µg/g, PP: 781.37µg/g), pituitary (PE: 44.54ug/g, PP: 56µg/g), and cranial nerves (PE: 2413ug/g, PP: 290ug/g).
These findings highlight the potential implications of

MNP accumulation on brain function and overall health. By enhancing the detection sensitivity for 12 distinct polymers in brain tissue, this research contributes to a more comprehensive understanding and map of MNP accumulation on brain function and overall health. As we further investigate MNPs in other organs, such research could reveal critical links between MNP accumulation and specific diseases. Additionally, it opens up new avenues for exploring environmental and health policies to mitigate the effects of MNPs on human health. Future studies may examine correlations between MNP buildup and disease, helping to uncover possible connections between plastic accumulation and a wide range of health conditions.

Nanoplastics Origin, Physicochemistry, and Health Risk

Mechanism of Quiescent Nanoplastic Formation from Semicrystalline Polymers

Sanat Kumar, PhD
Columbia University

Sanat Kumar. Department of Chemical Engineering, Columbia University, New York, New York, 10027, USA.

Polymers are known to spontaneously produce microplastics (sizes 1μm - 3mm) and nanoplastics (10nm - 1μm). Still, the mechanisms by which environmentally-triggered Å-level random bond breaking events lead to the formation of these relatively large fragments are unclear. Significantly, ≈70 % of commercial polymers are semicrystalline, with a morphology comprised of alternating crystalline and amorphous layers, each tens of nanometers thick. It is well-accepted that chain scission events accumulate in the amorphous phase. We show that this leads to mechanical failure and the concurrent release of particulate nanoplastics comprised of polydisperse stacks of lamellae even under quiescent conditions. Noncrystalline analogs, which do not have a well-defined microstructure, do not form nanoplastics. While the amorphous phase of the semicrystalline nanoplastics continues to degrade, crystal fragments do not, and hence, they temporally persist in the environment. These results stress the critical role of polymer microstructure and fracture mechanics on particulate nanoplastic creation.

Morphological and chemical characterization of nanoplastics in human tissue

Aaron Erdely, PhD
Editor in Chief, Particle and Fibre Toxicology

Micro- (≤ 5 mm) and nano- (≤ 1 μm) plastics have become ubiquitous resulting in inevitable human exposure. Evidence exists of mass-based accumulation of plastic in human tissues with visualization of micron-sized particles (> 1 μm). To date, there is little evidence to address accumulated nanoplastics. Understanding internalized plastic particle morphological and chemical characteristics is essential to facilitate proper design of future mechanistic and controlled exposure health effects studies to determine whether any health-related risks exist. Here we show microscopic evidence and quantitative dimensional analysis of nanoplastics in human decedent brain, kidney, and liver tissues. Mean particle lengths (nm) across the five decedents were 171.2±4.6 for brain, 124.4±3.6 for kidney, and 147.6±6.6 for liver. Mean particle widths (nm) were 45.9±1.5 for brain, 32.3±0.7 for kidney, and 36.1±1.3 for liver. When examining the aspect ratio, 78-83% consisted mostly of an elongated nanometer sized fiber morphology. The study provides isolation with physical and chemical characterization of nanoplastics in human tissues. Interestingly, differences were greater between tissues of a single decedent than across decedents. Consistently, the nanoplastics were largest in the brain. The observations overall suggest specificity with respect to systemic internalization and subsequent tissue accumulation of plastic particles less than one micron.

Visualization of putative nanoplastic particles within historical and modern tissue samples of kangaroo rats

Eve Rowland, PhD

University of New Mexico

Eve N. Rowland (1), Matthew J. Campen (2), Jonathan L. Dunnum (1), Joseph A. Cook (1), Rui Liu (2), Eliane El Hayek (2), Sakshi Patil (2), and Marcus A. Garcia (2).
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2Department of Pharmaceutical Sciences, University of New Mexico, Albuquerque, NM, USA

Multiple studies have demonstrated that micro/nanoplastic particles are present in a variety of vital organs within humans and other organisms. However, the visualization of the particles within the tissue has been limited. Additionally, no studies exist that determine if these same particles can be found within historical samples collected from a period where environmental plastic is absent. Our study aims to test historical samples against modern samples to provide confirmation that the particles visualized within tissue are MNP particles. The Museum of Southwestern Biology maintains a collection of fluid-preserved historical samples. From their collections, kangaroo rats (Dipodomys ordii) from 1966 were obtained. Samples were then collected in 2025 from the same locality and preserved using the same methods as the historical samples. Brain, kidney, and liver samples were obtained, digested with KOH, and processed for transmission electron microscopy (TEM) imaging. From TEM imaging, we identified shard-like particles roughly 200nm in size within brain, kidney, and liver tissue from 2025 samples of kangaroo rat tissue. These particles were present in high amounts throughout the prepared samples, especially within the brain tissue. Within the 1966 tissue, these particles were almost entirely absent. These images suggest that the particles identified within the tissue are MNP particles due to their absence in the historical samples.

Communication of the Global Plastics Problem

Messaging about Microplastics and Human Health

Becca Lauzon , PhD

University of Rochester

Katrina Korfmacher, Becca Lauzon

Public interest in microplastics is high, and many people are concerned about the potential human health effects of microplastics. However, while the field of microplastics research is growing quickly, much scientific uncertainty remains. Balancing public demands for information about health effects with scientific uncertainty poses a challenge for microplastics communication. The Lake Ontario Microplastics Center (LOMP) has developed a messaging "toolkit" for communicating about microplastics and human health. LOMP's approach is based on a set of "key points" – an internal tool for Center researchers, staff, and engagement staff informing talking points for communications including media interviews, educational materials, and presentations and trainings. The key points focus on the complexity and diversity of microplastics, what questions researchers are asking, and why we don't have simple answers. This approach has informed a growing library of LOMP materials including a flagship brochure, infographics summarizing research approaches and findings, and a suite of workshops for educators. The messaging is designed to evolve over time to reflect the current state of the science and to fill gaps in public understanding. The entire LOMP team reviews the updated messaging annually to ensure accurate, consistent, locally relevant messaging across LOMP's communications and products

Big conversations about tiny plastics: NGO communication strategies and public perceptions data on microplastics and health

Katherine Pelch, PhD

Natural Resources Defense Council

Katie Pelch, Renee Sharp, Shannon Goff, Margie Kelly
Natural Resources Defense Council

NRDC works to safeguard the earth—its people, its plants and animals, and the natural systems on which all life depends. With the expertise of scientists, lawyers, and other environmental specialists, our team is working to reduce plastic production, minimize the harm of plastic that is produced, and spark increased public concern about plastic pollution. We have recently published a fact sheet on the potential harms associated with microplastics. The fact sheet is meant to be both a comprehensive and easily accessible summary of the broad landscape of microplastics research for interested media and policy makers. However, with over 70 endnotes it is not likely to be useful for individual consumers, who often ask what they can do to reduce their own exposures. Therefore we also published an accompanying consumer guide with ten ways to reduce your (and your family's) exposure to microplastics. As we were publishing these resources we wanted to better understand the public's concerns related to microplastics. Partnering with Swayable, we surveyed 2,978 people nationally, asking baseline questions about their concerns and knowledge of the science of microplastics. Then, using a randomized control trial design, some participants viewed content from the NRDC consumer guide and others viewed unrelated content. Participants were then asked additional questions to see if their perceptions regarding microplastics changed after viewing content from the consumer guide. Overall, respondents were mostly concerned with the presence of microplastics in drinking water, in food and in the human body (versus in the ocean or consumer products). The majority of people, 81.6%, say they are "very concerned" or "somewhat concerned" about "the chemicals leaching from the microplastics." Exposure to the consumer guide reinforced this concern. Respondents ranked their concern for specific health impacts related to microplastics exposure on a scale of 0-100 (0 being "Not at all Concerned" and 100 being "Very Concerned"). Respondents were most concerned about the impact

microplastics have on the brain (74.1), the heart and cardiovascular system (73.4), the hormone/endocrine systems (70.2), and finally, on fertility and reproduction (67.4). The polling also highlighted that most respondents were not aware of some major sources of microplastics, including clothing and kitchenware. Furthermore, when asked who they thought was most responsible for microplastics, respondents ranked the oil and gas industry as most responsible (25%), followed by retailers (23.7%), consumers (22.6%), and governments (20%). Overall, our polling reinforces that the general public is very concerned about the presence of microplastics. It also highlighted that the consumer guide was effective in educating the public about sources of microplastics they had not previously considered. We will use this feedback to inform our future science and policy resources.

Using narrative portraiture to understand experiences of plastics in the UNESCO Biosphere Reserve of Menorca (Spain)

Bethany Jorgensen, PhD

University of New Mexico

Bethany Jorgensen, PhD (NM-INSPIRES Center, University of New Mexico), Scott Peters, PhD (Global Development, Cornell University), Marianne Krasny, PhD (Civic Ecology Lab, Cornell University)

At this point, the harms of plastics-derived pollution throughout the plastic life cycle are well documented in the peer-reviewed literature. When it comes to humans, plastics' impacts range from the cellular to the socio-cultural. Plastics pollution is a global environmental injustice given the inequitable distributions of its harms and benefits. Plastics pollution is now considered to be ubiquitous in the global environment, and for all the awareness of plastics pollution and policies to ban or regulate plastics in certain applications, plastics production shows no sign of slowing. This research draws from 15 years of a transdisciplinary action research process called Zero Plastic in Biosphere Reserves, and presents findings from an innovative arts-based method for exploring ways in which people are impacted by and responding to plastics pollution as individuals and collectives, with the intention of answering the question: “What do we do about plastics pollution?” We will share our findings from developing and applying the draMatIzed naRRative pORtraiture (MIRROR) method to understand experiences of rapid global change through the case study example of plastics on the island and UNESCO Biosphere Reserve of Menorca (Balearic Islands, Spain). Through the resulting narrative portraits of 11 study participants, we gain insights into the stories that allow them to "hold their own" in their efforts to address plastics pollution and live with ongoing socioecological changes to their island, their well-being, and their way of life.

Trusted Voices in a Turbulent Landscape: P-SNAP’s Strategy for Communicating Microplastics Science

Megan J. Wolff, PhD MPH

Physician and Scientist Network Addressing Plastics and Health (P-SNAP)

Megan J. Wolff, Emily Sbiroli, Samantha Romanick, Julia Cohen

Microplastics in human tissue are now a major news story, prompting public concern and questions for experts ranging from physicians to online influencers. The guidance people receive can shape behavior, markets, policy, and trust in science, making both messages and messengers crucial. Physicians and scientists remain highly trusted, yet research is emerging and interpretations vary. P-SNAP is a national network of physicians, scientists, and healthcare personnel brought together to communicate and take action on plastics and health. Megan Wolff, its executive director, will discuss its role in communicating with medical audiences, law makers, journalists, patients, and others. Which audiences has P-SNAP come to prioritize, and why? What questions do participants most often encounter? What strategies has the network evolved to counter skepticism, overcome fearmongering, and clarify complicated science? How does it adjust its messaging to incorporate the new theories and changing findings of a nascent and fast-growing field?

Microplastics and human health translation to policy and action

Session Description:

Microplastics are an immense planetary challenge, and thus to date hundreds of policies focused on monitoring and reducing both occurrence and environmental impacts have been implemented or proposed at the regional, national, and global levels. This session will include presentations from leaders at several U.S. based NGOs, including the Plastic Pollution Coalition, The 5 Gyres Institute, and The Pew Charitable Trusts, summarizing recent and current policy efforts with a focus specifically on microplastics in the US, local states, and global policy landscape.

Panelists will present on the the Global Plastic Laws database, the #MicroplasticsFreeUS campaign, Pew's Breaking the Plastic Wave 2025 report, as well as efforts by the Scientists Coalition for an Effective Plastics Treaty; and how these activities are linked to recent relevant research developments. The session will close with an opportunity to discuss the future of microplastics research and policy, and how transdisciplinary collaboration can lead to science-informed policy.

Poster Sessions

Note: Please be sure to check the website, as some things may have changed after printing

Full abstracts are available digitally on the conference website, here

Monday 1/12/2026

Board#	Name	University	Title
1	Olivier Irumva	University of Nebraska-Lincoln	Micro- and Nanoplastics Release and Toxicity from Disposable Coffee Cups under Consumer-Relevant Conditions
2	Ashish Jachak	RHP Risk Management, Inc.	Screening-Level Risk Characterization of Microplastics in Drinking Water Across Five U.S. States
3	Derek Ho	University of Pennsylvania	Developing Multispectral Fluorescence Imaging (FIMAP) for accessible Microplastic Detection and Identification in Environmental Systems
4	Athena Nguyen	Frontier Lab America	Pyrolysis-GCMS analysis of Microplastics in the air atmosphere
5	Alba Torrents de la Peña	Scripps Research	p-CAPture: A novel method to identify and quantify micro- and nanoplastics
6	Sabina Halappanavar	Health Canada	Challenges and Opportunities in the Toxicology of Microplastics in Ambient Air
7	Ramesh Ganpisetti	alliance university	Automated Quantification Microplastics in membrane filtration using flow cytometry and machine learning
8	Vickie R. Walker	National Institute of Environmental Health Sciences (NIEHS)	Tracing a Trail of Tiny Plastics: Leveraging Automation to Rapidly Map Emerging Nano- and Microplastic Research
9	Md Bayzid Mahmud	Bangladesh Maritime University	Quantifying Widespread Microplastic Pollution in Coastal Ecosystems of Bangladesh: A Multi-Matrix Assessment
10	Maryam Hamidi	University of New Mexico, College of Nursing	Indoor Hospital Airborne Microplastic Contamination and Antimicrobial-Resistant Pathogens
11	Rama Gullapalli	University of New Mexico	Plastic Pollution and Hepatic Pathophysiology: Emerging Paradigms of Plastic Characterization Using Optical and Mass Spectrometry Approaches
12	Shirmin Islam	State University of Newyork at Binghamton	Polystyrene nanoplastics impact the growth and architecture of a “synthetic” small intestinal microbiota
13	Lingjun Li	Arizona State University	Metabolic Reprogramming in Gut Microbiota Exposed to Polystyrene Microplastics
14	Paulita Bennett-Martin	5 Gyres Institute	#MicroplasticFreeUS: a comprehensive policy approach to addressing microplastic pollution by the 5 Gyres Institute
15	Tianyu Li	North Carolina State University	Engineering Vibrio natriegens for degrading and assimilating poly(ethylene terepthalate) microplastics
16	Charles "Warren" Edmunds	PerkinElmer US LLC	Microplastics Analysis and Workflow using Infrared Microscopy

17	Elizabeth Ryznar	St. George's University, Johns Hopkins School of Medicine, and PSNAP	The State of Global Policy on Microplastics
18	Cesar Gomez	University of Nebraska - Lincoln	From Behavior to Exposure: Integrating Expert Weighting and Machine Learning to Assess Multidimensional Drivers of Nano- and Microplastic Exposure Risk
19	Jingjing Zhao	University of Louisville	NLRP3 inflammasome activation is a potential mechanism linking oral micro-nanoplastics exposure to atherosclerosis
20	Laurissa Barela	University of New Mexico, College of Pharmacy	Quantitative Analysis of Microplastics in Breast Milk Using Integrated Microscopy and Spectroscopic Approaches
21	Eve Rowland	University of New Mexico	Microplastic bioaccumulation in a mammal of conservation concern, the San Nicolas Island Fox (Urocyon littoralis dickeyi)
22	Inyeong Park	Korea Brain Research Institute	Inhaled Nanoplastics Drive PINK1/Parkin-Mediated Mitophagy and Metabolic Dysregulation, Compromising Neurovascular Integrity
23	Ross Clark	University of New Mexico	Dietary Ocean Micronanoplastics are Associated Accelerated Atherosclerosis in ApoE-/- Mice
24	Yingyue Ni	Department of Environmental Health, Boston University School of Public Health	A machine-learning powered pipeline for microplastic quantification and classification using Py-GC/HRMS: Toward generalizable microplastic exposure assessment
25	Olga Khaybullina	University of Alabama at Birmingham	Rethinking Fetal Risk: What 14C-Polystyrene Reveals About Nanoplastic Accumulation During Pregnancy
26	Naixin Qian	Columbia University	Role of Nanoplastic in Decreasing the Intestinal Microbiome Ratio
27	Naixin Qian	Columbia University	Rapid Single-Particle Chemical Imaging and Analysis of Nanoplastics by Stimulated Raman Scattering Microscopy
28	Sydney Thrall	Oregon State University	Potent Neurotoxicity of Nanoplastic and Pesticide Co-exposures In Vitro
29	Ronald Smith	Emory University	Developing In-House Techniques for Creating Calibration and Quality Control Materials of Microplastics
30	Edgar Carrete	University of New Mexico Health Sciences Center	From Ocean to Organism: Decoding the Cellular Impact of Microplastic Exposure on Peripheral Blood Mononuclear Cells (PBMCs)
31	Steven Sutton	University of New England (US)	Label-Free In Vivo Imaging of Nanoplastics Biodistribution by Stimulated Raman Scattering Microscopy
32	Susanne Brander	Oregon State University	Similarities across responses in fish to diverse micro and nanoplastic particle types, informing common mechanisms of action across vertebrates
33	Kyle Kim	University of Washington	Elucidating the effects of environmental microplastics on the gut-brain axis of humanized ApoE3/E4 mice
34	Christian Freeman	Emory University	A Comprehensive Approach for Quality Control and Sample Flagging in PY-GC-HRMS Micro- and Nanoplastic Quantitation within Human Samples Utilizing Skyline and R-Programming

35	Robert Taylor	University of New Mexico	Trouble in Paradise: Characterization and Modeling of Heavy Metal Adsorption on Microplastics Across Global Beach Locations
36	Oluniyi Fadare	Eastern New Mexico University	Potentiating effect of Polystyrene Nanoplastics to Dichlorodiphenyltrichloroethane (DDT) in Zebrafish larvae.
37	Oluniyi Fadare	Eastern New Mexico University	Transport and occurrence of tire-related chemicals and their transformation products in sediments of populated Newport Bay, CA.
38	Han Ngoc Nguyen-Luu	Lamont-Doherty Earth Observatory, Columbia Climate School, Columbia University	Exposure of Micro- and Nano-plastics in Common Soft Drinks in the US
39	Myla Stanford	Baylor College of Medicine	Polymer, Size, and Time Shape Microplastic Cytotoxicity Across Placental and Immune Cells With Links to Preterm Birth-Relevant Immune Microenvironments
40	Yasue Mitsukura	Keio University	Unexpectedly High Accumulation of Nanoplastics in the Human Placenta: Higher Levels than in the Brain and Liver
41	Gaku Ichihara	Tokyo University of Science	Assessment of occupational exposure to micro/nano particles generated from carbon fiber-reinforced plastic processing
42	Sudha Ananthakrishnan	University of New Mexico	Evaluation of UV-C sterilization effects on N95 mask structural integrity and mask performance for safe reuse.
43	Idoia Meaza	University of Louisville	A Pilot Study of Plastic Polymers from Marine Microplastics in Whale Blubber
44	Anna A. Ivanova	Centers for Disease Control and Prevention (CDC)	A Robust Pyrolysis–GC/MS Workflow for Identifying Micro- and Nanoplastics in Biological and Environmental Matrices
45	Marcus Garcia	University of New Mexico	Evaluation of Micro- and Nanoplastics Accumulation in Alzheimer's and Related Demetias
46	Seul-Ki Park	UCLA	Photoaged Microplastics Impair Mechanosensitive Endothelial Ion Channels to Alter Calcium Flux and Notch Signaling
47	Sakshi Patil	University of New Mexico	Advancing the method for isolating and quantifying MNPs in human cerebrospinal fluid for Brain Waste Clearance Studies
48	Nisarg Mehta	Silesian University of Technology	Microplastic Exposure in Indian Hospitals: Ingestion Risks from Settled Dust, Characterization, and Implications for Vulnerable Populations
49	Britta Baechler	Ocean Conservancy	Exposure of U.S. Adults to Microplastics from Commonly-Consumed Proteins
50	Muhammad Saiful Islam	University of Nebraska-Lincoln	Elevated temperatures and extended periods accelerate the release of nano- and microplastics from thermoplastic packaging into foods, raising the risk of human exposure
51	Sydney Stradtman	Oregon State University	Evaluating the Effects of Nanoplastic Exposure on Amyloid-β Aggregation and Neurotoxicity
52	Justin Kidd	Rutgers University	Maternal Transfer and Systemic Deposition of Polyamide-12 Micro and Nanoplastics Into the F1 Generation: a Cross-Foster Rat Study

53	Elise Granek	Portland State University	Environmental microplastics - from our households to our rivers and oceans and back to our table
54	Sanjay Giridharan	Arizona State University	Innovative Modelling Driven Membrane-Free Microfluidic Separation of Microplastics Model Optimized with Machine Learning
55	Karen McGuire-Diemer	Oklahoma State University	Structural degradation of microplastics from thermal oxidation increases carbon leaching in aquatic environments
56	Elaine L. Bearer	University of New Mexico Health Sciences Center	Visualizing micro/nanoplastic effects on the brain: Microvascular pathology
57	Andrea Arredondo-Navarro	Oklahoma State University	Spatiotemporal assessment of microplastic incidence in the Atoyac basin — a key watershed in Mexico
58	Andrea Adamcakova-Dodd	University of Iowa	Spray Dryer Preparation of Micro- and Nanoplastic Particles for Toxicity Assessment Studies
59	Lauren Heine	University of New Mexico College of Pharmacy	Exposure to Polystyrene Microplastics Potentiates Macrophage-Mediated Proinflammatory Responses
60	Teagan Horan	SiMPore Inc.	Silicon Nanomembrane Analysis Pipeline (SNAP): A Flexible Workflow for the Multi-modal Analysis of Particulates from Varying Sample Types
61	Ruben Trujillo	University of New Mexico	Positioning of Microstructures within Acoustic Waves Enhances Particle Trapping
62	Phoebe Stapleton	Rutgers University	Micro and nanoplastic inhalation throughout pregnancy disrupts placental invasion and morphology in Sprague-Dawley rats
63	Antara Verma	The Pennsylvania State University	Axonal Transport of Nanoplastics by Kinesin
64	Siwen Zheng	Stanford university	Deciphering the Causal Impacts of Polyethylene and Polyvinyl Chloride Nanoplastics on Vascular Remodeling and Atherosclerosis
65	Todd Gouin	TG Environmental Research	Evaluating microplastic particles as vectors of exposure for plastic additive chemicals using a food web model
66	Custodio Muianga	CDC-ATSDR	Agency for Toxic Substances and Disease Registry Resources for Interactive Visualizations of Micro- and Nanoplastics and Human Health Research Data
67	Cassandra Rauert	The University of Queensland	Determining human exposures and internalisation of micro and nanoplastics, an update from the Minderoo Centre – Plastics and Human Health
68	Brad Younggren	Circulate	PLASMA EXCHANGE FOR LOWERING THE CIRCULATING BURDEN OF MICRO- AND NANOPLASTICS
69	Ranalda L. Tsosie	New Mexico Institute of Mining and Technology	Uncovering Microplastic Pollution Pathways in Cave Systems Using Cutting-Edge Spectroscopy

Tuesday 1/13/2026

Board#	Name	University	Title
1	Kazi Albab Hussain	University of Nebraska-Lincoln	Everyday Storage and Handling of PET Bottled Water Increase Human Exposure to Nano- and Microplastics: Influence of Socio-Economic Factors
2	Custodio Muianga	Agency for Toxic Substances and Disease Registry (ATSDR)	The Agency for Toxic Substance and Disease Registry: Necessities and Data Gaps for Addressing the Environmental Exposures of Micro- and Nanoplastics and Resulting Health Impacts
3	Katrina Korfmacher	University of Rochester	Messaging about Microplastics and Human Health
4	Mark R. Wiesner	Duke University	Plastic aging and its impact on fragmentation and additive release
5	Yi Wang	Xi'an Central Hospital, Xi'an, Shaanxi, China	China-Specific Advances in Microplastic Exposure and Human Health: A Literature Review of 2024–2025 Research
6	Timothy O'Toole	University of Louisville	Microplastics consumption potentiates atherosclerotic lesion development in ApoE-/- mice
7	Girija Prasad	CIPET:SARP-LARPM, Bhubaneswar, Odisha, India	Spatial and Seasonal Patterns of Riverine Microplastics and Their Ecological Risks: A Case Study from the Cauvery River, India
8	Changcheng Zhou	University of California, Riverside	Microplastic exposure elicits sex-specific atherosclerosis development in low-density lipoprotein receptor-deficient mice
9	Grace Davies	The University of Queensland	Defining Unequivocal: Increasing Confidence In The Analysis And Reporting Of Micro- And Nanoplastic Particles In Biological Matrices.
10	Archana Krovi	RTI International	Advancing the fabrication and characterization of environmentally relevant nanoplastics: insights from PET and polyamide models
11	Sumira Phatak	University of New Mexico	Sex, diet, and micro/nano-plastics: enhancing translational fidelity in toxicological models
12	Andrea Iturralde-Carrillo	University of New Mexico	Micro- and nanoplastics are elevated in femoral atherosclerotic plaques compared with undiseased arteries.
13	Erin Risotto-Urbanowicz	University of New Mexico	Dietary Nanoplastics are Associated with Non-glycocaliceal Mesenteric Endothelial Dysfunction in ApoE-/- mice
14	Oluniyi Fadare	Eastern New Mexico University	Eco-corona-based Characterization of environmentally weathered microplastics using Ultra-performance Liquid Chromatography, Fourier Transform Infrared Spectroscopy (FTIR) spectra, and unsupervised machine learning algorithms.
15	Pierce Leroux Massie	University of New Mexico, Department of Surgery	A novel model of acute vascular nanoplastics exposure
16	Jacques Robert	University of Rochester	LEVERAGING XENOPUS TO ASSESS THE RISKS OF MICROPLASTIC EXPOSURE ON DEVELOPMENT AND IMMUNITY
17	Yang Mi	National Institute for Environmental Studies, Japan	Neonatal Brain Exposure to Nanoplastics via Oral Route: Size-Dependent Uptake and Regional Localization

18	Namrata Pandey	University of Plymouth	Investigating the impact of Polystyrene Nanoplastics in liver using hepatic cell lines and human precision-cut liver slices
19	Phoebe Stapleton	Rutgers University	Sexually Dimorphic Metabolic Dysfunction in Sprague-Dawley Rat Offspring after Gestational Exposure to MNP aerosols
20	Fatima Kanwal	Federal Urdu University of Arts Science and Technology	Microplastic contamination in commercially available table salts of Pakistan
21	Kazuki Harada	National Institute for Environmental Studies	Investigation of hazardous effects by nanoplastic particles on intracellular signaling dynamics and respiratory functions
22	Jay Anderson	Photothermal Spectroscopy Corp	Smaller Plastics, Bigger Risks How Sub-micron IR (O-PTIR) Reveals the Invisible Threat of Nanoplastics and Microplastics
23	Samantha Romanick	Environmental Working Group (EWG)	Feeding consumer interest in reducing microplastic exposure: a review of food contamination studies
24	Ximeng Liu	Arizona state university	Precision Probiotics Regulate Blood Glucose, Cholesterol, Body Fat Percentage, and Weight under Eight-Week High-Fat Diet
25	Mackenzie Pavlik	University of Rhode Island	The Effects of Nano-Microplastics Exposure on Alzheimer's Disease Pathology Characterized in APP/PSEN1 Mice
26	Kelsea Carrier	University of New Mexico Hospital	Microplastics Identified in Human Urinary Lithiasis: First Evidence
27	Genoa Warner	New Jersey Institute of Technology	Polystyrene and polyethylene terephthalate nanoplastics differentially impact mouse ovarian follicle function
28	Aaron S. Romero	University of New Mexico	Chronic Dietary Microplastic Exposure Weakens Skeletal Integrity
29	Eve Rowland	University of New Mexico	Visualization of micro/nanoplastic (MNP) particles within historical and modern tissue samples of Dipodomys ordii via transmission electron microscopy
30	Hyeong-Moo Shin	Baylor University	Placental Microplastics and Child Neurodevelopment: A Scoping Review of Emerging Evidence
31	Abhishek Biswas	Indian Institute of Science Education and Research Kolkata, India	Inhalable Microplastics as Vectors of Co-Contaminants: Quantification by Pyrolysis-GC/MS and Implications for Human Health
32	Margaret Park	University of New Mexico	Comparison of Digestion Protocols for Crop and Food Matrices Prior to Micro(nano)plastic (MNPs) Analysis and Quantification
33	Elsy El Khoury	Columbia University/Nanovib	Nanovib: particle analysis with chemical specificity and nano sensitivity
34	Sabrina Farias	Oklahoma State University	A Multifaceted Thermal Desorption-GCMS Approach for Simultaneous Profiling of Phthalate Leachates and Polymer-Specific Fragments from PET and PVC
35	Kyu-sung Kim	DGIST	Airway Exposure to Polyethylene Terephthalate Micro/Nanoplastics Disrupts Blood–Brain Barrier Integrity and Glymphatic Function in Mice
36	Justin Scott	Cove Environmental	Trace Level Quantitation of Micro- and Nanoplastics Utilizing Thermal Desorption and

			Pyrolysis–GC/MS Coupled with Selective Ion Monitoring: Development and Validation
37	Risa Smith	College of Pharmacy-Pharmaceutical Sciences, University of New Mexico	When lipids and micro(nano)plastics co-aggregate: Mass Spectrometry challenges for exposures and toxicity research
38	Parth Jariwala	Emory University	Optimizing Digestion Strategies for Accurate Microplastic Quantification in Human Blood Samples
39	Sebastian Stoker	University of New Mexico - Department of Pharmaceutical Sciences	Toxins in Tandem: Dissecting the Combined Nephrocardiac Impact of Microplastics and Arsenic
40	Hailey Steichen	University of New Mexico	Polymer characterization in kidney and urine
41	Olga Ponomarova	University of New Mexico	Metabolic and physiologic effects of biodegradable microplastics in C. elegans model
42	Kazi Albab Hussain	University of Nebraska-Lincoln	From Packaging to Plate: Systematic Review and Meta-Analysis of Nanoplastics and Microplastics Release from Food Packaging
43	Andrew Ortiz Balsero	University of Nebraska-Lincoln	Benchmarking the Invisible: Modeling Neurotoxicity of Ingested Micro- and Nanoplastics Through Bayesian Dose–Response Analysis aided by systematic evidence integration
44	Ashish Jachak	RHP Risk Management, Inc.	Particle deposition in the human lung as a function of microplastics' shape, size, orientation, and type
45	Zainab Afzal	NCCU	Combined impacts of PFAS and Micro/Nanoplastics on early neural development and behavior in zebrafish
46	Ricki Sheldon	A.T. Still University	The Effect of Environmental Micro- and Nanoplastics on Human Joint Health
47	Miranda Jackson	Oregon State University	Tire Particles as Emerging Aquatic Pollutants: Detection, Composition, and Ecotoxicological Impacts
48	Olivia Cartron	University of New Mexico	Evaluating EpiIntestinal® Tissue as a Physiologically Relevant In Vitro Model to Assess Nanoplastic Transport
49	Scott Coffin	California Office of Environmental Health Hazard Assessment	Evaluating the Health Effects of Microplastics in Drinking and Bottled Water: OEHHA's Mandate and Considerations for a Regulatory Risk Assessment Framework
50	Enrico Barrozo	Baylor College of Medicine and Texas Children's Hospital	Micro- and Nanoplastics (MNPs) in the Human Reproductive Tract: Blank-Corrected Polymer Burdens in Follicular Fluid and Endometrium Associate with IVF Endpoints and Path-Confirmed Polyps
51	Huiping Deng	Columbia University	Accumulation of Micro- and Nanoplastics in Human Cerebral Spinal Fluid
52	Cuizhu Ma	Columbia University	Human Inhalation of Microplastic and Nanoplastic from E-cigs
53	Megan Dodge	Oregon State University	Micro- and Nanoplastics in the Environment: Insights from the Degradation of Fossil fuel- and Bio-Based Plastics
54	Prabu Paramasivam	Department of Pharmaceutical Sciences, College of Pharmacy, University of New Mexico Health Sciences,	Role of ApoEε3/4 variants in modifying endothelial uptake and toxicity of microplastics derived from the Pacific Gyre

55	Milad Mazloumibakhshayesh	University of New Mexico	Chylomicron-Mediated Translocation of Oxidized Nano- and Microplastics into the Circulatory System and Human Heart Tissue
56	Imari Walker-Franklin	RTI International	Multi-Omic Evidence of Respiratory Toxicity from Tire-Derived Microplastics
57	Kuanliang Shao	Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University	An exposomic analytical framework for measuring micro- and nano- plastic in human biospecimens.
58	Aerlin Decker	University of New Mexico College of Pharmacy	Detection and Quantification of Microplastics in Human and Murine Lung Tissue
59	Shahid Dar	National Institute of Technolgy Srinagar	Source apportionment and risk assessment of microplastics and nanoplastics in the glaciers of the North-Western Himalayas
60	Bree Oatman	Oglala Lakota College	DIY Microplastic Detectives: Visualizing plastics with fluorescence
61	Xiaozhong Yu	University of New Mexico	From Dogs to Humans: Micro-Nanoplastic Bioaccumulation in Testes and Semen and Its Impact on Sperm Quality
62	Katherine Pelch	Natural Resources Defense Council	Big conversations about tiny plastics: NGO communication strategies and public perceptions data on microplastics and health
63	Bethany Jorgensen	University of New Mexico	Using narrative portraiture to understand experiences of plastics in the UNESCO Biosphere Reserve of Menorca (Spain)
64	Megan Wolff	Physician and Scientist Network Addressing Plastics and Health (P-SNAP)	Paths and Perils of Communication: Talking to the Public about Microplastics Research
65	Brandon Pearson	Oregon State University	Experimental models to test causal relationships between MNP exposure and Alzheimer's disease pathology
66	Mark Wiesner	Duke University	Plastic aging and its impact on fragmentation and additive release
67	Julia Cohen, MPH	Plastic Pollution Coalition	The State of Global Policy on Microplastics
68	Nohi Leyva	University of New Mexico	Integrating Environmental Aging and Cryomilling to Model Realistic Micro- and Nanoplastic Exposure Pathways
69	Max Zarate-Bermudez	National Center for Environmental Health, Division of Environmental Health Science and Practice	A state-of-the-science review of micro and nanoplastics in water and challenges to better understand their potential impact on human health

Poster Session 1

Monday, January 12, 2026

1. Micro- and Nanoplastics Release and Toxicity from Disposable Coffee Cups under Consumer-Relevant Conditions

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Disposable coffee cups, with over 51 billion consumed annually in the United States, represent a significant yet underrecognized source of micro- and nanoplastics (MNPs) exposure for consumers. The study provides the first quantitative evidence of MNP release from commercial coffee cups under realistic consumer conditions and demonstrates direct cytotoxic effects using cup-derived particles. MNP release increased with temperature, exposure duration, and agitation, with nanoplastic concentrations (up to 6.0×10^8 particles/mL) being 102-103 times higher than microplastic levels. Pre-use rinsing significantly reduced release by 65-85%, indicating loosely adhered surface residues as a dominant source. Spectroscopic analyses identified polyethylene and polypropylene as the dominant polymers (with 36% each), with scanning electron microscopy revealing irregular, fractured morphologies consistent with thermal and mechanical degradation. Toxicological assessment using femtosecond laser-generated cup-derived particles demonstrated dose- and time-dependent cytotoxicity in human kidney epithelial cells, with IC_{50} values decreasing from 1220 µg/mL (24 h) to 158 µg/mL (72 h). Red blood cell hemolysis exceeded 25% after 4-h exposure, indicating significant membrane disruption potential, while oxidative stress responses were minimal. These findings establish disposable coffee cups as a significant source of ingestible polymer particles with demonstrated cytotoxicity. The results highlight an urgent public health concern that necessitates attention to product safety standards and consumer protection measures.

Keywords: Disposable coffee cups; Polyethylene nanoplastics; Hemolysis; Reactive Oxygen Species; Thermal degradation; Cytotoxicity; Human kidney epithelial cells

2. Screening-Level Risk Characterization of Microplastics in Drinking Water Across Five U.S. States

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RHP Risk Management, Inc.

Microplastics in drinking water can act as particulate stressors and as vectors that release or transport additives and sorbed pollutants, creating combined particle–chemical hazards. The World Health Organization (WHO) reports no evidence of widespread human-health risk at currently measured concentrations, but major uncertainties persist—especially for nanoplastics and long-term exposure. Release from particles depends on size, weathering, and water chemistry (pH, temperature, salinity, dissolved organics). Phthalate plasticizers such as diisodecyl phthalate (DIDP), diisononyl phthalate (DINP), and di(2-ethylhexyl) phthalate (DEHP) are common in polyvinyl chloride (PVC); when PVC becomes microplastic, these phthalates may be present within particles and leach to water. Other polymers (e.g., polyethylene, polypropylene) can also sorb and later desorb phthalates. In addition to chemical transport, particle morphology, surface oxidation, and aging can modify reactivity and bioavailability, further complicating exposure assessment. In this screening-level study, two potable-water samples from each of five U.S. states (CA, IL, MI, PA, TN) were collected at local public libraries at 10:00 and 17:00 on two days, shipped under chain of custody, filtered through 5 µm silicon filters, and analyzed by confocal Raman microscopy. A mosaic image located particles, a spectrum was acquired for each, and identifications were accepted at High-Quality Index (HQI) ≥ 60%. Polyethylene (PE) and PVC were most frequently detected; PVC was used for exposure modeling because its additive burden is better characterized in the literature, and it ranked among the dominant polymers in our data set. Because chemical burdens in recovered particles and PVC type (flexible vs rigid) were unknown, we assumed

DIDP, DINP, and DEHP at 30% w/w each as a bounding case to explore a conservative risk envelope. Estimated oral intakes were compared with benchmarks from the U.S. EPA, EFSA, and ECHA; all risk characterization ratios (dose/reference) were well below 1, indicating risk is adequately controlled under study conditions and within the stated assumptions. Limitations include a small, geographically narrow sample (library taps), limited time points, a size detection window of ~20–500 µm, and no direct measurement of additive concentrations or PVC type. Raman-based identification can be biased by fluorescence and by dark or highly weathered particles, potentially leading to under- or misclassification. Future work should broaden sources and seasons, lower size cutoffs to include nano-scale particles, quantify additive burdens and leaching kinetics on recovered particles, and integrate water-chemistry/infrastructure data to reduce key uncertainties. Incorporating standardized QA/QC, interlaboratory comparisons, and harmonized reporting units will improve comparability across studies and support development of robust, health-relevant monitoring programs.

3. Developing Multispectral Fluorescence Imaging (FIMAP) for accessible Microplastic Detection and Identification in Environmental Systems

Derek Ho, Samantha McBride
University of Pennsylvania

The pervasive distribution of microplastics (MPs) in the environment presents significant challenges for their reliable detection and identification. Fluorescence imaging has emerged as a promising technique to enhance the visibility of plastic particles and enable their classification based on fluorescence characteristics. However, conventional image segmentation methods often suffer from low signal-to-noise ratios, uneven illumination, thresholding inconsistencies, and false positives arising from natural organic matter (NOM).

To address these challenges, this study introduces the Fluorescence Imaging for Microplastic Analysis Platform (FIMAP), a retrofitted multispectral imaging system equipped with four optical filters and five excitation wavelengths. FIMAP enables comprehensive characterization of the fluorescence behavior of ten Nile Red-stained polymers—high-density polyethylene (HDPE), low-density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), expanded polystyrene (EPS), acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC), polycarbonate (PC), polyethylene terephthalate (PET), and polyamide (PA, commonly known as Nylon)—while effectively excluding NOM through Fenton oxidation. Robust particle segmentation is achieved using K-means clustering (Intersection over Union = 87.7%), and classification is performed using a 20-dimensional color coordinate multivariate nearest neighbor approach for MPs larger than 3.14 mm, yielding 90% precision, 90% accuracy, 100% recall, and a 94.7% F1 score. Among the ten polymers, only polystyrene was occasionally misclassified as expanded polystyrene. For smaller MPs (35–104 µm), classification accuracy declined, likely due to reduced fluorescent dye sorption, limited pixel representation, and camera instability.

FIMAP has demonstrated its efficacy in detecting MPs across diverse environmental matrices, including surface waters, avian stomachs, and breast milk, and is currently being deployed in Philadelphia to monitor the spatial and temporal trends of MPs. Additionally, FIMAP is being integrated into higher-magnification imaging systems, such as microscopes, and trained on environmentally sourced MPs to further enhance identification accuracy. In summary, FIMAP establishes an automated, high-throughput framework for comprehensive microplastic detection and lays the foundation for robust spectral classification across diverse and complex environmental matrices.

4. Pyrolysis-GCMS analysis of Microplastics in the air atmosphere

Athena Nguyen
Frontier Lab America

Microplastics are now a global problem. They are tiny fragments shed during the degradation of larger pieces of plastic. They are light enough to be transported by the wind over large distances. Due to their small size, Microplastics (MPs) end up in all

sorts of places, including the air we breathe and the water we drink.
In this presentation, we demonstrate the study of microplastics (MPs) in the air atmosphere. The method requires very little sample preparation. The MPs were collected by passive sampling method in three different rooms. After 30 days, the analysis was carried out using the micro-furnace pyrolyzer to perform Flash Pyrolysis-Gas chromatography/ Mass spectrometry (Py-GC/MS).

Micro-furnace Py-GC/MS is an easy solid sample introduction technique that expands the application areas of GC/MS. It is easy to use and simple to operate. The solid samples can be analyzed as is without going through any solvent extraction steps. This fastens the workflow and reduces labor intensive.
The data obtained were analyzed by using the F-search MPs library. The software created the calibration curve automatically, and quantification was done within minutes.

5. p-CAPture: A novel method to identify and quantify micro- and nanoplastics

Alba Torrents de la Peña[1], Jiapsi Gomez[1], Nakeisha Favors[1], Imari Walker-Franklin[2], Matthew J. Campen[3], Andrew B. Ward[1]
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The ubiquitous existence of micro- and nano-plastics (MNPs) raises concerns associated with their potential impact on human and planetary health. However, while mapping MNPs has been conducted in various environmental settings, including marine, freshwater, terrestrial, and atmospheric systems, and, more recently, in human tissues, the low throughput, a lack of standardized protocols and sparse sampling density hinder the development of comparable maps. As a result, while environmental and human microplastic mapping has begun, scalable, sensitive, and cross-validated techniques are still needed to accurately assess distribution, exposure, and risk. For instance, FTIR and Raman spectroscopy allow for non-destructive chemical identification but can only analyze particles larger than 10 µm. Py-GC/MS, while capable of detecting a broad range of polymer types and particle sizes (from nanometers to micrometers), relies on mass-based detection rather than size resolution. The need for large sample together with the slow/laborious processing time (a few hours to days) poses barriers to widespread monitoring and exposure assessment.

Our lab has developed p-CAPture (plastics – Color and Photographs Capture), with the aim to standardize and increase the sensitivity and throughput of the current techniques to detect and quantitate MNPs in environmental and human matrices. p-CAPture is a dye-based and machine learning-based technology that uses Fluorescent Activated Cell Sorting (FACS) and trained neural networks with images from a high throughput bright field camera to characterize MNPs (type, size and amounts). A 50-200 µL aliquot of each sample is incubated with a panel of eight fluorescent dyes. This thermal dye incubation enhances the generation of distinct fluorescence signatures that aid in polymer-type identification. Flow cytometric data is acquired, capturing quantitative fluorescence signals across nine fluorescent detectors. These multichannel signatures enable the generation of unique spectral profiles corresponding to specific polymer classes. In addition, the cytometer collects up to 30,000 brightfield images per sample of the dye-labeled MNPs. These images are curated and pre-classified and then undergo detailed analysis using our neural network-based classification model (model 8). This integrated approach enables polymer identification and quantification, providing detailed information on both the types, relative size abundance and shape of MNPs present in each sample.

Our current technology processes 50–200 µL per sample in 4–9 minutes, with a size detection limit down to 300 nm. This capability enables the analysis of at least 90 samples per day, substantially surpassing the throughput of current methods, while offering the potential to expand the detectable range of MNP monitoring. These advancements position the platform as a powerful tool for environmental surveillance, and public health applications.

6. Challenges and Opportunities in the Toxicology of Microplastics in Ambient Air

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Human health effects of microplastics/nanoplastics (MP/NP) remain unclear due to a lack of systematic studies. Reference MP/NP reflective of real-world exposures are not available for toxicological testing, and there are currently no standardized protocols for isolating sufficient quantities of MP/NPs from complex environmental samples. In this study, ambient air samples were analyzed to identify the types of MP/NP present. Subsequently, standard operating procedures were developed for the laboratory-scale generation of well-characterized MP/NP representative of environmental exposures. The potential of these particles to induce lung injury or toxicity was assessed using human lung epithelial cells.

Commercially available PS beads of various sizes, nylon powder, PMMA, and polyethylene MP/NPs were purchased. Additionally, respirable size MP/NP of different shapes were generated in-house using plastic water bottles, storage containers, and nylon tea bags, abundant sources of MP/NP pollution in the air, using different methods, and weathered using a solar box. Both the purchased and in-house generated MP/NPs were characterized for dry size, shape, size distribution in the exposure medium, and chemical composition. Toxicity was evaluated using lung cells. Endpoints assessed included cell viability, immune and inflammatory responses, gene expression changes, genotoxicity, and particle uptake. The gene expression profile induced by the most toxic MP/NP was compared to previously generated gene expression data from nanomaterial exposure in these cells.

The study successfully established several methods, including methods for isolating, weathering and characterizing MP/NP from plastics used and abandoned every day. Exposure of cells to the collection of individual MP/NP resulted in dose, time and MP/NP type-dependent reductions in cell viability. Commercially available 100 nm PS, PMMA and in-house generated polyethylene terephthalate MP from plastic water bottles induced secretions of inflammation associated proteins and the formation of micronuclei, a marker of genetic damage. The smaller size fractions of MP/NP types were more genotoxic compared to their larger counterparts. Weathering impacted MP characteristics of some and influenced their toxicity. Gene expression analysis revealed pathways associated with pathogen response in MP-induced toxicity.

In the absence of information on effects of real-world MP/NP exposures, the methods developed and insights gained in this study are valuable. Preliminary results indicate that exposure to MP/NPs can be harmful to cultured cells. Although some apical responses are similar to those observed in cells exposed to nanomaterials, the molecular-level responses differ. Overall, these findings highlight the need for further research to fully understand the human health effects of environmental MP/NP exposure.

7. Automated Quantification Microplastics in membrane filtration using flow cytometry and machine learning

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Accurate characterization of microplastics (MPs) in complex environmental water systems is critical for reliable risk assessment While flow cytometry (FC) enables rapid, high-throughput quantification and basic size determination, it remains limited in resolving particle morphologies (e.g., spheres, fibers, fragments) within heterogeneous mixtures. This constraint hinders its utility in fate and transport studies, where particle morphology plays a critical role in governing environmental behavior. This study aims to overcome this analytical limitation by introducing an advanced FC-based approach that integrates multi-parameter light scattering and fluorescence data with machine learning, enabling accurate classification and quantification of MP morphologies in real water samples. A comprehensive reference library of standard MP particles with well-defined shapes (spheres, fibers, and fragments) will be established. A high-resolution flow cytometer will record multi-angle forward (FSC) and side-scatter (SSC) signals, and fluorescence signals from thousands of particles,

generating datasets to train supervised machine learning models for identifying morphology-specific scattering signatures The trained model will be rigorously validated and then applied to profiles MPs throughout an entire water treatment train. We anticipate creating a robust, automated classifier capable of quantifying the relative abundance of diverse MP morphologies. Application to a water treatment plant is expected to reveal morphology-dependent removal efficiencies, such as effective fragment removal by coagulation but lower efficiency for fibers.This approach represents a paradigm shift, transforming FC from a basic particle counter into a high-throughput analytical tool for comprehensive MP characterization. The insights gained will substantially improve our understanding of MP behavior in engineered systems, directly supporting advanced risk assessment and the optimization of treatment strategies.

References: LaRue, R. J., Koo, S., Warren, A., McKay, Y. G., & Latulippe, D. R. (2024). A strategy for quantifying microplastic particles in membrane filtration processes using flow cytometry. Chemosphere, 368. https://doi.org/10.1016/j.chemosphere.2024.143613

8. Tracing a Trail of Tiny Plastics: Leveraging Automation to Rapidly Map Emerging Nano- and Microplastic Research

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NIEHS

Background: Widespread detection of tiny plastic particles – microplastics (1 µm–5 mm) and even smaller nanoplastics (1nm to 1 µm) – in the environment and particularly in human biosamples is a growing concern for public health. These plastics find their way into our bodies through inhalation of airborne particles, ingestion of contaminated food or water, and dermal absorption of plastics in consumer products like clothing and cosmetics. The ubiquitous exposure and bioaccumulation of nano/microplastics could potentially lead to range of health effects depending on the nature of the exposure and the chemicals or substances involved. There has been a rapid increase in research on nano/microplastics and their potential health effects over the last 10 years. This publication growth presents a challenge for traditional evidence synthesis methods, which are too slow to adequately keep pace. There's a critical need for an up-to-date resource that comprehensively identifies and collects this emerging research, making health effects data on nano/microplastics findable and accessible to inform research and policy decisions. The Toxicity of Microplastics Explorer (ToMEx) database published in 2022 has begun to address these needs.

Objective: To develop a rapid systematic evidence map (SEM) workflow that complements the ToMEx database in capturing published literature on nano/microplastics environmental exposure and health effects. Utilizing an integrated workflow of automated and semi-automated (human verification) approaches, we plan to identify, collect, curate, and present the published literature in an interactive visual format. The SEM will serve as a living, comprehensive resource on environmental exposure and health effects research on nano/microplastics.

Methods: Existing automation tools and workflow will be used to streamline the process, leveraging machine learning and natural language processing to automate tasks such as screening and data extraction of key entities (e.g., study design, population, exposure). Workflow will be validated and overseen by a team of human reviewers to ensure accuracy and rigor. Exposure and health effects experts working on microplastics including the ToMEx research group will be consulted to inform the focus of the search strategy, entities for data capture, and minimize overlap with ToMEx. The SEM will be presented through an interactive, open-access dashboard, allowing stakeholders to explore the data, locate evidence to their specific research question, identify research gaps, and prioritize future studies.

Anticipated Impact: This project will create a surveillance tool that provides a real-time, comprehensive collection of the nano/microplastics exposure and health effects literature. By facilitating a transparent and efficient workflow, the SEM will support researchers, regulators, and policymakers in making timely, evidence-informed decisions to help mitigate the risks associated with nano/microplastics.

9. Quantifying Widespread Microplastic Pollution in Coastal Ecosystems of Bangladesh: A Multi-Matrix Assessment

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Microplastics (MPs) pose a substantial environmental threat, jeopardizing marine ecosystems and biodiversity worldwide. This study provides a comprehensive, multi-matrix assessment of MP pollution across the eastern and western coastal zones of Bangladesh, analyzing surface water, sediment, and gastrointestinal tracts (GITs) from twelve commercially vital fish species. MP characterization was conducted using stereomicroscopy and Fourier Transform Infrared (FTIR) spectroscopy. The study reveals significant MP contamination, with peak concentrations observed in Cox's Bazar water (673 items/L) and Kuakata sediment (594 items/kg). Fibers were the dominant morphology (>50% of all MPs), and particles below 1 mm were the most abundant size class. Analysis of fish GITs demonstrated pervasive ingestion, with loads varying significantly among species; the highest burden was found in Lutjanus Lemniscates at 11.56 ± 1.05 MPs per gram. The most abundant polymer types were polypropylene (PP), polyethylene (PE), and polystyrene (PS). The contamination levels documented here are notably higher in some cases by an order of magnitude than those reported in previous regional studies. The pervasive presence of MPs across water, sediment, and biota underscores a severe and immediate threat to marine biodiversity and human food security. This research provides an urgent call to action and delivers the critical baseline data necessary for policymakers to develop effective mitigation strategies against plastic pollution in the Bay of Bengal.

10. Indoor Hospital Airborne Microplastic Contamination and Antimicrobial-Resistant Pathogens

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Antimicrobial-resistant (AMR) infections are responsible for an estimated 2.8 million annual cases, resulting in more than 35,000 deaths in 2019 alone. Additionally, the Centers for Disease Control and Prevention data emphasize that the transmission of the most dangerous AMR infections occurs in healthcare settings, which is associated with more than $4.6 billion in annual healthcare costs. Various methods are known to facilitate the spread of AMR genes and infections in hospital settings; however, the influence of suspended atmospheric micro- and nanoplastic (MNP) particles and the potential role of indoor air MNP particles in the horizontal gene transfer of AMR genes remain underexplored. MNP particles, defined as particles smaller than 5 mm that originate from the degradation of larger plastics in soil, water, and air, possess specific characteristics, such as “hydrophobicity, enhanced adsorption, and unique surface chemistry” that render them ideal substrates for biofilm formation and facilitate horizontal AMR gene transfer. Horizontal gene transfer is the transfer of genetic material between organisms, a method that facilitates the proliferation of AMR genes, thereby exacerbating the issue of AMR infections. The long-term goal of this application is to develop a method that can prevent the horizontal transfer of AMR genes via MNP particles present in indoor hospital air. The objective of this project is to eliminate MNP particles in indoor air in healthcare settings to reduce the transfer of AMR genes and minimize healthcare-acquired infections. There are two specific aims: (i) To test the hypothesis that there are considerable MNP particles in indoor hospitals. (ii)To test the hypothesis that the suspended indoor air MNP particles carry AMR genes and are associated with horizontal gene transfer. We will use a PM10-high-volume air sampler in various hospital units to measure the concentration of suspended indoor air microplastics. We will use the 16s ribosomal RNA gene sequencing to isolate the microbial genes.

11. Plastic Pollution and Hepatic Pathophysiology: Emerging Paradigms of Plastic Characterization Using Optical and Mass Spectrometry Approaches

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Metabolic (Dysfunction) Associated Fatty Liver Disease (MAFLD) is an emerging liver disease of global concern. MAFLD is implicated in the rapidly rising trend of hepatic morbidity and mortality across the globe. Chronic liver disease (CLD; including MAFLD) rates are highest in the southwestern United States, including in the state of New Mexico (NM). NM has the highest rate of CLD in the US (36.4/100,000 in 2022), mainly among Hispanic and Native American populations. We are currently developing an array of optical imaging techniques to understand the effects of nano- and microplastic (NMP) pollution on hepatic pathophysiology. Our initial optical technique study uses a high-throughput optical imaging platform, Cellomics CX7 (ThermoFisher, Waltham, MA), to quantitatively measure reactive oxygen species (ROS) levels in human liver cell models. In a second optical technique project, we evaluated nano- and microplastic (NMP) uptake in decedent human liver tissues for the first time using polarized light approaches in brain, liver and kidney tissues. This novel optical approach was titled polarization wave microscopy (PWM). Subsequently, we have extended this optical imaging technique by studying an additional thirty-two human liver samples (M=19; F=13) to determine the NMP accumulative patterns among New Mexican residents in a quantitative manner. In addition to polarization wave microscopy (PWM), we conducted detailed histopathological analyses to determine the NMP cellular distribution patterns in the hepatic tissues. Additional orthogonal assessment using pyrolysis-gas chromatography-mass spectrometry, multi-spectral fluorescence and transmission electron microscopy (TEM) and scanning electron microscopy (SEM) imaging approaches confirm these refractile bodies detected using PWM imaging. We are currently developing newer optical imaging-based techniques such as fluorescence lifetime imaging microscopy (FLIM) and confocal Raman spectroscopy to confirm the presence of plastic contaminants in various tissues. Preferential accumulation of NMPs in steatotic hepatic cells is a finding of major concern in light of the rapidly increasing global incidence of hepatic fatty liver diseases across the globe. Novel optical techniques established in the lab, highlight the usefulness of optics-based approaches to understand toxicological impacts of plastic pollutants in the liver. Our studies underscore the need to develop novel imaging techniques to understand and characterize the precise biological effects of environmental pollutants in the human liver tissues. Novel approaches are needed to understand the role of chronic pollutants as emerging environmental risk factors driving global chronic liver dysfunction patterns observed among humans.

12. Polystyrene nanoplastics impact the growth and architecture of a "synthetic" small intestinal microbiota

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Background: The small intestine is critical for nutrient absorption and microbial interactions but remains underrepresented in gut microbiome research due to limited accessibility and a dynamic environment. Biofilms formed by commensal bacteria in the small intestine play key roles in host-microbe interaction, barrier integrity, immune response initiation, and maintaining mucosal homeostasis. However, the impact of environmental contaminants such as nanoplastics (NPL) on small intestinal bacterial communities and their biofilm formation remains poorly understood. This study examines how polystyrene NPL at physiologically relevant concentrations and with varying surface charges affect the growth and biofilm behavior of representative small intestinal bacterial species.

Methods: Both single-species and four-species in vitro models simulating the small intestinal microbiota—comprising Bifidobacterium bifidum, Enterococcus faecalis, Lacticaseibacillus rhamnosus, and Streptococcus salivarius—were used to evaluate the effects of positively, negatively, and neutrally charged NPL at concentrations of 0.01, 1, and 100 mg/L. Planktonic bacterial growth in the presence of NPL was evaluated using optical density-based growth curves. Biofilm

biomass was quantified by crystal violet assays; viable counts were assessed through CFU enumeration and 16s rDNA. Moreover, established four-species biofilms were visualized by confocal laser scanning microscopy (CLSM) to assess structural and biomass alterations following NPL exposure.

Results: Bacterial growth was not significantly affected by NPL exposure across charge types, except at 100 mg/L of positively charged NPL, which inhibited growth and biofilm formation in both single- and four-species systems. Established biofilms exposed to 100 mg/L NPL for 4 h or 24 h showed no significant changes in viability. However, CLSM imaging revealed that all NPL types, particularly at 100 mg/L, disrupted the structure and reduced biomass of mature four-species biofilms.

Conclusions: Small intestinal biofilms are structurally sensitive to polystyrene NPL; effects depend on surface charge and concentration. A 100 mg/L dose of positively charged NPL inhibited bacterial and biofilm growth in both single- and multi-species systems. While lower concentrations had minimal impact on viability, biofilm architecture was notably disrupted. These findings demonstrate that NPL exposure can alter gut microbial biofilm structure and potentially disrupt microbial ecosystems.

13. Metabolic Reprogramming in Gut Microbiota Exposed to Polystyrene Microplastics

Lingjun Li, Jinhua Chi, Jeffrey S. Patterson, Yan Jin, Kyle Joohyung Kim, Freeman Lewis, Lingjun Li, Nicole Lalime, Daniella Hawley, Xuan Wang, Matthew J. Campen, Julia Yue Cui and Haiwei Gu

Background: Microplastics (MPs) are small plastic fragments with diameters less than 5 mm in size and are prevalent in everyday essentials and consumables. Large global plastic production has now led to a flooding of MPs in our natural environment. Due to their detrimental impacts on the planet's ecosystems and potentially our health, MPs have emerged as a significant public health concern. In this pilot study, we hypothesize that MPs exposure will negatively affect gut microbiota composition and function, in which metabolic reprogramming plays an important role.

Methods: Using in vitro experiments, three bacterial strains (Escherichia coli MG1655, Nissle 1917, and Lactobacillus rhamnosus) were selected to investigate the impacts of MPs exposure. The bacterial strains were individually cultured in an anaerobic chamber and exposed to 1 μm polystyrene MPs at various concentrations (0, 10, 20, 50, 100, and 500 μg/mL) in the culture medium.

Results: MPs exposure reduced the growth of all three bacterial strains in a dose-dependent manner. Liquid chromatography mass spectrometry (LC-MS)-based untargeted metabolomics revealed significant differences in multiple metabolic pathways, such as sulfur metabolism and amino sugar and nucleotide sugar metabolism. In addition, we extracted gut microbiota from C57BL/6 mice, and16SrRNAsequencingresults showed a significant upregulation of Lactobacillales and a significant reduction in Erysipelotrichales due to MPs exposure. Furthermore, targeted and untargeted metabolomics corroborated the in vitro results and revealed alterations in microbial tryptophan metabolism and energy producing pathways, such as glycolysis/gluconeogenesis and the pentose phosphate pathway.

Conclusions: These findings provide evidence that MPs exposure causes comprehensive changes to healthy gut microbiota, which may also provide insights into the mechanistic effects of MPs exposure in humans.
Keywords: gut microbiota; microplastics; mass spectrometry; metabolomics; 16S rRNA

14. #MicroplasticFreeUS: a comprehensive policy approach to addressing microplastic pollution by the 5 Gyres Institute

Paulita Bennett-Martin
5 Gyres Institute

Microplastic pollution has emerged as a pervasive environmental and human health threat in the United States and globally, contaminating air, soil, water, food, and ecosystems. The #microplasticfreeUS campaign, launched in 2025 by the 5 Gyres Institute, aims to galvanize public support and effect policy change to mitigate and significantly reduce microplastic pollution. Guided by scientific research and polling data showing that roughly 80% of U.S. residents perceive microplastics as harmful and believe immediate action is necessary, the campaign takes a targeted approach to increasing technical knowledge, elevating awareness, and strengthening bipartisan backing of legislation to address microplastics. The 5 Gyres team works with decision makers to transform public concern into legislative and regulatory intervention. Key components of the campaign include educating citizens and decision makers on the many forms of microplastics; advocating for policy solutions that address mitigation, leakage, production design, and product formulation.

The campaign is already resulting in heightened awareness and support from the broader movement to address microplastic pollution. And the 5 Gyres team is currently implementing the policy campaign in California by sponsoring AB 823 a bill to expand the microbead ban of 2015, and Federally by advancing several Federal bills in the 119th Congress to address microfibers and research on microplastics and human health. 5 Gyres plans to expand into at least one new state in 2026. By working strategically, with more local coalitions, we can provide tools and support to more geographies across the country creating a network for state coalitions working to address microplastics locally.

By framing microplastic pollution as both an environmental and public health issue, the #microplasticfreeUS drives systemic change that protects ecosystems, wildlife, and human well-being. The long-term goal is a U.S. regulatory landscape that restricts or bans unnecessary microplastic sources, mandates responsibility for producers, and ensures that communities—especially those disproportionately burdened—benefit from cleaner air, water, and food.

15. Engineering Vibrio natriegens for degrading and assimilating poly(ethylene terepthalate) microplastics

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Poly(ethylene terephthalate) (PET) is among the most widely used plastics, yet its high durability and limited recyclability have led to global environmental accumulation. Inefficient recycling practices and persistent littering generate PET microplastics, which pose risks to marine ecosystems and potential hazards to human health through ingestion and exposure. Addressing this challenge requires innovative, sustainable strategies for PET degradation under environmentally relevant conditions.
In this work, we harness synthetic biology to develop Vibrio natriegens—a fast-growing, nonpathogenic marine bacterium—as a whole-cell biocatalyst for PET depolymerization and assimilation in brackish environments. We engineered V. natriegens to express and surface-display a two-enzyme system from Ideonella sakaiensis—IsPETase and IsMHETase—enabling the breakdown of PET into its monomers, terephthalic acid (TPA) and ethylene glycol (EG), at 30°C in seawater like media. Concurrently, we enhanced the organism's metabolic capacity to grow on PET-derived intermediates. Through metabolic engineering and directed evolution, we developed strains capable of utilizing TPA and bis(2-hydroxyethyl) terephthalate (BHET) as sole carbon sources, achieving stable growth.
This integrated system demonstrates a novel approach to biologically degrade and valorize PET microplastics in marine-like conditions. By coupling PET hydrolysis with microbial assimilation, our work lays the foundation for sustainable biotechnological solutions to mitigate microplastic pollution. Such strategies have the potential to reduce environmental persistence of microplastics, decrease human exposure, and ultimately improve ecosystem and public health outcomes.

16. Microplastics Analysis and Workflow using Infrared Microscopy

Warren Edmunds

PerkinElmer US LLC

Identification and quantification of microplastics in various sample types is crucial to further our understanding of the impacts of microplastics on human health and the environment. Infrared microscopy is a leading analytical technique for the analysis of microplastics. Using IR microscopy, the infrared spectra of individual microplastic particles are collected and used to identify the polymer type. The combined visible imaging system is used to collect visible images enabling measurements of size, shape, and count for each polymer type. In this presentation, a typical microplastic analysis workflow using IR microscopy will be demonstrated. Challenges associated with organic matrix interference (eg. from wastewater) will be discussed, and data processing techniques to address these challenges will be shown.

17. Neuropsychiatric Implications of Plastic Pollution

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Recent findings of micro- and nanoplastics (MNPs) in human brains have prompted widespread concern about their impact on the brain. This talk will present a framework for understanding the myriad ways that plastics can impact the brain from a neuropsychiatric perspective. Firstly, the framework recognizes that MNPs directly impact brain health through multiple pathways, including altered gene expression, cytotoxicity, oxidative damage, mitochondrial dysfunction, and/or altered protein folding. Secondly, the framework acknowledges that brain health also depends on bodily health. MNPs have been linked to heart attacks and strokes, gastrointestinal inflammation and dysbiosis, placental dysfunction, and cancer. All of these are risk factors for neurodevelopmental, mental health, or neurocognitive disorders. Thirdly, the framework integrates the plastics life cycle into the health assessment. Plastics production and disposal contribute to climate change, air pollution, and environmental injustices, which carry their own independent risks for various neuropsychiatric conditions. Furthermore, plastics use causes exposure to plastics-related chemicals, which carry their own direct and indirect impacts on the brain. Finally, the framework conveys the quality of evidence behind each mechanism or health risk. Transparent communication about how established these findings are is necessary to maintain public trust.

18. From Behavior to Exposure: Integrating Expert Weighting and Machine Learning to Assess Multidimensional Drivers of Nano- and Microplastic Exposure Risk

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Polypropylene (PP) and polyethylene terephthalate (PET) are commonly used food contact packaging materials in a variety of applications, from drinking water and beverage bottles to infant formula bottles, single-use cups, and food storage containers, because of their excellent barrier properties and cost efficiency. However, several studies have shown that these packaging materials can leach nano- and microplastics (NMPs) into foods and drinks. Although some studies have examined how contact time and temperature affect the total amount of release, no systematic work has addressed their effects on release kinetics or particle release mechanisms.

In this work, we systematically examined the release kinetics of NMPs from PP and PET, under multiple temperature conditions with two types of food simulants (i.e., ultrapure water and 3% acetic acid). To reduce the influence of plastic additives on particle release, we used standard-grade PP and PET rather than consumer products. We exposed PP and PET

to ultrapure water (simulating bottled water, coffee, and tea) and 3% acetic acid (simulating beverages, juices, and syrups) at temperatures from 20 to 90 °C, from 0.5 minutes to 10 days. To understand release mechanisms, we examined plastic surfaces before and after exposure for morphology, carbonyl index, surface roughness, and chemical composition.

NMP release from both PP and PET increased strongly with temperature and contact time and was approximately linear over the exposure period. Short, high-temperature exposures (70–90 °C) produced particle counts within 4 hours that exceeded those observed after 10 days at 20–40 °C, indicating much faster release at elevated temperatures. PET followed the same trends as PP but released fewer particles under comparable conditions. In all experiments, NPs dominated over MPs: at 90 °C and 4 hours, NPs outnumbered MPs by factors of about 16 for PP and 23 for PET. Overall, these results show that modest increases in temperature and duration substantially enhance NMP release from common food-contact plastics, with the released particles predominantly in the nano-size range.

Keywords: Plastic food packaging, nano- and microplastics, release kinetics, human exposure.

19. NLRP3 inflammasome activation is a potential mechanism linking oral micro-nanoplastics exposure to atherosclerosis

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Background: Micro-nanoplastics (MNPs) have become widespread in the environment. Emerging studies have linked MNPs exposure to adverse cardiovascular outcomes. MNPs have been detected in multiple human tissues including arterial plaques. However, the underlying mechanisms linking MNPs exposure to disease outcomes are largely unknown.

Hypothesis: In this study, we tested the hypothesis that the exposure to MNPs promotes sustained inflammation through NLRP3 inflammasome activation leading to adverse outcomes.

Methods and Results: To test this hypothesis, we initially examined the mRNA expression levels of NLRP3 and IL-1beta, a pro-inflammatory cytokine produced and secreted as a consequence of inflammasome activation, in the aortas of exposed mice. We found that mice consuming either polystyrene (PS) beads or the combination of polyethylene and polyvinyl chloride (PE+PVC) beads had increased levels of NLRP3 (2.07 and 2.05-fold respectively). While IL-1beta levels remained at baseline in PE+PVC-exposed mice, levels increased by 2.58-fold in PS-exposed mice. Follow up studies were conducted in macrophage-differentiated THP-1 cells. When treated with a mixture of ocean-derived MNPs (10 ug/ml for 24hr), these cells demonstrated increased secretion of IL-1beta into culture media (average of 5.86-fold over untreated cells). This increase was blocked by co-incubation with the NLRP3 inhibitor, MCC950 (0.54-fold increase over untreated cells). Interestingly, when C57BL/6J mice were orally gavaged with the ocean-derived MNPs (5mg/kg) they also demonstrated increased endothelial expression of NLRP3 (1.23-fold) and IL-1beta (1.47-fold) over control mice.

Conclusions: These results indicate that exposure to MNPs promotes NLRP3 inflammasome activation and suggest that this may be a mechanism contributing to sustained inflammation and adverse cardiovascular outcomes.

20. Quantitative Analysis of Microplastics in Breast Milk Using Integrated Microscopy and Spectroscopic Approaches

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The pervasive presence of micro- and nanoplastics (MNPs) in the environment has raised growing concerns about their potential effects on human health, particularly during vulnerable life stages such as infancy. MNPs are the result of

widespread plastic production and degradation, infiltrating ecosystems, food chains, and the environment. Recent studies have identified MNPs in various human biological samples, including blood, lungs, and placenta, suggesting that no organ system is entirely protected from exposure. While previous research has detected MNPs in human breast milk using techniques such as infrared imaging and Raman micro-spectroscopy, these approaches are limited by particle size detection thresholds and potential misidentification of polymer types. To date, no studies have employed a combination of chemical digestion and Pyrolysis Gas Chromatography/Mass Spectrometry (Py-GC/MS) for identifying and quantifying a broad range of polymer types in breast milk analysis.

This study addresses that gap by analyzing breast milk samples, including both donor milk and infant formula, collected in 2022 through a collaboration with the NYU Grossman School of Medicine. By optimizing detection sensitivity for 9 distinct polymers, this work provides a comprehensive assessment of microplastic presence in breast milk.

The results raise critical questions about potential links between MNP accumulation and maternal lactation challenges, with preliminary associations observed between MNP presence and conditions such as breast engorgement, mastitis, and low milk supply. These findings have broader implications for maternal and infant health, as well as for ongoing research into how plastic-derived pollutants may influence human physiology.
Ultimately, this study not only expands the current understanding of MNP distribution in human tissues but also underscores the urgent need for environmental and public health policies aimed at reducing plastic exposure during critical developmental stages.

21. Microplastic bioaccumulation in a mammal of conservation concern, the San Nicolas Island Fox (*Urocyon littoralis dickeyi)*

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Microplastics and nanoplastics (MNPs) are found in diverse environments worldwide and hypothetically accumulate in wild and domestic mammals in a variety of vital organs. Because of concerns for human bioaccumulation of MNPs and possible health effects, understanding the scope of environmental contamination and possible routes of exposure in animals is essential to mitigating risk from this pollutant. Samples of brain tissue from island foxes (*Urocyon littoralis dickeyi*) endemic to San Nicolas Island (SNI) were archived over multiple decades (2003-2023) and provide a temporal record of potential exposure to environmental contaminants, making this an ideal group for testing MNP bioaccumulation. SNI has a small human population so the limited human interactions with SNI foxes provides an exceptional system for investigating environmental contamination in wildlife. A subset of the fox specimens (n = 34) was assessed using pyrolysis-gas chromatography/mass spectrometry and transmission electron microscopy to document MNP bioaccumulation. We found evidence of nylon, polyethylene, and poly(methyl methacrylate) in high concentrations in brain tissue, but no evidence of different concentrations between sexes, age classes, or year of death, suggesting exposure to these contaminants over several decades in these insular foxes. Potential anthropogenic sources include beach cast plastic and military machinery and infrastructure. Our findings emphasize that MNP accumulation may be widespread in wildlife and should be monitored as a potential stressor for species of conservation concern even in relatively remote systems.

22. Inhaled Nanoplastics Drive PINK1/Parkin-Mediated Mitophagy and Metabolic Dysregulation, Compromising Neurovascular Integrity

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The global plastic production has resulted in widespread human exposure to airborne nanoplastics (NPs), creating an urgent need to understand their neurotoxic potential. Here, we demonstrate that short-term inhalation of polystyrene NPs causes significant neuropathological changes in the murine brain. Our findings show that NPs exposure induces notable neuronal loss in the cerebral cortex, characterized by dendritic degeneration and mitochondrial pathology, through disruption of neuronal and vascular integrity, ultimately leading to cellular metabolism. Furthermore, we observed significant NP accumulation not only within neuronal and cerebrovascular endothelial cells but specifically concentrating in the mitochondrial compartment of these cell types. Importantly, initial NP accumulation was also evident in the synaptic cleft before major damage. Mechanistically, we identify the PINK1/Parkin-mediated mitophagy pathway as a central driver, not only of neuronal injury but also of concurrent endothelial cell dysfunction. This disruption leads to the breakdown of the blood-brain barrier (BBB) and subsequent perivascular hemorrhage. These structural and functional deficits were accompanied by a neuroinflammatory cascade, highly characteristic of early-stage neurodegenerative processes. Through integrated in vivo and in vitro analyses, we define a mechanistic pathway by which nanoplastics compromise neuronal and vascular integrity. Finally, bulk RNA sequencing of brain tissue revealed significant alterations in transcriptionally related gene pathways, correlating with the observed neuroinflammatory cascades. This study underscores the potential of airborne nanoplastics to accelerate or contribute to pollution-associated brain disorders and highlights the urgent need for environmental policy and targeted therapeutic interventions.

23. Dietary Ocean Micronanoplastics are Associated Accelerated Atherosclerosis in ApoE-/- Mice

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Introduction: Micronanoplastics (MNPs) are a recently recognized ubiquitous environmental contaminant linked to atherosclerotic and cardiovascular disease outcomes in humans. The mechanisms by which MNPs may affect the pathophysiology of atherosclerosis remain obscure. Animal models of atherosclerosis development, such as the ApoE-/- mouse, may permit the study of MNP-atheroma interactions in a controlled setting. We aim to investigate the effects of dietary ocean-derived MNPs on atherosclerosis development.

Methods: Adult male and female ApoE-/- mice (n=5-7/group) were fed standard or Western diet (WD) with and without 1% (w/w) added ocean MNPs milled into the chow. After 6 or 12 weeks of exposure, animals underwent aortic pulse wave velocity (PWV) recordings using the transit time method. Whole aortas were used to measure atheroma development using Oil Red O (ORO) assay and aortic root histologic analysis by H&E. Ex vivo pin myography of 5 mm aortic rings evaluated wall stiffness by collagen and elastin modulus. Bulk RNAseq of dissociated aortic tissue compared differential gene expression between MNP exposures.

Results: Animal weights did not differ between MNP-fed and control (non-MNP) animals within diet groups. WD-fed animals had mean weight of 29 g at week 6 compared to 25 g in standard chow group (P=0.02). Aortic PWV was 307 cm/s in MNP-fed animals eating a WD compared to 263 cm/s in non-MNP group (P=0.01), suggesting increased aortic stiffness. ORO disclosed significantly greater aortic atheroma area in MNP-fed animals eating a WD (0.66 mm2) versus non-MNP group (0.19 mm2, P=0.007). Aortic root atherosclerotic area was 2.8-fold greater in MNP-fed animals (16.4 um2) compared to control (5.8 um2, P=0.008) with MNP-fed animals demonstrating mean 6 hemosiderin-laden macrophages per high-power

field compared to 1.9 in control (P=0.03). Myography confirmed greater elastin modulus in MNP-fed animals (660 vs 587 AU, P<0.05) with a strong trend toward greater collagen modulus (21162 vs 16892 AU, P=0.06) as well. Bulk RNAseq disclosed significant upregulation of several pro-atherogenic genes known to be expressed in vascular smooth muscle cells (VSMC) and macrophages including Slc2a5 (10.5 fold), Acly (3.7 fold), Lep (2.0 fold), and Me1 (2.1 fold), (all P<0.01).

Conclusions: These data provide strong evidence that dietary MNPs, when paired with Western diet in an atherogenic-prone animal model, contribute to accelerated atherosclerosis development as evidenced by greater aortic atheroma in complementary measures as well as aortic wall biomechanical changes and physiologic differences in aortic hemodynamics. Pro-atherogenic changes in genes known to be related to pro-inflammatory macrophage signaling and VSMC phenotypic switching may be mechanistic links that deserve future investigation.

24. A machine-learning powered pipeline for microplastic quantification and classification using Py-GC/HRMS: Toward generalizable microplastic exposure assessment

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Ubiquitous microplastic exposure raises concerns for human health. However, the exposure assessment of microplastics continues to be a formidable challenge, with over 2,400 substances exhibiting potentially toxicity. Existing analytical methods remain limited in identifying signals from complex mixtures, with traditional approaches primarily focusing on quantitative analysis of target polymers and relying on manual compound annotations. Our team established a pipeline to quantify and classify microplastic polymers based on Pyrolysis–GC/High-resolution MS (Py-GC/HRMS) total chromatogram full-scan mode data. Further, it validated the additivity of the full-spectrum signal matrix. We proposed and implemented a novel framework with the ability to deconvolute mixture microplastic signals, which was constructed through random linear addition of signal matrix from different polymers and concentrations in our experimental dataset. This method effectively identifies major components and their absolute concentrations. Capable of automated and reproducible processing of high-throughput data. With the establishment of a comprehensive polymer reference database, this framework demonstrates significant potential for scalable human exposure assessment.

25. Rethinking Fetal Risk: What 14C-Polystyrene Reveals About Nanoplastic Accumulation During Pregnancy

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Micro- and nanoplastic exposure is now a certainty; what remains uncertain is how particles distribute and translocate during pregnancy. We propose a quantitative, artifact-resistant framework for tracking nanoplastic accumulation using carbon-14-labeled polymers. 14C-radiolabeling has become a valuable technique for understanding the in vivo behavior of various compounds while preserving their original composition and properties. Here, we have synthesized 14C-labeled polystyrene particles of three different sizes (33 ± 11 nm, 246 ± 81 nm, and 1052 ± 189 nm) and tracked their translocation in pregnant mice. In late-gestation mice, we compared two exposure routes – repeated intranasal administration and single intravenous injection – and then performed whole-organ radioassay across maternal tissues, placentae, fetuses, blood, and excreta. Biodistribution and excretion of the polystyrene particles followed patterns observed with other nanoparticles: pulmonary retention and excretion through the GI tract after intranasal administration (0.5 mg per mouse on GD12, GD14, and GD16, n = 7), and accumulation in liver, spleen, and lungs after intravenous injection (1.5 mg per mouse on GD16, n = 7). We did not detect 14C in placentae or fetuses after intranasal administration. After intravenous administration, around 0.10-0.15% of the injected polystyrene particles were detected in the placentae with all particle sizes. Our results indicate that a small number of polystyrene particles in the blood flow may accumulate in the placenta. However, the portion of plastic particles in the blood flow remains low due to the efficient clearance mechanisms of nanoparticles in mammalian

systems. The polystyrene particles used here had the radiolabel covalently incorporated into the backbone of the material. This allows for the tracking of unmodified polystyrene particles, preserving their intrinsic behavior. Importantly, the use of radiolabeled particles avoids the confounding issue of background signal; any radioactivity detected in tissues can be confidently attributed to the administered dose. The use of 14C-labeled particles can be extended to other polymer materials and chronic exposure investigations that are required to fully recapitulate the real-world human exposure.

26. Rapid Single-Particle Chemical Imaging and Analysis of Nanoplastics by Stimulated Raman Scattering Microscopy

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Nanoplastics represent an emerging class of environmental contaminants with the potential to cross biological barriers and impact human health. However, their small size and chemical diversity have made accurate identification and quantification at the single-particle level particularly challenging. Here, we present a stimulated Raman scattering (SRS) microscopy platform that achieves rapid, chemically specific imaging of individual nanoplastics down to 100 nm. By combining a comprehensive spectral library with data-driven polymer identification algorithms, our method recovers chemical specificity beyond conventional spectral-matching approaches. We apply this workflow to bottled water, quantifying thousands of individual micro- and nanoplastics with multidimensional statistical profiling, including number- and mass-based abundance, polymer-specific size distribution, and particle morphology. This single-particle approach reveals tremendous heterogeneity in nanoplastic populations and uncovers previously inaccessible exposure information. Beyond environmental monitoring, our framework provides a broadly applicable strategy for imaging nanoplastics in biological matrices, laying the foundation for mechanistic studies of biodistribution and toxicity

27. Label-Free In Vivo Imaging of Nanoplastics Biodistribution by Stimulated Raman Scattering Microscopy

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Columbia University

The biological fate of nanoplastics remains poorly understood due to the lack of analytical tools capable of label-free, chemically specific imaging in complex tissue environments. Here, we demonstrate the use of stimulated Raman scattering (SRS) microscopy to visualize and quantify nanoplastics in vivo with high sensitivity and without fluorescent labeling. Using polystyrene nanoparticles as a model system, we injected nanoplastics into mice and harvested tissues for imaging. Our approach circumvents tissue autofluorescence and leverages polymer-specific vibrational signatures to identify and count plastic particles within biological matrices. With single-particle resolution, we reveal the long-term retention of nanoplastics across multiple tissues, quantify their abundance in situ, and map their spatial distribution and heterogeneity of interactions with surrounding biomolecules. This work establishes SRS microscopy as a powerful label-free strategy to investigate nanoplastic biodistribution and persistence in vivo, providing critical insights into their potential health impacts.

28. Potent Neurotoxicity of Nanoplastic and Pesticide Co-exposures In Vitro

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There is growing concern about the increasing presence of micro- and nanoplastics (MNPs) in environmental and biological samples. Nanoplastics (NPs) are of particular interest due to their ability to cross the blood-brain barrier, raising concerns

about neurotoxicity and their contributions to neurodegenerative diseases. Importantly, nanoplastics entering the human body are associated with a complex exposome, including chemicals that adsorb to the plastic particles. This study examines the potential of polystyrene nanoplastics to modulate the neurotoxic effects of Parkinson 's-linked pesticides. We hypothesized that co-exposure to polystyrene nanoplastics and fenpyroximate, rotenone, paraquat, and endothall yields varying synergistic neurotoxicity, with nanoplastic-induced alterations in the toxicokinetics of the pesticides based on their relative lipophilicity. Primary mouse cortical neurons were isolated on embryonic day 15.5 and cultured in 96-well plates. At seven days in vitro, neurons were exposed to a nine-point concentration range of each pesticide and 50 nm polystyrene (0.78 – 200 µg/ml) individually, followed by a co-exposure with a fixed 50-nanometer polystyrene concentration (5 µg/ml) across the same pesticide dilution, for 24 hours. Cell viability was assessed using a fluorescent live/dead cell assay, and a baseline concentration-response relationship was examined for both types of exposures. Polystyrene nanoparticles were not cytotoxic. However, the combination of rotenone or fenpyroximate and polystyrene nanoplastics exerted a strong synergistic effect, increasing cell death and decreasing the rotenone AC50. The combination of the nanoplastics with paraquat or endothall, pesticides with lower logP, did not produce a significant exacerbation of neurotoxicity. Our results suggest that the neurotoxicity of highly lipophilic neurotoxicants is enhanced by the presence of small concentrations of nanoplastics. Our work is currently evaluating endpoints other than cell death to better recapitulate human neurologic disease processes. Taken together, the regulation and risk assessment of environmental chemicals and plastics must consider additive and synergistic potential to protect human neurological health.

29. Developing In-House Techniques for Creating Calibration and Quality Control Materials of Microplastics

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The increasing use of pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) to quantify micro- and nanoplastics (MNPs) in biological samples has highlighted the need for reliable and representative quality control materials. Current commercial options are limited to inorganic powder suspensions containing plastics in both particle and dissolved forms, which require tedious gravimetric preparation and raise concerns about recovery, contamination, and matrix interferences. A microbalance is necessary to achieve masses low enough to create method limits of detection low enough to quantify the trace amounts of plastics expected in biological samples. These equipment and material costs can be an unrealistic hurdle for labs entering the field of microplastics to overcome. To address these challenges, we investigated the use of in-house polymer particle suspensions as alternative QC and calibration materials. Cryomill techniques have been explored to provide the smallest possible particle size, which we find to provide an advantage in homogeneity. Our approach employs glycerol and a surfactant to stabilize suspensions that can be transferred volumetrically rather than weighed individually. Preliminary data indicate that liquid particle suspensions support linear determination of polymer concentrations by Py-GC-MS. Ongoing studies are evaluating accuracy and reproducibility to determine their suitability for routine biological MNP analysis

30. From Ocean to Organism: Decoding the Cellular Impact of Microplastic Exposure on Peripheral Blood Mononuclear Cells (PBMCs)

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BACKGROUND: Microplastics represent a pervasive class of environmental contaminants, yet their impact on human immune responses remains largely elusive. The application of single-cell RNA sequencing (scRNA-seq) provides an advanced framework for dissecting cellular responses to microplastic exposure, capturing nuances that conventional bulk RNA analyses may overlook.

OBJECTIVE: Characterize the dose-dependent transcriptional alterations in human peripheral blood mononuclear cells (PBMCs) following microplastic exposure and correlate these changes with established patterns from recognized inflammatory stimuli.

METHODS: PBMCs were exposed to microplastics at various concentrations and exposure times. Lipopolysaccharide (LPS) and a PMA/ionomycin cocktail served as positive controls. scRNA-seq libraries were sequenced via Illumina NextSeq 2000. Data was processed with Illumina/DRAGEN and analyzed in Seurat with standard QC, integration, clustering, and annotation. Cell-type–stratified pseudobulk differential expression, pathway enrichment, and module scoring evaluated key programs (NF-κB/inflammation, interferon-stimulated genes, lysosome/endocytosis, oxidative phosphorylation, and cellular stress).

PRELIMINARY FINDINGS: Microplastic exposure elicited dose-dependent transcriptional alterations that were cell type-specific. Notably, classical and intermediate monocytes, along with dendritic cells, exhibited pronounced transcriptional changes characterized by upregulation of genes associated with lysosomal and endocytic trafficking, oxidative stress responses, and moderate inflammatory signaling. T and NK cells demonstrated a shift towards activated or stress-associated phenotypes, marked by reprogramming of their cytotoxic functions and metabolic pathways. In contrast, B cells exhibited modifications in antigen processing and presentation routes. When comparing to controls, LPS stimulation resulted in widespread inflammatory and interferon-related expression profiles across various cell lineages, whereas PMA/ionomycin predominantly influenced T-cell activation dynamics. Dimensionality reduction and integrated mapping revealed that microplastic-associated transcriptional states were localized within distinct subclusters, suggesting specific remodeling patterns that, while partially overlapping, were distinguishable from those induced by traditional inflammatory stimuli.

SUMMARY & NEXT STEPS: This preliminary single-cell dataset reveals the relationship between microplastic exposure and cell-type–specific transcriptional responses in PBMCs. The findings highlight the involvement of lysosomal trafficking and metabolic stress pathways, particularly within the monocyte and dendritic cell subsets, as promising candidates for deeper exploration in immunotoxicology research. Future directions encompass the expansion of time points, concentrations, and various microplastic types to enhance understanding of these effects.

31. Role of Nanoplastic in Decreasing the Intestinal Microbiome Ratio

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Exposure to micro- and nanoplastic (MNP) can result in poor gut health, leading to a myriad of diseases. The inter-relatedness of the microbiome bacteria and the differences between the two major phyla of the microbiome Gram-negative and Gram-positive bacteria partially explains how and why nano- rather than micro- plastic decreases the Firmicutes and Bacteroidetes (F/B) ratio. This shift is linked to damage in the intestinal barrier, including weakened cell junctions, loss of protective mucus, higher levels of harmful molecules called reactive oxygen species, and more inflammation. A scoping review of the MNP literature from 2000-2025 was completed and focused on 56 studies that reported intestinal microbiome dysbiosis and poor gut health after exposure to plastic. Overall, the evidence base shows that nanoplastics compromise intestinal homeostasis, with F/B ratio decreases consistently aligned with barrier injury and ill gut health. Although the F/B ratio is a simple marker, the same shift was noted when the broader Gram+/Gram- ratio was used. Future research should focus on realistic exposure levels, use modern methods that reveal the functions of gut microbes, and carefully track how microbes and the gut lining interact, thus potentially lead to better long-term human health outcomes.

32. Similarities across responses in fish to diverse micro and nanoplastic particle types, informing common mechanisms of action across vertebrates

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Micro and nanoplastics (MNPs) are ubiquitous in the environment and have been detected in most ecosystems, including those that are relatively isolated. The class of contaminants categorized as MNPs are quite broad and encompass variable polymer types, shapes, and sizes. Few studies have compared responses between varied particle types. Fibers are the most frequently detected in the environment, followed by fragments, but also represent a relatively small number of studies. Additionally, most research is conducted using virgin particles when the majority of MNP pollution is from secondary microplastics, which have weathered and broken down over time, modifying surface properties and density. To address these data gaps, we exposed the model fish Inland Silverside, Menidia beryllina, for 21-days to micro and nano cryo-milled tire particles, micro and nano polylactic acid, and polyester microfibers, with both weathered and unweathered treatments included in testing. We evaluated the impacts of these particles on growth, behavior, and gene expression to compare the relative toxicities of the different particles. Overall, the nanoparticles (both PLA and TP) and weathered fibers had the greatest effect on behavior and gene expression. Gene ontology analysis revealed strong evidence suggesting MNP exposure affected pathways involved in both muscle contraction and function, with overlap between NPs and weathered fibers, which we confirmed were breaking down into nano-sized fragments. Similar responses have been observed in other vertebrates. Only unweathered microfibers significantly decreased growth which is likely a result of food dilution. Our results also suggest that under weathering conditions polyester microfibers breakdown into smaller sizes and induce toxicity similar to nanoparticles. This has implications for vertebrate and for human health, given that we are exposed to new textiles and other products that shed fiber in our homes. This study highlights the variable effects of MNPs in fish and emphasizes the importance of considering particle shape and size in toxicity studies. We will discuss the findings of this study and how they align with research on other species.

33. Elucidating the effects of environmental microplastics on the gut-brain axis of humanized ApoE3/E4 mice

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Microplastics are emerging environmental contaminants due to the rise in their global plastic production. Most common sizes microplastic particles detected in the environment range from 4-15 um in diameter. Their pervasive presence in various settings—including soil, household dust, and aquatic environments—raises significant environmental and public health concerns. Previous studies detected 5μm plastic microspheres in human gastrointestinal tract, blood, and brain, and the gut-brain axis is increasingly recognized as a key player for neurotoxicity. Microplastics are known to significantly change the gut microbiome composition in wildtype mice; however, very little is known regarding how microplastics modulate the gut-brain axis.

Eight-week-old male and female C57BL/6 mice were orally gavaged vehicle (0 mg/week), a low dose (2 mg/week) of a microplastic mixture (MPs), or a high MPs dose (4 mg/week), twice a week for 4 weeks (n = 4/sex/exposure). The MPs include 5 um polystyrene (PS), polyethylene (PE), and the biodegradable medical plastic congener poly-lactic-co-glycolic acid (PLGA). At the end of the exposure, fecal samples were collected. Total microbial DNA was extracted and subjected to metagenomic shotgun sequencing (MGS). Serum was subjected to both untargeted and targeted short-chain fatty acid (SCFA) metabolomics. TMM normalization followed by Bonferroni's p-value correction looking at a p-value of 0.05- and 1.2-fold change was done on the microbiome data.

MPs in wild-type mice differentially regulated 14 microbial species in males and 18 in females. The high MPs dose decreased the neuroprotective SCFA-producing Akkermansia muciniphila and Bacteroides thetaiotaomicron in males. The high MPs dose increased opportunistic pathogens such as Enterococcus faecalis and Stenotrophomonas pavanii in females. Untargeted metabolomics showed that the MPs altered pathways involved in amino acid metabolism/biosynthesis, anti-inflammatory pathways, and mitochondrial function, with more prominent effects observed at the low MPs dose and in females.

A subsequent in vivo project was conducted on humanized ApoE3/E4 mice to observe the gene-environment interaction of MPs within a humanized Alzheimer's model. Eight-week-old male and female mice were orally gavaged vehicle (0mg/week) or an MPs mixture (2mg/wk) twice a week for 4 weeks (n = 8/sex/genotype/exposure). Total microbial DNA was extracted and subjected to nanopore metagenomic shotgun sequencing (N-MGS). Serum was subjected to both untargeted metabolomics and lipidomics. Left-hemisphere brain sections were prepared for immunohistochemistry (n = 4/sex/genotype/exposure).

In conclusion, the present study shows that MPs altered the mouse fecal gut microbiome in a sex and dose-dependent manner associated with altered serum metabolomes within wild-type mice. Future studies will determine the potential long-term gene-environment interactions of MPs on the gut-brain axis.

34. A Comprehensive Approach for Quality Control and Sample Flagging in PY-GC-HRMS Micro- and Nanoplastic Quantitation within Human Samples Utilizing Skyline and R-Programming

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Micro- and nanoplastic particle (MNPs) analysis, due to the nature of plastic polymers, aren't suitable for traditional quantitation methods like liquid chromatography and gas chromatography- mass spectrometry (GC-MS). Pyrolysis-GC-MS, which pyrolyzes plastic particles in the absence of oxygen to produce a polymer fingerprint, has shown promising results for consistent instrument detection of MNPs at levels ranging from 0.01-0.04 ug/g for multiple plastic polymers1. Despite promising results, streamlined protcols for data analysis, quality control, and statistical evaluation of MNP samples has not been explored. Spectral matching algorithms exist for identifying and quantifying MNP particles, however, this workflow is automated and may introduce inaccuracy when not simultaneously accounting for matrix interferences and chromatogram shifts during matching2. Here we propose a data analysis pipeline geared toward processing raw PY-GC-MS data for quantitative and statistical results for sample batches involving human tissue containing trace amounts of MNPs. Skyline was optimized for fast peak identification and normalized target and confirming ion area extraction in data, allowing for select-ion areas to be processed externally using R. Our post-processing script performs quality control evaluation by determining variance among QC samples across batches and comparing internal standard detection intra-batch. Trace polymer concentrations were calculated using calibration curves, and multi-variate statistics were applied for grouping of unique samples, separating high levels of MNP consumption or samples with contamination for further evaluation. This workflow allows for determining routine quality control of the method and sample quality intra or inter-batch. In addition to quality and batch control, multi-variate statistics can be applied to sample unknowns to distinguish patterns related to sample morphology, yielding pre-liminary connections to tissue or blood extraction location and microplastic deposition. This approach combines QC and sample integrity monitoring with statistical grouping for a more efficient workflow. (1) Ana, T.-A.; Giuseppina, Z.; Silvia, L. Pyr-GC-Orbitrap-MS method for the target/untargeted analysis of microplastics in air. Journal of Hazardous Materials 2024, 469, 133981. DOI: https://doi.org/10.1016/j.jhazmat.2024.133981. (2) Kazuko, M.; Takahisa, I.; Marco, M.; Itsuko, I.; Atsushi, W.; Norio, T.; Hajime, O.; Chuichi, W. Identification algorithm for polymer mixtures based on Py-GC/MS and its application for microplastic analysis in environmental samples. Journal of Analytical and Applied Pyrolysis 2020, 149, 104834. DOI: https://doi.org/10.1016/j.jaap.2020.104834.

35. Trouble in Paradise: Characterization and Modeling of Heavy Metal Adsorption on Microplastics Across Global Beach Locations

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Microplastics (MPs) are emerging as vectors for heavy metals and metalloids (HMs), presenting significant ecological and human health risks. This study characterizes MPs collected from the beaches of Easter Island, Christmas Island, Hawaii, and Mauritius. These locations span the Indian and Pacific Oceans and were selected to examine regional variability in polymer composition, HM contamination, and adsorption behavior. We employed microscopy, Fourier-transform infrared spectroscopy (FTIR), pyrolysis-gas chromatography-mass spectrometry (Py-GCMS), inductively coupled plasma mass spectrometry (ICP-MS), and thermogravimetric analysis (TGA) to analyze the samples. The mean particle size of cryo-milled MPs across the sites was 81.2 ± 91.7 µm, with light microscopy. Christmas Island MPs had a unique profile with high concentrations of polystyrene (PS) at 85.09 mg/g and significantly elevated levels of HMs (As, 25.24 ± 18.19 ppm), (Cd, 31.08 ± 11.30 ppm), and (Cr, 28.31 ± 7.70 ppm), compared to other sites ($p < 0.001$).

The study introduces a novel modified Langmuir isotherm model tailored to the heterogeneous nature of MP compositions, accounting for polymer density and adsorption site variability. This model was used to simulate adsorption behavior across a range of equilibrium concentrations (C_e), providing insights into metal interactions with PS-rich MPs. Key findings include maximum adsorption capacities (q_max) of 0.85 mg/g for As and 0.67 mg/g for Cd, demonstrating the significant role of PS in metal uptake.

By revealing the hidden capacity of our favorite beach destinations to accumulate hazardous metals, this study highlights a deeper concern: the increasing presence of MPs could transform these coastal paradises into reservoirs for toxic contaminants, harboring pollutants that may pose risks to both marine life and the humans who cherish these environments.

36. Potentiating effect of Polystyrene Nanoplastics to Dichlorodiphenyltrichloroethane (DDT) in Zebrafish larvae.

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Micro- and nanoplastics (MNPs) are increasingly recognized as critical vectors influencing the environmental fate, transport, and biological impacts of organic pollutants. More than 70% of the U.S. EPA priority pollutants have been reported to associate with plastic particles in aquatic systems, and over 150 fish species are known to ingest them, raising significant ecological and human health concerns. In this study, we investigated the potentiating effect of polystyrene nanoplastics (NPs; ≤100 nm) on the developmental toxicity of dichlorodiphenyltrichloroethane (DDT), a legacy pesticide with known neurotoxic and endocrine-disrupting properties, using zebrafish (Danio rerio) as a model organism. Fertilized embryos (8 hpf) were exposed for 96 hours to NPs, DDT, or combined NPs/DDT mixtures following OECD Test Guideline 236. Endpoints included acute toxicity, acetylcholinesterase (AChE) inhibition, mRNA expression of genes associated with neurotoxicity, hepatotoxicity, and estrogen disruption, morphological alterations, and biodistribution of fluorescently labeled NPs. NP-only exposures induced no observable mortality or major developmental defects, demonstrating minimal acute toxicity under

test conditions. However, the presence of NPs significantly enhanced DDT toxicity. The 96-h LC_{50} values for DDT alone and for the NPs/DDT mixture were 7.73 mg L^{-1} and 2.13 mg L^{-1}, respectively, indicating a more than threefold increase in DDT potency when co-occurring with nanoplastics. AChE activity assays showed strong inhibition in NPs/DDT groups relative to DDT alone, suggesting that nanoplastics enhance DDT-induced neurotoxicity, potentially by increasing its bioavailability or altering toxicokinetic pathways. Confocal imaging confirmed internalization and time-dependent accumulation of labeled NPs in larvae, supporting the potential for NPs to act as carriers or stressors that facilitate co-transport of hydrophobic organic contaminants. Gene expression analyses further demonstrated that combined exposures altered transcriptional patterns more extensively than DDT alone across multiple pathways relevant to developmental neurotoxicity, endocrine disruption, and hepatic stress. Most genes exhibited higher modulation in the NPs/DDT groups, highlighting the synergistic toxicity driven by nanoplastic–pollutant interactions. Together, these results indicate that nanoplastics significantly potentiate DDT toxicity in zebrafish larvae, altering both physiological and molecular responses. This study underscores the need to consider mixture toxicity in aquatic environments where legacy pollutants and nanoplastics co-exist, and it supports broader concerns that MNP pollution may amplify the ecological risks of chemical contaminants.

37. Transport and occurrence of tire-related chemicals and their transformation products in sediments of populated Newport Bay, CA.

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Limited knowledge exists on the fate, transport and distribution of tire-and-road wear particle (TRWP)-related chemicals into the aquatic environment. The combined effect of mechanical abrasion, UV radiation, temperature, and precipitation results in volatilization, leaching, transformation, and release of tire-related chemicals into urban watershed systems. Recent studies have shown that TRWP-related chemicals, including organic accelerators, anti-scorching agents, plasticizers, and antioxidants, used in tire vulcanization, protection, and processing, pose an emerging threat to aquatic ecosystems. This study investigated the abundance, distribution, and variability of TRWP-related chemicals in sublittoral sediments of Newport Bay, CA. Subtidal sediments (0-5 cm), collected with grab samplers, were extracted and analyzed using UPLC-MS/MS with ESI (+) source in multiple reaction monitoring mode. We detected 19 target compounds in sediments of two particle size ranges (< 100 μm and 100-250 μm) with a total concentration range of 77.6 to 2957.4 ng g-1 and 70.1 to 2.883.1 ng g-1, respectively. Benzothiazole and its transformation products exhibited the highest maximum concentrations (3.6-1605 ng g-1 and 4.3-1412 ng g-1 for < 100 μm and 100-250 μm particle sizes, respectively). Antioxidant derivatives p-Phenylenediamine (PPDs) and PPDs-derived quinones (PPDQs) were also detected at concentrations of up to 28.6 ng g-1 and 9.7 ng g-1, respectively. Our results show that contaminant concentrations are particle-size dependent, with sediment-bound contaminants preferring particles < 100 μm in size. This study highlights the pivotal role of sediment in TRWP-related chemical transport and storage and discusses the potential impact of these contaminants on water quality and aquatic ecosystems.

38. Exposure of Micro- and Nano-plastics in Common Soft Drinks in the US

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Microplastics (≤5 mm) have been detected in various environments and are known to threaten over 1,300 aquatic and terrestrial species. Alarmingly, they have also been found in human tissues, organs, and bodily fluids, including blood cells, sputum, lungs, liver, and breast milk. These particles are common in everyday products such as food, beverages, and cosmetics, and they can easily enter the human body through ingestion, inhalation, and skin absorption. Although many efforts have been made, there remain challenges in identifying plastic particles that are less than 1 μm, known as

nanoplastics, which have the potential to cross biological barriers. Thus, this study aims to fill that research gap by examining the presence and concentration of micro- and nanoplastics (MNPs) in popular soft drinks in the U.S., using a combination of scanning electron microscopy (SEM) and stimulated Raman scattering (SRS). Soft drinks, after being oxidized to eliminate sugars and colorants, were analyzed using SEM and SRS to detect and quantify MNPs. Our preliminary SEM results show that the detected materials vary in size and shape and exhibit moderate carbon concentrations, aligning with the carbon-based structure of plastic polymers. SRS analysis indicates that a 12-ounce can of Coca-Cola contains approximately 3.74×10^6 MNPs, of which 78% are nanoplastics. The MNP level is about 15 times higher than that found in bottled water. Notably, nearly 50% of the identified MNPs were found to be polyethylene. Ongoing research will further investigate the concentration of MNPs in different soft drinks and container types, including glass and plastic bottles, as well as cans.

39. Polymer, Size, and Time Shape Microplastic Cytotoxicity Across Placental and Immune Cells With Links to Preterm Birth-Relevant Immune Microenvironments

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Background. Micro- and nanoplastics (MNPs) are increasingly detected in human tissues; however, there is limited quantitative toxicity data for placental and immune cell types. Understanding when and where different cell types are most vulnerable can help guide mechanistic research.

Objective. Test whether MNP exposures create cell-type–specific susceptibility windows aligned with preterm birth (PTB)-relevant immune microenvironments. We hypothesized that smaller particles and more reactive chemistries (e.g., those releasing additives) would reduce CC50 values, particularly in macrophages compared to trophoblasts and T cells, with peak effects at 24–48 hours. These windows were expected to mirror pro-inflammatory niches observed via spatial transcriptomics at the maternal–fetal interface.

Methods. CC50 values were measured across three polymers (PE, PS, PVC), two sizes (Small, Large), and four timepoints (3, 6, 24, 48 h) in human trophoblasts (BeWo, HTR8, JEG3), T cells (Jurkat), and macrophages (THP-1). Replicate-level dose-response data were modeled using a mixed-effects framework: cc50 ~ cell_line Size + cell_line Timepoint + cell_line*Treatment + (1|Replicate). Contrasts referencing Jurkat were obtained using emmeans. To control for multiple testing while maintaining power, we applied weighted Benjamini–Hochberg FDR (weights $\propto 1/SE^2$, mean-normalized) within biologically relevant families (e.g., Timepoint × Treatment × Size). Sensitivity analyses included hierarchical FDR and cell-type–specific family groupings. Inference was based on q-values.

Results. Jurkat cells showed the highest resistance (reference CC50) and were used to assess differential susceptibility. After weighted FDR correction, responses varied by condition and did not follow global trends across polymers or cell types. A notable susceptibility window appeared in trophoblasts at 24 h with PS–Small: BeWo (ΔCC50 = −84; 95% CI −126, −42; q=0.042) and JEG3 (Δ = −99; 95% CI −141, −56; q=0.042) were significantly more sensitive than Jurkat. In contrast, PVC–Small at 48 h showed no FDR-significant differences (all q≥0.05), despite small nominal p-values, supporting a context-dependent, rather than universal, cytotoxicity profile. Interaction summaries highlighted additional condition-specific effects: at 24 h with PE/Mix, BeWo (Δ ≈ −96; 95% CI −153, −40; q≈0.001) and HTR8 (Δ ≈ −59; 95% CI −102, −16; q≈0.003) were sensitive; size-specific effects were seen in JEG3 Small/PE (Δ ≈ −62; q≈0.03) and HTR8 Large/PE (Δ ≈ −63; 95% CI −111, −15; q≈0.009). No broad, polymer-independent differences remained after correction.

Conclusions. MNP cytotoxicity in pregnancy-relevant systems is context-dependent, shaped by polymer, size, duration, and cell type. This analysis pipeline—mixed modeling with weighted FDR in transparent families—yields reproducible toxicity metrics and supports integration with spatial and epidemiologic datasets related to preterm birth.

40. Unexpectedly High Accumulation of Nanoplastics in the Human Placenta: Higher Levels than in the Brain and Liver

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Nanoplastics (NPs), plastic particles smaller than 1 μm, have become a major environmental and public health concern. They can enter the human body through food, air, and water, yet direct evidence of their biodistribution, particularly across maternal and fetal organs, remains scarce. This study investigated the distribution of fluorescently labeled polystyrene nanoplastics (100 nm) in pregnant rats, focusing on their presence in the placenta, fetal liver, and brain.

Pregnant rats on gestational day 15 received intravenous injections of fluorescent nanoparticles. After 48 hours, placental and fetal tissues were collected, fixed, and analyzed by confocal fluorescence microscopy under standardized conditions. Quantitative image analysis revealed strong NP fluorescence in the placenta and lower but detectable signals in the fetal liver and brain. The fluorescence intensity in the placenta was about 2.5 times higher than in the liver and 3.1 times higher than in the brain, indicating that the placenta serves not only as a semipermeable barrier but also as a major accumulation site.

These findings provide direct evidence that nanoplastics can cross the placental barrier and reach fetal organs. Two mechanisms may explain this transfer: (1) endocytic uptake by trophoblast cells followed by accumulation, and (2) transcytosis-mediated transport into the fetal circulation. The detection of NPs in both fetal liver and brain implies systemic distribution after transplacental passage, suggesting that prenatal exposure could cause long-term developmental or immunological effects.

The pronounced accumulation of NPs in the placenta highlights its dual role as both a filter and a reservoir. The higher concentration compared to fetal tissues may reflect its active uptake and limited clearance capacity. These results agree with previous findings on microplastics in human and animal placentas but provide the first microscopic evidence at the nanoscale level.

As environmental nanoplastic pollution continues to increase, understanding maternal–fetal transfer is crucial. Further studies should address chronic low-dose exposure, developmental toxicity, and the physicochemical factors affecting placental permeability. Improved analytical methods such as Raman or FTIR spectroscopy will be essential for accurate particle identification and contamination control.

In conclusion, nanoplastics penetrate the rat placenta and accumulate in fetal tissues, with the placenta showing the highest concentration among examined organs. These results emphasize the vulnerability of developing organisms to nanoplastic exposure and highlight the urgent need to minimize maternal exposure during pregnancy.

41. Assessment of occupational exposure to micro/nano particles generated from carbon fiber-reinforced plastic processing

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Carbon fiber-reinforced plastics (CFRP) are leading functional materials with superior strength and low mass density compared to metal. Our previous factory site analyses found that CFRP processing generates fibrous debris and fine micro/nano-sized particles of various shapes. The present interventional study was conducted at a factory located in Japan

and evaluated debris consisting of various-sized particles generated during the industrial processing of CFRP, such as cutting, grinding, and turning of CFRP pipes, using real-time particle monitoring devices of the following: PM4 Digital Dust Monitor (DDM), handled Optical Particle Counter (OPC), Condensation Particle Counter (CPC), and Scanning Mobility Particle Sizer (SMPS). In addition, personal exposure of workers was evaluated using a novel wearable PM2.5-compatible device (P-sensor). First, we confirmed the presence of micro/nano particles in the dust generated during industrial processing of CFRP. Finer CFRP-generated particles were detected by the nanoparticle-compatible devices; CPC and SMPS, but not by OPC or DDM. The dynamic detection pattern of the P-sensor resembled that recorded by the nanoparticle-compatible devices. The novel wearable P-sensor can be used to measure finer particles generated by CFRP processing in occupational settings. Second, the exposure assessment was conducted twice and the levels of the micro/nano particles in the second survey were significantly (less than half) lower than that in the first survey. By avoiding immediate power-off of the exhaust system after operations, the scattering of particles was effectively reduced. Our results indicate that effective use of local exhaust ventilation system improves the workplace environment for particle exposure.

42. Evaluation of UV-C sterilization effects on N95 mask structural integrity and mask performance for safe reuse.

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Prior to the COVID-19 pandemic, the use of commercial masks outside of hospitals was primarily limited to those living in densely populated areas with poor air quality (e.g., Delhi, India; Lahore, Pakistan; Dhaka, Bangladesh; Chengdu, China, etc.). During the pandemic, the demand for this personal protective equipment (PPE) far outstripped the supply, and sterilization procedures were investigated to allow for the reuse of masks. However, UV sterilization was not recommended by mask manufacturers such as 3M, suggesting that this method was damaging to the non-woven fibers of N95 and other masks. In this work, we investigate the impact that repeated cycles of exposure to UV C (254 nm) have on single-use mask (N95) fibers. Using Scanning Electron Microscopy (SEM) and image processing software - ImageJ, N95 masks' layers were analyzed to determine the void fraction of mask layers before and after exposure. To correlate the material properties of masks prior to and following exposure to filtration efficiency, we exposed the N95 masks to aerosols like woodsmoke, room air, and nebulized saline mist, examining the aerosol properties and particle size distribution using a laser aerosol spectrophotometer. We found that exposure to UV for the time recommended for decontamination (15 minutes) yielded sufficient damage to the non-woven fibers of N95 masks that particulates less than 200nm (approximately the size of COVID particles) easily passed through the masks. We therefore conclude that the use of UV sterilization is not recommended to extend the life of single-use PPE masks. As the acute experiences of the pandemic have receded, the cost and availability of PPE have normalized, and well-funded populations have ceased to focus on the issue of sterilization and reuse. However, members of at-risk communities are still grappling with ways to best adapt to supply chain shortages and masking needs. Therefore, these results will be of interest to those seeking to understand how UV-C affects the reusability of N95 masks for purposes such as the filtration of pollutants, nano and microplastics, and other potential inhaled pathogens.

43. A Pilot Study of Plastic Polymers from Marine Microplastics in Whale Blubber

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Microplastics are widespread pollutants in the marine environment and a health concern. Marine mammals are long-lived sentinel species often used for biomonitoring the health of our oceans. Previous studies showed marine mammals are exposed to microplastics, as evidenced by their presence in the gastrointestinal tract and fecal matter. However, the accumulation of microplastics in other organs has been largely unexplored. This study aimed to measure the levels and

types of plastic polymers in the blubber tissues of humpback whales (Megaptera novaeangliae) obtained from skin biopsies of free-ranging whales obtained during 2021-2023. A total of 12 samples were analyzed, including 9 females (3 calves, 6 adults) and 3 males (1 calf, 2 adults). Six animals were mother-calf pairs. Solid particulates were isolated from digested blubber tissue samples and combusted to identify signature mass spectra of the plastic polymers using pyrolysis gas chromatography-mass spectrometry. The results show polyethylene was the most abundant polymer in all samples analyzed, followed by polypropylene and polyvinyl chloride, which are the most abundant polymers in the oceans. Other polymer types were also present at lower levels, including styrene butadiene rubber, nylon 6, acrylonitrile butadiene styrene, polycarbonate, polyurethane and polystyrene. Among 4 mother-calf pairs, two calves had higher levels than their mothers, while two calves had lower levels. Altogether, we show the presence of plastic particles in the blubber tissues of humpback whales, indicating plastics are moving from the site of exposure into distal tissues in both adults and calves. Future research will expand this pilot study to include a greater number of humpback whales, other species and effects on marine mammal cell lines. This work was supported by the NIEHS R35ES032876 and P30ES030283.

44. A Robust Pyrolysis–GC/MS Workflow for Identifying Micro- and Nanoplastics in Biological and Environmental Matrices

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Plastic pollution represents a growing global concern. The environmental degradation and fragmentation of plastics produce micro- and nanoplastics (MNP), which have been detected in diverse environmental and biological matrices. Public health concerns are triggered by evidence showing that submicron plastic particles can traverse mucosal barriers, enter the bloodstream, and potentially accumulate in organs and arterial plaques. Estimated human exposure is approximately 0.5–1 g of microplastics weekly, through diet and air pollution. Animal studies and in vitro experiments indicate that MNP exposure may contribute to inflammatory and metabolic disturbances. The main analytical challenge for biomonitoring is the low concentration of MNPs in biospecimens, as well as variability in particle size and polymer type of environmentally occurring MNPs.

To provide scientifically rigorous and reproducible data on human exposure to MNPs, we developed a pyrolysis–gas chromatography/mass spectrometry (Py-GC/MS) method for detection and characterization. Commercial polymer standards (Frontier Lab) diluted with SiO_2 or $CaCO_3$ were analyzed on an Agilent GC/MS equipped with a Gerstel TDU/CIS heated inlet (TDU: from 40 to 300°C for 0.33 min, pyrolysis at 650 °C, with the rate 720 °C min^{-1}). The method produced reproducible, polymer-specific pyrograms with diagnostic ion fragments for common polymers, enabling confident identification in complex mixtures.

Preliminary results show that the Py-GC/MS platform provides a robust analytical foundation for MNP biomonitoring. Advancements in evidence-based evaluation of potential microplastic-associated toxicity and long-term health effects require enhancement of MS detection specificity and reproducibility, and interlaboratory standardization, as the most urgent steps.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. The use of trade names is for identification only and does not imply endorsement by the CDC.

45. Evaluation of Micro- and Nanoplastics Accumulation in Alzheimer's and Related Dementias

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Micro- and nanoplastics (MNPs) are increasingly recognized as an emerging environmental contaminant of concern in human health. However, their mechanisms for uptake within the body and potential role on neurodegenerative disorders are still not well understood. Although a direct link between MNP exposure and Alzheimer's disease or related dementias has not yet been established, accumulating evidence suggests differential patterns of MNP accumulation across neurodegenerative diseases, indicating potential disease-specific vulnerabilities or transport mechanisms.

In this study, we quantified MNPs accumulation in postmortem brain tissues from individuals diagnosed with progressive supranuclear palsy, familial Alzheimer's disease, Alzheimer's disease, dementia with Lewy Bodies, and frontotemporal dementia, compared against cognitively unaffected control tissue. Using pyrolysis-gas chromatography/mass spectrometry (py-GC/MS), we determined polymer type, and total MNP concentration within isolated brain tissues.

As a result, across all dementia types, the mean MNP concentration was approximately 1,400ug/g of tissue, which was considerably higher than the 460ug/g average detected in cognitively unaffected controls. Notably, Alzheimer's disease and dementia with Lewy Bodies exhibited significantly elevated levels of polypropylene compared to controls, indicating a potential selective retention or transport of this particular polymer type in these neurodegenerative disorders.

While these findings do not prove causation, they do reveal consistent trends of increased MNP burden across multiple forms of dementia. This study emphasizes the importance of investigating environmental plastic exposure as a potential factor influencing neurodegenerative processes and further highlights the need for mechanistic studies exploring MNP transport, accumulation, and interaction with brain tissue and disease progression.

46. Photoaged Microplastics Impair Mechanosensitive Endothelial Ion Channels to Alter Calcium Flux and Notch Signaling

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Introduction: Nanoplastics (NPs; <1 μm), formed by photooxidative degradation of larger plastics, have been found at higher levels in human brain tissue in dementia, suggesting a compromised blood-brain barrier. The mechanisms underlying NPs' dissemination to the brain and the regulation of heart function are poorly defined. We hypothesized that photoaged microplastics (PA-MPs) impair gut-vascular barrier integrity to facilitate systemic translocation, leading to disrupting endothelial Piezo1-mediated calcium influx and Notch signaling.

Methods and Results: Pristine nanoparticles (NPs) were exposed to ultraviolet light for 4 weeks, resulting in surface oxidative modifications and observable shape alterations. These PA-MPs, at a concentration of 1 μg/μL, were micro-gavaged into transgenic zebrafish at 5 days post-fertilization (dpf). In transgenic Tg(flk1:EGFP) larvae, PA-MPs compromised both the intestinal epithelial and vascular barriers, facilitating the translocation of particles into the systemic circulation. In the Tg(elavl3:GCaMP6f) larvae, PA-MPs caused a significant reduction in neuronal calcium activity within the optic tectum of the brain ($n=9$, $p<0.05$), which was associated with an altered swimming pattern. In the Tg(cmlc:GCaMP) larvae, a decrease in myocardial calcium signaling correlated with impaired swimming endurance ($n=12$, $p<0.05$). Moreover, in the Tg(flk1:tp1:EGFP) Notch reporter line, CRISPR-Cas9-mediated inhibition of endothelial-specific Piezo1 corroborated the suppression of Notch signaling. In cultured human aortic endothelial cells (HAECs), PA-MPs diminished calcium influx, as measured by Fluo-4AM, in the presence or absence of Yoda1 treatment, accompanied by downregulation of Notch1 signaling and the induction of apoptosis.

Conclusion: Our findings elucidate that PA-MPs impair gut-vascular barrier integrity, facilitating systemic translocation and disrupting endothelial Piezo1-mediated calcium influx and Notch signaling, accompanied by altered swimming pattern and endurance.

47. Advancing the method for isolating and quantifying MNPs in human cerebrospinal fluid for Brain Waste Clearance Studies

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MNPs have been detected in human feces, urine, blood, and various organs, raising concerns about human exposure and potential health implications. However, isolating and quantifying MNPs from complex biological matrices remains a major analytical challenge. Our team has made significant development by developing a novel approach to isolate and quantify MNPs from human tissues using advanced spectroscopic and microscopic techniques. The findings show significant MNPs accumulation in the human brain compared to the liver and kidney, raising concerns about brain waste management and potential toxic effects on the central nervous system (CNS) function. Here, we assess the quantity and physicochemical properties of MNPs in human cerebrospinal fluid (CSF) using pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS). The initial quantitative measurement was conducted on CSF samples (n=14) collected from a brain injury cohort. Polymer concentrations ranging between 13.3 and 82.8 µg/ml were detected, with a mean of 22 µg/ml for the summed polymer concentrations. To validate our experimental approach, artificial cerebrospinal fluid (aCSF) spiked with known polymer standards is analyzed to assess matrix interference removal and recovery efficiency. This will help us advance the methodological precision to facilitate the implementation of accurate correlation studies with brain waste clearance and CNS pathologies.

48. Microplastic Exposure in Indian Hospitals: Ingestion Risks from Settled Dust, Characterization, and Implications for Vulnerable Populations

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Microplastics (MPs) in indoor environments represent an emerging pollutant with significant human health implications, particularly through ingestion and inhalation pathways. In healthcare settings, where vulnerable populations such as infants and immunocompromised patients spend extended periods. Despite global concerns, data on MP contamination in Indian hospitals remain scarce, limiting evidence-based mitigation. This study provides the first insights into MP exposure in public and private hospitals in Rajkot, India, emphasizing ingestion as a primary route and its potential links to inflammation, endocrine disruption, and respiratory issues. Settled dust samples were collected from diverse zones in two Rajkot city, India hospitals. Samples underwent organic digestion, density separation, and filtration. MPs were quantified and morphologically classified via optical microscopy. Polymer identification used FTIR spectroscopy. Estimated Daily Intake (EDI) via ingestion was modeled using EPA equations. Result shows mean MP concentrations were 65.0 ± 20.3 MPs/g (Hospital 1) and 80.0 ± 38.5 MPs/g (Hospital 2), with fibers dominating (52–69%) and red/blue particles (22–54%) prevalent, linked to PET (dominant polymer) and PE from textiles and disposables. Sizes peaked at 200–500 µm (27–37%), though <50 µm fractions were underrepresented. EDI values highlighted stark risks: infants faced up to 0.82 MPs/kg/day in high-traffic OPDs/corridors—exceeding adult levels (0.02–0.04 MPs/kg/day) by 20–40-fold—due to higher hand-to-mouth behavior and lower body weights. PCA revealed institution-specific patterns, with high-traffic zones driving elevated exposure via homogenized fiber distribution. These levels suggest chronic ingestion could amplify health burdens, including oxidative

stress and pollutant bioaccumulation in patients. This baseline reveals substantial MP ingestion exposure in Indian hospitals, disproportionately affecting infants and underscoring the need for urgent interventions like synthetic material substitution, enhanced filtration, and single-use plastic regulations. Future work should integrate inhalation modeling and advanced techniques (e.g., pyrolysis-GC-MS) to refine risk assessments and safeguard healthcare environments.

49. Exposure of U.S. Adults to Microplastics from Commonly-Consumed Proteins

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This research, published in 2024, investigated microplastic (MP) contamination in 16 commonly-consumed protein products (seafoods, terrestrial meats, and plant-based proteins) purchased in the United States (U.S.) with different levels of processing (unprocessed, minimally-processed, and highly-processed), brands (1 – 4 per product type, depending on availability) and store types (conventional supermarket and grocer featuring mostly natural/organic products). Mean (±stdev) MP contamination per serving among the products was 74 ± 220 particles (ranging from 2 ± 2 particles in chicken breast to 370 ± 580 in breaded shrimp). Concentrations (MPs/g tissue) differed between processing levels, with highly-processed products containing significantly more MPs than minimally-processed products ($p = 0.0049$). There were no significant differences among the same product from different brands or store types. Integrating these results with protein consumption data from the American public, we estimate that the mean annual exposure of adults to MPs in these proteins is 11,000 ± 29,000 particles, with a maximum estimated exposure of 3.8 million MPs/year. These findings further inform estimations of human exposure to MPs, particularly from proteins which are important dietary staples in the U.S. Subsequent research should investigate additional drivers of MPs in the human diet, including other understudied food groups sourced from both within and outside the U.S.

50. Elevated temperatures and extended periods accelerate the release of nano- and microplastics from thermoplastic packaging into foods, raising the risk of human exposure

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Polypropylene (PP) and polyethylene terephthalate (PET) are commonly used food contact packaging materials in a variety of applications, from drinking water and beverage bottles to infant formula bottles, single-use cups, and food storage containers, because of their excellent barrier properties and cost efficiency. However, several studies have shown that these packaging materials can leach nano- and microplastics (NMPs) into foods and drinks. Although some studies have examined how contact time and temperature affect the total amount of release, no systematic work has addressed their effects on release kinetics or particle release mechanisms.

In this work, we systematically examined the release kinetics of NMPs from PP and PET, under multiple temperature conditions with two types of food simulants (i.e., ultrapure water and 3% acetic acid). To reduce the influence of plastic additives on particle release, we used standard-grade PP and PET rather than consumer products. We exposed PP and PET to ultrapure water (simulating bottled water, coffee, and tea) and 3% acetic acid (simulating beverages, juices, and syrups) at temperatures from 20 to 90 °C, from 0.5 minutes to 10 days. To understand release mechanisms, we examined plastic surfaces before and after exposure for morphology, carbonyl index, surface roughness, and chemical composition.

NMP release from both PP and PET increased strongly with temperature and contact time and was approximately linear over the exposure period. Short, high-temperature exposures (70–90 °C) produced particle counts within 4 hours that exceeded

those observed after 10 days at 20–40 °C, indicating much faster release at elevated temperatures. PET followed the same trends as PP but released fewer particles under comparable conditions. In all experiments, NPs dominated over MPs: at 90 °C and 4 hours, NPs outnumbered MPs by factors of about 16 for PP and 23 for PET. Overall, these results show that modest increases in temperature and duration substantially enhance NMP release from common food-contact plastics, with the released particles predominantly in the nano-size range.

Keywords: Plastic food packaging, nano- and microplastics, release kinetics, human exposure.

51. Evaluating the Effects of Nanoplastic Exposure on Amyloid-β Aggregation and Neurotoxicity

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Plastic pollution has emerged as a global concern, with growing attention to the potential health impacts of nanoplastics. While environmental distribution is well documented, their neurotoxic potential and possible role in neurodegenerative processes remain poorly understood. In particular, links between nanoplastic exposure and Alzheimer's disease pathology have yet to be clarified. This work investigates how nanoplastics influence amyloid-β (Aβ) fibrillization kinetics and neuronal health. A cell-free in vitro assay was utilized to examine polymer-specific effects of 50 nm polystyrene (PS) and poly(methyl methacrylate) (PMMA) nanoparticles on Aβ aggregation. Increasing concentrations of both polymers shifted the fibrillization profile, altering the time to fibril formation. These findings guided subsequent studies in primary cortical neurons isolated from embryonic day 15.5 mice. Cultures were exposed on in vitro day 7 to a nine-point concentration range (0.8–0.003125 µg/µL) of PS or PMMA nanoparticles for 24 or 120 hours. Neurotoxicity was assessed via fluorescence-based live/dead cell assays and reactive oxygen species (ROS) detection. Exposure to both PS and PMMA does not induce significant changes in percentage of dead cells or ROS at multiple concentrations when compared to the control. Neurons were also co-exposed to synthetic Aβ (1–42) at concentrations of 2.5 or 1.25 µM together with 50 nm polystyrene (PS) nanoplastic particles at 0.05 or 0.00625 µg/µL for 120 hours, in an effort to reproduce the fibrillization phenomenon observed in the cell-free assay within primary neuronal cultures. The results showed a significant decrease in fluorescent signal labeling Aβ peptide and fibrils in the co-exposure group of 2.5 uM peptide with 0.05 ug/ul PS when compared to the control. These findings suggest that the current in vitro neuronal model and endpoints used in this study may not be optimal for detecting subtle or delayed neurotoxic effects of nanoplastics. Further optimization of the Aβ co-exposure model, including refinement of exposure conditions, time windows, and analytical endpoints, will be necessary to more effectively evaluate how nanoplastics may contribute to neurodegenerative disease processes in vitro.

52. Maternal Transfer and Systemic Deposition of Polyamide-12 Micro and Nanoplastics Into the F1 Generation: a Cross-Foster Rat Study

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Micro- and nanoplastics (MNPs) are increasingly recognized as emerging environmental and occupational contaminants with the potential to distribute beyond primary portals of entry and accumulate in internal organs. Although the systemic movement of MNPs is receiving growing attention, very little is known about exposure during pregnancy. Our laboratory has identified MNP neonatal tissues after maternal inhalation exposure throughout pregnancy. In this work, it is unclear if the majority of these particles are passaged across the placental barrier during gestation or across the GI via lactation during neonatal feeding. Therefore, the purpose of this study was to identify how gestational or neonatal exposure influences offspring MNP tissue burdens and localization in the F1 generation. To address these gaps, we conducted a cross-foster study in Sprague Dawley rats using polyamide-12 (PA-12) MNPs, an industrially relevant engineering polymer frequently identified in airborne particulate matter and human tissues. Adult rats were exposed to PA-12 MNP aerosols or clean air

from gestational day (GD) 6 to 19 and randomly assigned to four foster combinations that enabled separation of exposure pathways: control dam with control pups, control dam with exposed pups, exposed dam with control pups, and exposed dam with exposed pups. At necropsy, F1 offspring were evaluated for PA-12 presence in brain, lung, and heart using analytical and visual techniques to verify the presence of PA-12 particulate. Tissue burdens were quantified using pyrolysis gas chromatography mass spectrometry (Py-GC-MS), targeting PA-12 specific marker ions to confirm polymer identity and mass within each organ. PA-12 particulate were visualized and quantified within the tissues using hyperspectral dark-field microscopy (CytoViva, Inc). As expected, the MNP burden was greatest in the pups exposed during gestation and neonatal feeding in the heart and lungs, followed by animals exposed in pregnancy only. Interestingly, in the brain, the MNP burden was greatest in animals exposed during the lactational period only, followed by gestation only. These findings provide new evidence that PA-12 MNPs can cross maternal barriers, reach multiple organs in developing offspring, and persist through early life, highlighting the importance of considering parental exposure status and intergenerational transfer when evaluating MNP health risks. *Supported By: NIH R01-ES-031285, P30-ES-005022, P20-GM130422, and T32-ES-007148*

53. Environmental microplastics - from our households to our rivers and oceans and back to our table

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Sources of environmental microplastics into urban environments include washing machines, and dryer vents. However, the extent to which these various sources contribute microplastics into our air and water have not been explicitly compared. To assess whether washing machines or dryer vents are greater contributors of environmental microplastics, we simultaneously installed and sampled filters on household washing machines and dryers across two coastal communities for a 30 day period. We quantified the dry weight of the microparticles in each of the filter types and compared within and between households. We also surveyed users about the ease of use of each filter type. Washing machine and dryer type and age affected the amount of microparticles collected in the filters. The efficacy of the washing machine and dryer vent filters at trapping microplastics and the user experience can inform policy for wider application to minimize environmental microplastics from laundry. Reductions in microfibers entering the environment is essential to reducing exposure by organisms, including humans.

54. Innovative Modelling Driven Membrane-Free Microfluidic Separation of Microplastics Model Optimized with Machine Learning

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The pervasive presence of microplastics (MPs) in drinking water poses significant health risks, yet current removal technologies particularly membrane-based filtration are costly, prone to fouling, and energy-intensive. This study proposes an innovative, cost-effective, membrane-free microfluidic device for MP separation based on size and shape, leveraging fundamental physical principles such as Reynolds number, inertial lift, and drag forces. The device features a specially engineered microchannel that generates targeted flow profiles, enabling precise particle separation through the interplay of inertial and drag forces influenced by channel geometry, flow rate, and particle characteristics. A Multiphysics computational model will simulate particle trajectories and optimize channel design, while a machine learning model trained on simulation data will predict optimal operating conditions for diverse MP types. This integrated approach aims to develop a passive, low-energy device capable of achieving >95% removal efficiency across a wide range of microplastics. By combining Multiphysics modeling with adaptive machine learning control, the system offers a scalable, sustainable, and

low-cost alternative to conventional filtration methods. The proposed strategy not only enhances water treatment efficiency but also addresses global challenges in providing safe drinking water, presenting a practical solution for microplastic mitigation in environmental and public health contexts.

Keywords: Microplastics; Membrane-free Filtration; Microfluidics; Multiphysics Modeling; Machine Learning; Water Treatment

55. Structural degradation of microplastics from thermal oxidation increases carbon leaching in aquatic environments

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This study aims to quantify and compare the leaching potential of polyvinyl chloride (PVC) and polyethylene terephthalate (PET) microplastics (MPs) after exposure to thermal oxidation. The rising global incidence of wildfires along with the frequency of open burning makes the thermal oxidation of MPs an emerging environmental concern. Although this process alters the chemical structure of MPs and may alter their behavior in the environment, the specific impacts of thermal oxidation on MP leaching mechanisms remain poorly understood. We quantified total carbon (TC) and dissolved organic carbon (DOC) in MP leachates using a total organic carbon (TOC) analyzer to compare release behavior differences between thermally oxidized MPs and non-thermally oxidized MPs when exposed to freshwater and DI water. To track chemical and physical changes before and after thermal oxidation and leaching, we analyzed MPs using attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectroscopy, scanning electron microscopy (SEM), elemental analysis (EDS), and zeta potential (ZP) measurements. These characterization techniques showed changes to elemental composition, increased carbonyl index, and decreased ZP attributed to burning, proving that thermal oxidation alters the chemical structure of MPs. Our results showed an increase in TC leaching as a result of thermal oxidation, with 100ºC burned PVC leaching 1.3x more and 250ºC PVC leaching 8.9x more TC into water compared to non-oxidized PVC. PET showed limited leaching across all oxidation conditions. Current work focuses on in-depth kinetic modeling of DOC release, particularly in thermally oxidized PVC, investigating the role of temperature, agitation, and concentration on leaching mechanisms. These findings highlight the distinct chemical fingerprint and unique leaching behavior of thermally oxidized MP to help better understand their reactivity in the environment.

56. Visualizing micro/nanoplastic effects on the brain: Microvascular pathology

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Neurodegenerative disease is definitively diagnosed by histopathology post-mortem. While diagnosing such cases, perivascular glossy deposits were discovered. Earlier neuropathologists dismissed these as hemosiderin from old hemorrhages which should stain for iron. However, these newly observed deposits did not stain. Guessing these might be plastics, we subjected tissue (~5 mg) adjacent to sections taken for histopathology to plastics isolation (saponification, centrifugation, and ethanol washes, followed by pyrolysis gas-chromatography/mass spectroscopy). We found abundant plastics: 30,908µg/g of tissue in white matter of Alzheimer's Disease (AD), and 21,441µg/g in Binswanger's dementia (BD), an order of magnitude above that of healthy brains (average, 4,800µg/g). Cortical gray matter from both diseases also contained more microplastics by weight than healthy brains. We further characterized these particles by negative stain and whole mount transmission TEM and SEM with EDS. To develop optical microscopy of these plastics within tissue sections, we performed confocal lambda scans on isolated particles, exciting with 10 different wave lengths and collecting emissions at 8 nm steps across 419 – 797nm. Then we performed these lambda scans on histopathological slides of brain tissue stained from cases of AD and BD. Thus we determined a combination of excitation and emission that produced strong emission from plastics and little to none from human brain tissue. Results indicated that micro/nanoplastics in human brain were: Abundant in brains from 2023-2024 but minimal in the 1960's; composed of different types of plastic particles in the

same individual (shapes and sizes, and excitation/emission spectra) and between individuals; were primarily located in the walls of blood vessels but also sprinkled throughout the parenchyma; at highest level with microhemorrhage and vascular leakage; engulfed by CD68 macrophages; surrounded by loose amyloid but not consistently with amyloid plaques; and no evidence of association with tau phosphorylation. We conclude that plastics may cause mechanical, chemical and/or physiological damage. Much work will need to be done to understand whether they inert bystanders, cause harm, or both depending on their chemical composition, location, size and shape. How they invade the blood brain barrier is also an important question. Vascular pathology is multifactorial and contributes to many types of cognitive impairment and neurodegenerative disease. Classification of vascular pathology for scoring across individuals has recently been published (Bearer, American Journal of Pathology, 2025) and will lead to better understanding of role(s) micro/nanoplastics may play in cognition.

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57. Spatiotemporal assessment of microplastic incidence in the Atoyac basin — a key watershed in Mexico

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This spatiotemporal study quantified and analyzed the types, shapes, and sizes of microplastics (MPs) in surface water and sediments from the Atoyac sub-basin in Puebla, Mexico, a region impacted by highly populated areas, agriculture, and extensive industrial activity. Microplastics were quantified via fluorescence microscopy and analyzed using two complementary techniques: Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy and pyrolysis–gas chromatography/mass spectrometry (pyro-GC/MS). Sediment concentrations ranged from 1.0 to 23.8 mg MPs kg−1, while item counts varied from 7.15 to 135 particles g−1. In water, MP concentrations reached up to 238±42 particles L−1. Spatial trends revealed higher MP concentrations in urban and industrial areas, linking anthropogenic activity to pollution. We observed seasonal variation in MP distribution: for both water and sediments, upstream sites (1, 2, and 3) showed higher concentrations in the dry season, while downstream sites (5 and 6) exhibited the reverse trend in the wet season. This finding suggests that drought-influenced flow rates and sediment resuspension are key governing factors in MP transport, indicating a complex transport model is needed. In sediments, our work highlighted the necessity of multi-technique analysis: we found complementary results for polymer composition, with rayon prevalent via ATR-FTIR, and Polyethylene (PE), Polypropylene (PP), and Polystyrene (PS) dominating pyro-GC/MS analyses. This study demonstrates the benefit of combining complementary techniques to quantify and identify MPs, which is required to accurately reveal the environmental factors—including spatial variations, sources, sinks, flow, seasonality, water depth, and biological factors—governing their fate and distribution. Ultimately, this work advances understanding of MP sources, fate, and transport, providing a basis for developing effective mitigation strategies in similar environments.

58. Spray Dryer Preparation of Micro- and Nanoplastic Particles for Toxicity Assessment Studies

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Background: Toxicity studies on micro- and nanoplastics (MNPs) require particles of relevant sizes in sufficient quantity, particularly for inhalation exposure models. For studies investigating inhalation exposures of environmentally relevant MNPs using either in vitro (human airway cells) or in vivo (small rodents) models, particle size of MNPs must be in respirable range < 5 μm (simulating human exposure) or < 3 μm (if mice or rats are used and deep lung deposition is considered). Spray drying method is an established method for production of pharmaceuticals or food powders. The aim of our studies was to test a spray dryer technique to produce and characterize MNPs for future toxicity studies.

Methods: A custom spray dryer (CSD) system was built in the laboratory. The CSD consisted of a nebulizer (vibrating mesh or Collison nebulizer), heated stainless steel tube, heat tape with a controller, glass drying chamber and stainless-steel filter holder with 47 mm Teflon filer. Pristine polymer pellets (polyamide 12 and polystyrene) and medical grade plastic were tested with following solvents: acetone and dichloromethane (DCM). Several different concentrations of polymers in solvents were tested. Dissolved polymers were put through CSD system where they were aerosolized, dried and collected on the filter. Electrostatic precipitator for collection of produced particles was also tested. Particle size and morphology was characterized using scanning electron microscopy (SEM). Dynamic light scattering (DLS) was used to measure size and charge of produced particles.

Results: We demonstrated that our CSD system successfully produced micro- and nanosize particles with diverse morphologies. Depending on the type of polymer, produced particles were either spheres or irregular shape with smooth or distinct porous texture. The size of produced plastic particles can be controlled by 1) concentration of plastic in solvent used for nebulization, and 2) the type of nebulizer used (generated particle droplet).

Conclusions: Our preliminary results show spray drying is a promising technique for generating dry MNP powders with tunable size and morphology. Such produced particles can be used in toxicity assessment studies after oral or inhalation exposure. Produced materials can be further aged or contaminated by organic or inorganic compounds for further toxicity assessment studies. Advantages of spray drying technique for production of MNPs for toxicity studies are: a control over the produced particle sizes, generation of dry powders as opposed to particles in suspension and a potential for scalability.

59. Exposure to Polystyrene Microplastics Potentiates Macrophage-Mediated Proinflammatory Responses

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Microplastics (MPs) are persistent environmental pollutants that have emerged as a growing global health concern. Although MPs are widespread, the biological consequences of MP exposure remain poorly understood, particularly regarding their effects on the immune system. Macrophages play a central role in innate immunity; however, emerging evidence suggests they have limited capacity to phagocytose MPs, potentially leading to cellular dysfunction and dysregulated immune responses. The objective of this study was to evaluate the effects of polystyrene MPs on macrophage polarization and function using human and mouse macrophage cell models. Here, THP-1 human monocytes were differentiated into macrophages with phorbol 12-myristate 13-acetate (PMA) and were polarized toward either M1 (via lipopolysaccharide, LPS) or M2 (via IL-4) phenotypes. Cells were then exposed to 1 µm or 5 µm polystyrene MPs at concentrations of 0, 10, or 100 µg/mL for up to six days. Various endpoints related to monocytic function and polarization were assessed such as cellular metabolic activity, phagocytic capacity, cytokine secretion, and pro-inflammatory gene expression. Results showed that the highest concentration of MPs significantly suppressed THP-1 monocyte growth. Interestingly, exposure to MPs enhanced the metabolic and phagocytic activity of M1 macrophages, suggesting a heightened proinflammatory phenotype. Consistent with this, MP-treated M1 macrophages exhibited increased secretion of IL-1β and TNF-α following LPS stimulation. Conversely, MPs suppressed the secretion of the anti-inflammatory cytokine IL-10 in M2 macrophages, indicating impairment of a pro-resolving phenotype. Together, these findings suggest that MPs exacerbate inflammatory responses while suppressing anti-inflammatory pathways, thereby disrupting macrophage polarization dynamics. Complementary studies are currently underway to validate these findings using primary mouse alveolar macrophage-like models. Results from the present study provide important insight into the immunotoxicity of microplastics and will serve as a foundation for future mechanistic investigations.

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60. Silicon Nanomembrane Analysis Pipeline (SNAP): A Flexible Workflow for the Multi-modal Analysis of Particulates from Varying Sample Types

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A significant hurdle in microplastics analysis lies in effectively capturing and analyzing the particles of interest, as the most commonly available filters are not designed with microplastics analysis in mind. These filters may have pores of inconsistent sizes, shapes, and porosities. More concerning, they are made of polymers which complicate sample analysis. All of these drawbacks increase analysis costs and lengthen time to results.
Here, the Silicon Nanomembrane Analysis Pipeline (SNAP) will be presented as a means for addressing these challenges. SNAP is an analytical workflow utilizing novel Silicon nitride nanomembranes to capture, characterize, and enumerate microplastics and other microparticles of interest. The consolidated capture of particulates onto one non-polymeric, planarized observation area enables the direct multimodal analysis of particulates in an efficient manner. The highly conserved pore geometry and consistent background of silicon nanomembranes eliminates the need for error-prone transfers between substrates and improves automated particle recognition and analysis routines. The step-by-step methods for SNAP will be presented and its utility and advantages heuristically demonstrated through the analysis of model particles, biological aggregates, and consumer beverage products. The morphology, composition, and quantity of microplastics and other particulates were respectively determined in these samples, using optical and scanning electron microscopy (SEM), and Raman spectroscopy.

61. Positioning of Microstructures within Acoustic Waves Enhances Particle Trapping

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Introduction: Ultrafiltration, nanofiltration, and ultracentrifugation are popular techniques for separating microparticles and nano particles (MNPs), but are time intensive and do not operate as a continuous process. The separation of MNPs and biologics have been explored by applying acoustophoretic techniques. Particles in the presence of acoustic waves move due to their relative densities (primary acoustic force) and adsorb to structures based on their proximity (secondary acoustic force) (Laurell +, 2017). Successful acoustic trapping of microparticles flowing through a random mesh structure has been shown (Gupta +, 1997). We explore the acoustic focusing and trapping of microparticles in a novel device, strategically positioning a stainless steel through wire axially within a microcapillary. We designed devices using a cylindrical microcapillary with i) no through wire, ii) a centered through wire and iii) an offset through wire to evaluate acoustic focusing and trapping efficiency.

Methods: A custom cylindrical microcapillary was designed to allow axial placement of a stainless steel through wire (50 µm diameter). Experiments were conducted using high intensity fluorescent Nile red polystyrene microspheres at ~150,000 particles/mL (10-14µm) at a flow rate of 200 µL/min. The acoustic field was applied perpendicular to flow in the borosilicate capillary (1.12 mm ID, 2 mm OD) by a ceramic transducer (PZT). Videos were taken via a CMOS camera mounted to a fluorescence microscope. Videos were analyzed using MATLAB®. COMSOL was used to model flow and pressure profiles using system material properties, dimensions, and experimental conditions.

Results: The presence and positioning of the axial stainless steel through wire affected the flow profiles based on COMSOL simulations. The device with no through wire exhibits maximum flow at the center of the microcapillary, and a minimum flow at the tube walls due to no-slip boundary conditions. Devices with the through wire had minimum flow at the tube walls, as well as at the interface of the steel wire. The predicted pressure profiles for all three devices were nearly identical, suggesting that both the presence and positioning of the wire do not impact the acoustic pressure profiles. Particle trapping to the stainless steel through wire due to secondary acoustic forces occurred for both the centered and offset wire devices. Specifically, the device with the centered through wire achieved 3.3 times greater increase in particle concentration than the device without the wire, highlighting effective particle trapping.

Discussion: Precise positioning of microstructures within acoustic waves leads to optimal acoustic trapping via secondary acoustic forces. This work demonstrates the proof-of-concept that placing microstructures at the pressure node of an acoustic field does not hinder particle focusing, but rather enhances particle trapping, and is a novel approach for acoustophoretic separation techniques.

62. Micro and nanoplastic inhalation throughout pregnancy disrupts placental invasion and morphology in Sprague-Dawley rats

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Micro- and nanoplastic particles (MNP) are a ubiquitous environmental contaminants. Multiple studies have shown that MNP translocate to and deposit within human placental tissues. Central to placental function is appropriate uterine invasion and the adequate development of maternal-fetal blood spaces for nutrient and waste exchange. Impaired to placental invasion and morphological development have been associated with decreased maternal health and poor fetal outcomes. To date, placental development has not been assessed following maternal exposure to MNP throughout pregnancy. Pregnant Sprague-Dawley rats were exposed to polyamide-12 (nylon) MNP from gestational day (GD) 5 through GD 19. Gross and histological analysis of placental morphology, invasion of spiral arteries, and angiogenic signaling were evaluated on male and female placentas at GD 20. Maternal MNP inhalation reduced the relative distance of trophoblast invasion into the uterus and limited spiral artery remodeling as evidenced by residual staining of smooth muscle actin. Moreover, MNP inhalation significantly altered the size and number of maternal and fetal blood spaces collectively reducing surface area for maternal-fetal nutrient/waste exchange. Lastly, there were key changes in the enrichment and spatial distribution of angiogenic and antiangiogenic mRNA transcripts that regulate branching and surface area for maternal-fetal exchange in the placenta. Placental invasion, development, and morphology are necessary for a successful pregnancy and the maintenance of maternal-fetal health. Disrupted development can have severe consequences for the mother and developing fetus. Future studies are required to assess the influence of MNP exposure on generational health.

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63. Axonal Transport of Nanoplastics by Kinesin

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Nanoplastics (NPs), defined as plastic particles <1000 nm, are ubiquitous in our environment, but their impacts on human health are poorly understood. Several studies report NP accumulation in the central nervous system of fish, rodents and flies, and recent work has shown the uptake of different NPs in various neuronal cell types. Furthermore, there is growing

evidence that exposure to NPs is a strong risk factor in the development of neurodegenerative disease like Alzheimer's and Parkinson's. NPs enter the body through ingestion or inhalation, and may reach the brain via the circulatory system, the olfactory route, the trigeminal pathway or the vagus nerve. While there are ongoing efforts to study the uptake mechanisms of these NPs, there is little investigation into their post-internalization transport in neurons. Given our increasing exposure and the potential toxicity of NPs, understanding their transport inside our brains is a pressing need.

In neurons, intracellular cargo are transported at millimeters per hour speeds by the molecular motors kinesin and dynein along microtubules- the cytoskeletal filament tracks found throughout axons and dendrites. Kinesin-1, 2 and 3 are fast axonal transport motors, and their tail domains allow specific cargo binding. We hypothesize that these inherently "sticky" tails enable NPs to bind kinesins and hijack the axonal transport system. This would allow internalized NPs to be rapidly transported along axons to vital parts of the central nervous system, driving neurotoxicity and neurodegeneration.

To test this hypothesis, we incubated 50-nm diameter fluorescent plastic nanospheres with Drosophila kinesin-1 and visualized motility along immobilized microtubules in vitro using Total Internal Reflection Fluorescence Microscopy. We found that kinesin-1 can bind and transport polystyrene (PS), carboxyl modified polystyrene (c-PS), polyethylene terephthalate (PET), polyvinyl chloride (PVC), and polyethylene (PE) nanoparticles at speeds ranging from 200-900 nm/s, close to wild-type transport speeds of kinesin-1. Our binding assays indicate that different NPs have varying affinities for kinesin-1 which may be due to differences in surface chemistry. c-PS particles bind more tightly to kinesin-1 compared to PS particles, which we hypothesize is due to electrostatic interactions between the positively charged kinesin tail and negatively charged carboxyl group. PS, PET, PVC and PE particles, which are more hydrophobic, bind less tightly to kinesin.

Our results suggest that kinesin-based cytoskeletal transport may serve as a mechanism by which NPs spread through the brain, which may contribute to neurotoxicity and neurodegeneration. Because kinesin-based transport exists in all cells, our results may be generalized to other tissues and organs in the body.

64. Deciphering the Causal Impacts of Polyethylene and Polyvinyl Chloride Nanoplastics on Vascular Remodeling and Atherosclerosis

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Plastic degradation generates micro- and nanoplastics (MNPs), which are now detected in drinking water, food sources, and air, raising concerns about their cardiovascular effects. Nanoplastics (NPs) are particularly worrisome due to their ability to penetrate biological barriers, circulate systemically, and interact with vascular and immune cells. Recent human studies have revealed accumulation of polyethylene (PE) and polyvinyl chloride (PVC) MNPs in atherosclerotic plaques, correlating with elevated cardiovascular risk. However, the causal and mechanistic links between NP exposure and atherosclerosis remain unclear. Here, we investigated polymer-specific effects of chronic waterborne PE and PVC NPs on atherosclerosis using ApoE$^{-/-}$ mice fed a high-fat diet (HFD) for 16 weeks. Both polymers accumulated in aortic plaques and resulted in an increased plaque burden. However, scRNA-Seq analyses revealed that PE and PVC induced distinct transcriptional effects in mature and modulated smooth muscle cells (SMCs) within the aorta, suggesting a polymer type-specific mechanisms contributing to SMC phenotypic modulation and plaque progression. PE exposure induced a pronounced shift toward chondromyocytes, characterized by upregulation of Col2a1, Acan, and Ibsp, and enrichment of endochondral ossification and biomineralization pathways, suggesting accelerated vascular calcification. In contrast, PVC exposure primarily affected fluid shear stress–related signaling. In vitro exposure of human coronary artery SMCs (HCASMCs) further demonstrated polymer-specific intracellular interactions. PE preferentially associated with mitochondria, while PVC localized to the endoplasmic reticulum. Bulk RNA-Seq further revealed divergent immune and signaling responses in HCASMCs. PE primarily enriched TGF-β and Hippo signaling, indicating a more restricted response centered on cellular reprogramming,

whereas PVC broadly activated MAPK, PI3K-Akt, ECM-receptor, and shear stress pathways, consistent with amplified inflammation and vascular remodeling. Collectively, these results support a model in which nanoplastic exposure accelerates atherosclerosis progression through polymer-dependent SMC–immune crosstalk, providing new mechanistic insight into how environmental nanoplastics may contribute to cardiovascular disease.

65. Evaluating microplastic particles as vectors of exposure for plastic additive chemicals using a food web model

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Microplastic particles (MPs) represent potential hazards for humans and wildlife, including as vectors for chemical exposure (e.g. plastic additives and pollutants sorbed from the surrounding environment). The leaching of chemicals from MPs has been identified as a potential exposure pathway but the relative magnitude of this pathway under environmentally relevant conditions remains unclear. Here, we describe a modification of the ACC-HUMANSTEADY bioaccumulation model to include dietary exposure to MPs containing either accumulated chemicals from the surrounding environment or embedded plastic additive chemicals (PACs). Chemical transfer to humans and wildlife is described using two-film resistance concepts assuming spheroidal or cylindrical particles of different sizes. The relative contribution of MPs and environmental media to the estimated daily chemical intake in humans was assessed in various exposure scenarios, for a range of hypothetical chemicals with varying octanol-water and air-water partition coefficients (KOW and KAW, respectively; i.e. 0 <log KOW <8 and -5 < log KAW < 3). Results imply that MPs could act as sources of exposure to chemical additives when the ingestion rate of 1 µm MPs is >10 mg d-1, and the concentration of hydrophobic plastic additive is >5% wt wt-1. The contribution made by MPs as vectors of exposure decreased with increasing particle size and decreasing ingestion rates of MPs. Human health risks were evaluated for four specific PACs to illustrate the application of the model for risk assessment. Risks were negligible when the ingestion rate of MPs was <100 µg d-1. Uncertainties are high regarding the characterization and quantification of ingestion of MPs by humans and wildlife, including particle sizes and polymer composition, as well as on the presence of PACs in MPs. These data gaps need to be addressed if the issue of MPs as vectors of chemical exposure is to be fully understood. The work illustrates that mechanistic models, which account for all major exposure pathways, can be used to identify the importance of different exposure pathways, help prioritize research needs and support decision making.

66. Agency for Toxic Substances and Disease Registry Resources for Interactive Visualizations of Micro- and Nanoplastics and Human Health Research Data

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Micro- and nanoplastic research is rapidly expanding, producing a volume of literature that makes it difficult to synthesize findings and identify gaps. To address this challenge, the Agency for Toxic Substances and Disease Registry (ATSDR) Microplastic and Human Health workgroup has developed multiple data visualization tools to provide streamlined access to rigorously evaluated data. Hubs for Interactive Literature (HILs) compile literature used to produce the corresponding workgroup review articles. HILs filter and offer easy access to the original references. These visualizations allow rapid review of microplastics research data and isolate specific subtopics of interest to generate new ideas and quickly identify data gaps. HILs incorporate a novel world map to explore global microplastics data and related public health issues and enable targeted exploration of specific themes within the literature. Currently, there are four HILs that, collectively, have been viewed over 1,300 times. The Plastics Related Toxicological Profile Tool organizes health endpoint data extracted from 98 ATSDR toxicological profiles representing over 400 chemicals related to plastics production. It integrates ATSDR Substance Priority List rankings and polymers use information, helping contextualize chemical hazards within plastics production. The

tool has been accessed approximately 940 times. Additionally, the ATSDR Microplastics and Human Health workgroup website features two interactive maps. A world references map sortable by broad categories: environmental, chemistry, guidance, and human body/cellular exposure and additional subcategories. A human body map links references to specific organs and systems by study type. The interactive human body map features the broad categories of disease, animal study, cell study, model study, and tissue study as well as several more specific organ categories. Together, these ATSDR tools enhance the ability of public health professionals to navigate the expanding literature, synthesize findings, and identify priorities. This represents the first initiative to consolidate global microplastics research into interactive, publicly accessible tools, advancing collaboration and generating ideas in the important micro- and nanoplastic research field.

67. Determining human exposures and internalisation of micro and nanoplastics, an update from the Minderoo Centre – Plastics and Human Health

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It is globally recognised that micro and nanoplastics (MNPs) are pervasive in the environment and that we are continually exposed to these contaminants. Whilst inhalation and ingestion are considered our key everyday exposure routes, there are still gaps in our understanding on the extent of exposure from various sources and subsequent fate of these particles within the body. This presentation will provide an update on recent research activities from the Queensland Alliance for Environmental Health Sciences (QAEHS) and the Minderoo Centre – Plastics and Human Health that are aiming to address these knowledge gaps. Key results that will be presented include a recent Australian food diet survey, demonstrated that our key ingestion exposures are beverages rather than food with up to 12 µg/L (primarily polypropylene) detected in beer, wine, bottled and tap water. Additionally shedding of plastics from consumer items such plastic kettles, food storage containers or baby milk bottles can release up to 25 µg/L or 2 µg/bottle during their first use. The release follows first order kinetics and reduces with each wash of the product. Inhalation exposure in a number of laboratory environments demonstrated that the human traffic within that environment was the key determinant of how 'contaminated' it was. Additionally, challenges with currently available analytical techniques will be discussed including quantifying small MNPs in complex matrices (biological samples) and difficulties with developing realistic in vitro models to investigate NPs migration across biological barriers. In summary, the presentation will highlight progress that is being made to fill knowledge gaps in this challenging field but will also suggest priority areas for future research and the need for more interdisciplinary collaborations.

68. Therapeutic Plasma Exchange to Deplete Microplastic Particles from Patients' Bloodstream

Stella Yuksel, Brad Younggren, Zehra Stara Yuksel, Christina Anderson, Deborah Grant, Robert Weinstein

Circulate

Purpose: Microplastic (1-5 µM) and nanoplastic (<1µM) (together MNP) from commercial production and degradation of plastic waste are ubiquitous in our environment. When inhaled, absorbed or ingested they may make their way to the heart, lungs, CNS, GI tract, reproductive organs and other systems. They may cause adverse effects including hemolysis, platelet aggregation, thrombosis or organ dysfunction. There is no established method for removing MNP from the body after ingestion. A recent report from Germany described the incidental finding of MNP in the effluent plasma from double filtration plasmapheresis procedures. Although this was a qualitative finding, it indicated that MNP circulate in the blood and raised the possibility for removing them by apheresis.

Methods: Ambulatory patients who were undergoing therapeutic plasma exchange (TPE) consented to have their antecubital blood tested for MNP immediately pre- and post-apheresis. 100 µL of antecubital blood was obtained before and after the procedure, applied to test cards, air dried and sent for testing using *plastictox* (Arrow Lab Solutions, Burton, MI). TPE was performed using a Spectra Optia Apheresis System (Terumo BCT, Logan Utah) whereby blood is drawn from an arm vein to flow into a centrifuge where the plasma and red blood cells are separated. The plasma is continuously collected while the red blood cells are returned to the patient via the opposite arm. A solution of 5% human serum albumin in 0.9% NaCl is given as replacement for the collected plasma. Blood from study subjects whose pre-apheresis blood contained at least 30 MNP per 100 µL of blood was analyzed before and after plasma exchange using the Wilcoxon Signed Rank Test.

Results: MNP results from the first 12 TPE performed on 11 patients whose pre-apheresis MNP measurements were at least 30 per 100 µL of whole blood are depicted in the figure. Note the wide distribution of pre-apheresis MNP measurements. The mean (± SEM) [median] MNP was 56.333 ± 10.55 [40.50] pre-apheresis and 31.00 ± 5.334 [22.50] after apheresis (p=0.002, Wilcoxon Signed Rank Test). All TPE procedures were well-tolerated without adverse effects.

Conclusion: MNP circulate in human blood and are susceptible to removal using plasma exchange. To our knowledge, no other clinical procedure has been shown to be effective in removing MNP from the body.

69. Uncovering Microplastic Pollution Pathways in Cave Systems Using Cutting-Edge Spectroscopy

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Microplastics are an emerging contaminant of global concern due to their potential impacts on both environmental integrity and human health. While surface waters and marine environments have been widely studied, subsurface systems such as caves and karst aquifers remain largely unexplored. This study investigates microplastic contamination within the Fort Stanton Cave system near Ruidoso, New Mexico. Using a multi-analytical approach that integrates Raman spectroscopy, pyrolysis gas chromatography–mass spectrometry (Py-GCMS), and micro-Fourier transform infrared spectroscopy (micro-FTIR), we aim to characterize the presence, composition, and distribution of microplastics in cave and karst samples. By establishing baseline data for this unique subterranean environment, our work contributes to understanding the extent of microplastic infiltration into fragile groundwater systems and provides insights into potential pathways of human exposure through karst aquifers.

Poster Session 2

Tuesday, January 13, 2026

1. Everyday Storage and Handling of PET Bottled Water Increase Human Exposure to Nano- and Microplastics: Influence of Socio-Economic Factors

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This study quantified the release of nanoplastics and microplastics (NMPs) from single-use polyethylene terephthalate (PET) water bottles under real-world storage and handling conditions and examined how socio-economic factors influence exposure behaviors. Eight leading U.S. bottled water brands were tested under high temperatures (60°C), mechanical shaking (200 rpm), and 15-day temperature cycling to simulate storage in vehicles or outdoors. The highest release occurred under combined heat and shaking, where nanoparticle concentrations increased by 9.29-fold and microparticles also rose significantly. Prolonged freeze - thaw and high temperature cycling also significantly elevated nanoparticle concentrations, though microparticle release was less consistent. Raman spectroscopy identified PET, polyethylene, and polypropylene particles originating from both bottle body and caps. Surface degradation, rather than bulk changes, was the likely driver of particle release, as supported by differential scanning calorimetry showing heating-induced aging without increased release. A statewide survey (n = 1,673) in Nebraska revealed that individuals with higher awareness of microplastics and higher education levels were less likely to consume bottled water or store it under heat, underscoring the role of knowledge and behavior in shaping exposure risks.

2. The Agency for Toxic Substance and Disease Registry: Necessities and Data Gaps for Addressing the Environmental Exposures of Micro- and Nanoplastics and Resulting Health Impacts

Custodio V. Muianga[1], Gaston Casillas[1], Breanna Alman[1], Patricia Ruiz[1], Katie Stallings[2], Chris Reh[3]

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The Agency for Toxic Substances and Disease Registry (ATSDR) is a non-regulatory, environmental public health agency in the U.S. Department of Health and Human Services mandated by Congress to protect communities from harmful health effects related to hazardous substance exposures. Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the Superfund Amendments and Reauthorization Act of 1986, ATSDR has expert knowledge on the health effects of toxic chemicals and has developed critical resources for public health professionals, including toxicological profiles, minimal risk levels (MRLs), ToxFAQs, ToxGuides, and biomonitoring data. This presentation will highlight ATSDR's efforts to address the emerging contaminants of microplastics and nanoplastics (MNPLs). The National Center for Environmental Health (NCEH)/ATSDR's Microplastics and Human Health workgroup has assessed data needs and gaps by publishing eight peer-reviewed manuscripts, including four review articles, and has integrated findings from exposure to over 400 chemical substances associated with plastics manufacturing, as outlined in 98 toxicological profiles.

Preliminary results suggested that humans are commonly exposed via all routes (i.e., dermal, inhalation, oral), to microplastics (< 5 mm) and nanoplastics (< 0.1 µm) from commercialized plastic polymers including polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS), polyvinyl chloride (PVC), polyurethane (PUR), and others. Multiple metrics have been used to estimate exposure and human health risk, including the combination of plastic polymer type (i.e., composition), concentration as determined by particle count and mass per volume or mass, and the physicochemical properties of plastic particles. Reported health effects involve the digestive, respiratory, neurological, and immune systems, as well as cancer. By applying ATSDR's toxicological profiles, biomonitoring of environmental chemicals, and the framework for assessing health impacts from multiple chemicals, researchers can better design epidemiological and toxicological studies to assess MNPL health impacts and inform public health strategies. This work underscores ATSDR's role in advancing the evidence base on emerging environmental threats to safeguard community health.

3. Messaging about Microplastics and Human Health

Katrina Korfmacher, Becca Lauzon
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Public interest in microplastics is high, and many people are concerned about the potential human health effects of microplastics. However, while the field of microplastics research is growing quickly, much scientific uncertainty remains. Balancing public demands for information about health effects with scientific uncertainty poses a challenge for microplastics communication. The Lake Ontario Microplastics Center (LOMP) has developed a messaging "toolkit" for communicating about microplastics and human health. LOMP's approach is based on a set of "key points" – an internal tool for Center researchers, staff, and engagement staff informing talking points for communications including media interviews, educational materials, and presentations and trainings. The key points focus on the complexity and diversity of microplastics, what questions researchers are asking, and why we don't have simple answers. This approach has informed a growing library of LOMP materials including a flagship brochure, infographics summarizing research approaches and findings, and a suite of workshops for educators. The messaging is designed to evolve over time to reflect the current state of the science and to fill gaps in public understanding. The entire LOMP team reviews the updated messaging annually to ensure accurate, consistent, locally relevant messaging across LOMP's communications and products

4. Plastic aging and its impact on fragmentation and additive release

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Plastics often contain a wide variety of chemical additives as well as non-intentionally added substances such as degradation products, reaction by-products and/or impurities. Since these other chemicals are not generally covalently bound to the polymer matrix, they may leach out of the plastic. These leached chemicals include bisphenol A, phthalates, nonylphenols, brominated flame retardants, to name a few. Also, nanomaterials are sometimes incorporated as nanofillers into polymer formulations to enhance existing properties or to add new properties of interest in the products made from these plastic composites.

This presentation presents a modeling framework for describing additive release from plastics that considers the role of plastic fragmentation in increasing surface area and release rates over time and methods for parameterizing the models from plastic abrasion and additive leaching experiments. Derivations of mechanical stresses on plastics as a function of power input are related to rate constants in a population balance on plastic particle number distributions. The leaching of additives from homogeneous plastic spheres is estimated as function of fragment size and environmental conditions and the implications for exposure to additives are discussed. Data of weathering of plastics will be summarized and a framework

for modeling weathering and its impact on fragmentation rate will be presented focusing on the impact increased fragmentation rate on additive release.

5. China-Specific Advances in Microplastic Exposure and Human Health: A Literature Review of 2024–2025 Research

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Background: Microplastic exposure has emerged as a global health threat, with evidence linking it various human diseases. While studies have provided broad insights, Chinese research teams have developed a unique framework focused on large-scale exposure scenarios, such as takeaway packaging, bottled water, and biodegradable plastics. The purpose of this review is to integrate Chinese research (2024-2025) and evaluate the global understanding of microplastics and human health.

Methods: A systematic search was conducted across four databases: CNKI, Wanfang, PubMed, and Web of Science. Search terms included microplastics, nanoplastics, health toxicity, China, biodegradable plastics, PET (polyethylene terephthalate), polystyrene (PS), starch-based plastics, and PLA (polylactic acid). Screening focused on: toxic mechanisms, biodegradable plastics, and clinical detection technologies.

Results and Discussion: PET Microplastics disrupt intestinal and lung microbiota, impair bile acid metabolism, and activate the NFκB pathway. This "intestine-lung-heart" damage network can exacerbate cardiovascular risks. PS implicated in vascular calcification and neurological injury. PS induces gut dysbiosis, which promotes endotoxin translocation and systemic inflammation, driving osteoblastic transformation. PS can obstruct blood flow, causing cerebral thrombosis, which leads to neurobehavioral abnormalities. Nanoscale PS was found to accumulate in cancer cells and enhance their migration. Long-term exposure to Starch-Based microplastics, a type of biodegradable polymer, induced multi-organ damage, causing liver oxidative stress, ovarian cell apoptosis, and circadian rhythm gene disruption. PLA caused male reproductive toxicity, reducing sperm ATP production, interfering with meiosis, and increasing sperm deformity rates, raising concerns for male fertility. Clinical detection breakthroughs linked microplastic accumulation to disease severity. Microplastics in bone marrow (20–100μm) revealed a positively correlated with blood cancer severity, suggesting microplastics disrupt the hematopoietic microenvironment, promoting tumorigenesis. Microplastics (PS, PE, PVC) were detected in human semen, testes, and the endometrium of infertile women. This presence was associated with sperm dysfunction and decreased fertility, underscoring a direct reproductive health risk.

Conclusion: Chinese studies made significant contributions by elucidating specific mechanisms, challenging the safety of biodegradable plastics, and pioneering clinically relevant investigation. Critical gaps remain in methodological standardization, large-scale epidemiological evidence, and the translation to public policy. Future efforts should prioritize international cooperation, data integration, and thorough investigations aimed at mitigating the health risks of microplastics.

6. Microplastics consumption potentiates atherosclerotic lesion development in ApoE-/- mice

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Vast amounts of plastic materials are produced in the modern world and despite recycling efforts, much of this material is disposed in water systems and landfills. In these conditions, physical weathering and photochemical processes break down these polymers into smaller particles of the micro- and nano-scale. In addition, ecosystems can be contaminated with plastic particles which are manufactured in these size ranges for commercial purposes. Independent of source, micro- and nano-plastics (MNP) are abundant in the environment and humans are exposed to these materials through consumption, inhalation, or absorption. Indeed, MNP have now been identified in multiple human tissues. Nevertheless, the health

consequences of MNP exposure are largely unknown. Given reports of MMP accumulation in human cardiovascular tissues and some associations with adverse outcomes, we examined if MNP consumption might directly contribute to atherogenesis using a mouse mice. For this study we supplied disease prone, ApoE-/- mice with normal chow and either normal drinking water or that containing polystyrene beads (PS: 0.5□m, 1□g/ml) for 20wk. At the end of this time period, we observed significantly increased lipid accumulation (1.3-fold) in the heart valves of mice consuming the PS-containing water compared to that in mice consuming normal water. These PS-exposed mice also demonstrated increased levels of fasting plasma glucose, but lower levels of plasma insulin. There were no differences in HOMA-IR scores nor in plasma lipids or cytokines between the groups. An aortic transcriptomic analysis revealed that the top pathways upregulated in the PS-consuming mice consisted largely of those impacting immune cell function (T-cell/leukocyte activation, regulation of T-cell/lymphocyte activation, leukocyte proliferation, regulation of cell adhesion). Changes in these pathways are consistent with a pro-inflammatory, atherosclerotic phenotype. Minor changes in the levels of short chain fatty acids were also observed. In a second experiment, we supplied ApoE-/- mice with a Western diet and either normal drinking water or that containing a mixture of two of the most abundant MNP in human cardiovascular tissues, polyethylene and polyvinyl chloride (PE+PVC: PE: 0.065□m, 2.5ng/ml; PVC: 0.25□m, 200ng/ml) for 6wk. Likewise, at the end of this exposure we observed hyperglycemia, hyperinsulinemia and a 1.5-fold increase in lipid accumulation in the heart valves of mice consuming the PE+PVC-containing water. These results suggest that consumption of MNP promotes cardiovascular disease risk and potentiates atherosclerotic lesion formation.

7. Spatial and Seasonal Patterns of Riverine Microplastics and Their Ecological Risks: A Case Study from the Cauvery River, India

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Microplastic (MP) pollution in freshwater ecosystems poses a growing global concern due to its persistence, ecological risks, and potential for long-range transport. This study assessed the abundance, characteristics, polymer composition, and ecological risks of MPs in surface water from 19 sites along the Cauvery River, Tamil Nadu, India, during the dry (February) and wet (November) seasons. MP concentrations ranged from 0.52 to 6.16 particles L^{-1}, with higher values observed during the wet season, highlighting seasonal influences on transport and accumulation. Identified morphotypes included fibers, films, fragments, pellets, and beads, with fibers dominating. Most particles ranged between 500–1000 µm in size. Scanning electron microscopy indicated advanced weathering features such as cracks, fibrils, and surface pitting. Polymer analysis using µ-FTIR, Raman spectroscopy, and pyrolysis-GC/MS confirmed the presence of polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), and polyamide (PA). The polymer hazard index (PHI) varied from 20.2 to 29.65, classifying all sites as moderate hazard (Class III). Comparative insights with other Indian and international freshwater systems suggest that urban, industrial, and agricultural activities significantly influence MP pollution in the Cauvery River. These findings emphasize the importance of region-specific monitoring and management strategies to mitigate both point and non-point sources of MP contamination in riverine environments.

8. Microplastic exposure elicits sex-specific atherosclerosis development in low-density lipoprotein receptor-deficient mice

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Microplastics (MPs) are small plastic particles emerging as significant environmental pollutants and humans are ubiquitously exposed to microplastics. MPs can be detected in human atherosclerotic plaques and have been associated with a higher risk of cardiovascular disease (CVD) and stroke in humans. However, the impact of MP exposure on the cardiovascular system remains elusive. In the current study, we investigated the effects of MP exposure on atherosclerosis development in low-density lipoprotein receptor-deficient (LDLR-/-) mice. Male and female LDLR-/- mice were fed a semi-

synthetic low-fat diet and exposed to MPs via daily oral gavage for 9 weeks. We found that exposure to MPs did not affect body weight and circulating lipid profiles in both male and female LDLR-/- mice. Intriguingly, MP exposure led to significantly increased atherosclerosis in male but not female LDLR-/- mice. Single-cell RNA sequencing analysis of the whole aorta revealed that exposure to MPs affected the proportions and cellular processes of key atherogenesis-related cell types, especially endothelia cells. Consistently, MP exposure elicited pro-atherogenic gene expression in murine primary endothelia cells in vitro. Our findings reveal the atherogenic effects of MPs in vivo and contribute to our understanding of the association between MP exposure and increased CVD risk in humans.

9. Defining Unequivocal: Increasing Confidence In The Analysis And Reporting Of Micro- And Nanoplastic Particles In Biological Matrices

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The accurate quantification and characterisation of particles within biological systems is critical to assess potential health risk. However, identification of nanoplastics (<1µm) and small microplastics (<10µm) remains an analytical challenge, exacerbated in complex matrices such as environmental and human samples. Concerns regarding the potential impact of plastics on human health has, however, led to increasing numbers of studies aiming to identify small micron and nanoplastics within human tissues. Mass based quantification methods such as pyrolysis gas chromatography mass spectrometry are being increasingly used in attempts to identify and quantify small plastic particles in biological samples. However, this indirect analysis method is susceptible to sample matrix interference (e.g., due to the presence of lipids in biological tissues), resulting in quantification being unreliable for certain plastics such as polyethylene and polyvinyl chloride. Furthermore, no morphological information is provided, which is important toxicologically relevant information needed to inform accurate risk assessments. Optical microscopy coupled to spectroscopic methods such as Raman or Fourier-transform infrared are widely used for microplastic identification, however for smaller nano-sized particles, the resolution is not sufficient to accurately identify individual plastic particles. Therefore, we propose a framework to increase confidence by using multiple orthogonal techniques to identify plastics in biospecimens. The techniques use fundamentally different approaches which measure the same physical properties of a suspected plastic particle. Three categories of techniques are proposed, based on the amount of information they provide about chemical identification, morphology, and other physicochemical properties. The application of multiple techniques is proposed to enable unequivocal identification

within complex matrices. Examples of potential analytical techniques will be presented, with their benefits and drawbacks highlighted to exemplify how the framework can be used. The limitations of each technique will be identified, and the framework requires that such limitations are clearly communicated when research data are reported to ensure transparency. The framework also includes confidence levels for identification of plastic particles with suggested minimum data requirements listed. This framework is proposed as a starting point for future minimum standards regarding publishing human internal exposure data, which will be critical for human health research and future risk assessment.

10. Advancing the fabrication and characterization of environmentally relevant nanoplastics: insights from PET and polyamide models

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The persistence of microplastics (MPs) and nanoplastics (NPs) from globally dominant polymers, including polyethylene terephthalate (PET) and polyamides (nylons), has raised concerns regarding chronic human exposure and potential biological risks. Due to their nanoscale dimensions, diverse morphologies, and chemical compositions, NPs are increasingly recognized for their ability to penetrate epithelial barriers and cellular membranes, potentially triggering toxicological responses. To date, most NP exposure studies involved commercially-available spherical polystyrene (PS) nanoparticles. However, the biological responses to NPs comprising other plastics remain largely unknown, in part, due to the limited availability of these materials. Addressing gaps in current knowledge, our research presents advanced methodologies for synthesizing well-characterized NPs comprising PET and a comprehensive suite of polyamides, using biocompatible surfactants to achieve controlled size distributions.

NPs were fabricated either via nanoprecipitation or ultrasonication using bovine serum albumin (BSA), polyvinylpyrrolidone (PVP), or polyvinyl alcohol (PVA) as surfactants. Excess surfactant and other solvents used during the fabrication process were removed by repeated centrifugation and re-suspension in surfactant-containing aqueous solutions. Corresponding protocols were used to fabricate fluorescently-tagged NPs using Rhodamine B or Nile Red for intracellular tracking. All NP formulations were characterized for their size, polydispersity index, shape, surface charge, and fluorescent yield. Cytotoxicity assessments were conducted with RAW 264.7 which are murine alveolar macrophages wherein cells were exposed to NPs for 24 h and lactate dehydrogenase (LDH) release measurements were performed. NPs were reconstituted in fresh cell media (Dulbecco's modified Eagle's medium supplemented with 10% fetal bovine serum, 100 U penicillin/streptomycin) at 0.001 to 1.0 mg/mL prior to cell exposure studies.

All materials exhibited size distributions <1 µm (220 nm – 650 nm) with surface charges ranging from -40 to +48 mV. NP formulations showed a spherical or near-spherical morphology as determined by scanning electron microscopy with no apparent morphological differences for the corresponding fluorophore-tagged particles. Rhodamine B- and Nile Red-tagged particles achieved detectable fluorescent signals at 0.01 wt% and 1 wt%, respectively, with fluorescence loadings of ~3.3-7.5 µg fluorophore/mg particles. Exposure of RAW 264.7 cells and subsequent fluorescence microscopy assessments suggested internalization of fluorophore-tagged NPs in a dose-dependent manner.

Given the high global plastic production, efforts to produce a library of well-characterized NPs will support future studies to assess effects on biological systems impacting human health and disease. These preliminary findings underscore the importance of using relevant NPs to understand the biological responses.

11. Sex, diet, and micro/nano-plastics: enhancing translational fidelity in toxicological models

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Micro- and nanoplastics (MNPs) are increasingly detected in human tissues and food systems, raising concerns about their long-term health impacts. Many plastic particles and additives are lipophilic, suggesting that dietary components, particularly fat and fiber, may influence MNP absorption, bioavailability, and physiological effects. These interactions are further complicated by sexually dimorphic differences in dietary intake and metabolism. However, a critical gap remains in environmental toxicology: understanding how sex related dietary responses influence MNP toxicokinetics and outcomes. Sex differences play fundamental roles in shaping developmental biology, immune function, metabolism, and disease susceptibility. For instance, women are more prone to autoimmune diseases, whereas men are at higher risk for visceral fat associated metabolic conditions - each modulated by diet in a sex specific manner. These differences, driven by hormonal signaling, immune responses, and energy metabolism, are likely to influence how MNPs are processed and impact physiological systems. In our study, we examined the long-term effects of chronic dietary MNP exposure (0.5–5 μm polystyrene) in mice from adolescence to adulthood. To ensure translational relevance, we used defined purified diets to eliminate confounding non-nutrient variables found in standard chow. Our methodological approach addresses limitations of conventional exposure models: gastric gavage induces acute stress and bolus dosing, while drinking water models suffer from inconsistent intake and particle sedimentation. By incorporating MNPs directly into a defined diet, we achieved chronic, low-dose exposure under physiologically relevant conditions, better simulating real-world dietary exposure. Despite equivalent MNP intake across groups, we observed sexually dimorphic physiological responses. This study highlights the importance of integrating sex as a biological variable and controlling dietary context in environmental toxicology. These findings have broad implications for both experimental design and public health strategies aimed at mitigating plastic-associated risks. Moreover, our data suggest that dietary manipulation alone, while once considered a practical approach, may not provide reliable means to mitigate the physiological impact MNP and alternative lifestyle interventions strategies should be explored.

12. Micro- and nanoplastics are elevated in femoral atherosclerotic plaques compared with undiseased arteries.

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Introduction. As plastic production accelerates, its byproducts increasingly fill the environment. Once degraded into micronanoplastics (MNPs), particles may circulate into food, drinking water, or air. Emerging research shows that MNPs bioaccumulate in human tissues, including the blood, brain, and diseased vessels. MNPs have been found in thrombi and atherosclerotic plaques of diseased vessels, and these findings are linked to adverse clinical outcomes. However, there is currently a lack of data on MNP content in infrainguinal arterial occlusive disease. We studied the presence of MNPs in femoral plaques and examined patient clinical variables to characterize their associations in another area often affected by peripheral arterial disease (PAD).

Methods. Common femoral artery plaques were collected from patients undergoing common femoral endarterectomy (CFE) for medically refractory lower extremity PAD at the University of New Mexico Hospital between April 2024 and January 2025. These samples were sectioned, frozen, and analyzed with pyrolysis gas chromatography/mass spectrometry (Py-GC/MS) for MNP content by polymer. Twelve polymers were examined in triplicate. Decedents without clinical atherosclerosis served as controls, with whole carotid artery tissue used for comparison. Groups were compared using the Mann-Whitney U test.

Results. A total of 10 plaques from 8 patients were collected for the plaque group, while 30 entire carotids were gathered from decedents, including seven who were age-matched to the plaque group. The average age of patients for CFE was 73.8 years (± 5.9 years), with 90% being male. For the decedents, the average age was 45 years, with 63% male. The total MNP concentration was 80 times higher in femoral plaque compared to the control group (3,234 versus 34.65 μg plastic/g tissue,

p <0.0001). 12 studied polymers were significantly higher in plaque tissue compared to controls. Polyethylene was the most common plastic in plaques (2145 ± 3146.4 µg/g), followed by polyvinyl chloride (406.4 ± 331.6 µg/g) and nylon 66 (176.7 ± 164 µg/g). No sex differences were observed in either group; however, acrylonitrile butadiene styrene showed a negative correlation with age in the plaque group (r = -0.7342, p = 0.03). Among plaque patients, those undergoing surgery for chronic limb-threatening ischemia (CLTI) had a threefold higher concentration of polypropylene (PP) compared to patients who had surgery for claudication (247 µg/g vs. 71.89 µg/g, p = 0.0381).

Conclusion. We demonstrate a higher accumulation of MNPs in common femoral artery plaques compared to non-atherosclerotic artery tissue. This supports the idea that, despite similar ages between groups, MNPs tend to accumulate in atherosclerotic tissues. Patients with CLTI showed a greater concentration of certain polymers compared to those with claudication, raising questions about possible links between disease severity and different individual polymers.

13. Dietary Nanoplastics are Associated with Non-glycocaliceal Mesenteric Endothelial Dysfunction in ApoE-/- mice

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Introduction: The glycocalyx is a multifunctional dynamic structure involved in the vascular response to inflammation, dietary changes, and shear stress. The effects of diet introduced micronanoplastics (MNPs) on endothelial cell dysfunction are largely unknown. Utilizing animal models of atherosclerosis development, such as the ApoE-/- mouse, allows for study of MNP-diet interactions in a controlled environment. We aim to investigate the effects of dietary ocean-derived MNPs on the glycocalyx and endothelial cell dysfunction.

Methods: Adult male and female ApoE-/- mice (n=5-7/group) were fed standard or Western diet (WD) with and without 1% (w/w) added ocean MNPs milled into the chow. After 6 or 12 weeks of exposure, animals underwent acetylcholine and flow-mediated dilation of isolated mesenteric arteries to evaluate endothelial cell function. GlycoCheck of the mesenteric arteries evaluated microvascular density, RBC velocity, and perfused boundary region to evaluate the glycocalyx thickness. Hematologic testing was performed via cardiac puncture of the right ventricle.

Results: Animal weights did not differ between MNP-fed and control (non-MNP) animals within diet groups. WD-fed animals had mean weight of 29 g at week 6 compared to 25 g in standard chow group (P=0.02). Flow-mediated dilation in MNP-fed animals eating a WD was significantly impacted after a pressure gradient change of 20 cmH2O and 40 cmH2O compared to the non-MNP group (P=.006, .0012), with max dilation being 35% and 82% respectively (P=0.009). Acetylcholine induced dilation demonstrated a significant difference at 10-5 M concentration (P=0.008), but no significant differences in other concentrations or maximum dilation. There were no significant differences in microvascular density (µm/mm2), RBC velocity (µm/sec), Perfused Boundary Region (µm), or hematologic testing.

Conclusions: These data demonstrate that dietary MNPs when paired with Western diet in an atherogenic-prone animal model, have significant endothelial cell dysfunction despite preservation of the glycocalyx. Western diet has been shown in other studies to improve the glycocalyx properties, which may serve as a barrier to the effects of glycocalyx changes from MNPs. Given the effects of the Western diet on the glycocalyx, further studies of MNP exposure on the glycocalyx outside of the atherogenic-prone model are needed to determine the mechanistic relationship.

14. Eco-corona-based Characterization of environmentally weathered microplastics using Ultra-performance Liquid Chromatography, Fourier Transform Infrared Spectroscopy (FTIR) spectra, and unsupervised machine learning algorithms.

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The adsorption mechanisms and carrier effect in microplastics (MPs) are crucial to assessing their transport, fate, toxicity, and environmental risk. However, MP adsorption studies are complicated due to complex matrices with various environmental constituents, including natural organic matter, eco-proteins, organic pollutants, metals, and microbial colonization. In this study, we develop a new approach to examine corona formation and the characterization of organic compounds on MPs from environmental exposures. MPs were separated from marine particulate organic matter. This was done using three separation methods (NaOH, Formic Acid, and n-Hexane) or by hand (MPm). These plastic particles, as well as pristine microplastics (MPp), were analyzed using attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) and an unsupervised machine learning algorithm. Spectral integration of characteristic peaks for carbohydrate: protein ratio for each sub-fraction was compared with the MPm and MPp. High-resolution mass spectrometry (HSA-14C-HRMS) was used to quantify organic pollutants on the surface of isolated MPs. A total of 1400 ATR-FTIR spectra were collected for polyethylene, polystyrene, and polypropylene in each group. Unsupervised machine learning results showed promise as a tool for environmental MP characterization, achieving 72 -97% accuracy across all groups and polymer types. The MP separation methods showed variation in types and amounts of environmental constituents present on the surface of the MPs. Organic pollutants found on the MP included a stimulant (Caffeine), an anesthetic (Lidocaine), a progestin (Norethindrone), a synthetic fragrance (Tonalide, Galaxolide) sunscreens/cosmetics/personal care products (Benzophenone-3), a plasticizer, an extractant, a flame retardant, and a defoamer (Tributyl phosphate, Tris(2-carboxyethyl)phosphine, Tributoxyethyl phosphate, Diisononyl phthalate, Diisodecyl phthalate, Triphenyl phosphate, Tributoxyethyl phosphate) in the positive mode with only Bisphenol A found in the negative mode. Concentrations ranged from 1.67 – 79.9 (0.001 ± 3.63) ng g-1. This study provides a novel approach to how environmentally weathered microplastics could be effectively identified, enhances our knowledge of microplastic eco-corona formation, and demonstrates the carrier tendency and adsorption of organic pollutants on microplastics in the natural environment.

15. A novel model of acute vascular nanoplastics exposure

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Introduction: Micronanoplastics (MNPs) are a ubiquitous and ever-increasing pollutant in the natural environment. There is emerging evidence that MNPs are present in human tissues and may augment atherosclerosis and cardiovascular disease, though possible mechanisms remain obscure. Prior work from our lab has disclosed endothelial activation and dysfunctional physiology after systemic dietary MNP exposure. Mechanistic experiments to determine the effect of MNP localization to the vascular wall from an immune cell and inflammation perspective will require animal models to fully elucidate. The rat carotid balloon injury model is a rigorous and long-described method of recreating endothelial injury in mammals. Our group sought to modify the rat carotid injury model as a platform for future MNP-vascular exposure experiments.

Methods: Adult Sprague Dawley rats underwent non-survival procedures under four conditions: 1) with endothelium injured and exposure to fluorescent polystyrene (PS) nanospheres, 2) exposure to nanospheres without endothelial disruption, 3)

with endothelium disrupted and exposed to vehicle 4) completely undisturbed (control) arteries. Under anesthesia, animals underwent neck incision and vascular control of the common, internal and external carotid arteries. The endothelium was disrupted by using PE-10 microtubing (slightly larger than the diameter of the artery) passed through the length of the common carotid artery three times via an external carotid arteriotomy. PS nanosphere suspensions (200 nm mean diameter, 0.1% w/w) were incubated for 5 minutes. Nanospheres were labeled with a fluorophore with excitation maxima of 542 nm and emission maxima of 612 nm. After exposure, arteries were harvested, sectioned and stained for endothelial CD31 (rabbit, 1:100; Abcam) and Sytox green for nuclear staining. Photomicrographs were obtained with a confocal microscope (Leica Biosystems) using a 20x objective lens.

Results: Groups 4 and 3 demonstrated excellent visualization of the endothelium, media, and adventitia, with near-complete disruption of the endothelium in group 3. Groups 1 and 2 demonstrated fluorescent microspheres persistently attached to both the media and undisturbed endothelium, respectively.

Conclusion: PS nanospheres have an affinity for endothelium in disturbed and undisturbed arteries. Given that atherosclerosis development is linked to endothelial disruption, this may be the mechanism by which hematogenous MNPs enter and accumulate within early atheromas or established atherosclerotic lesions. Future studies will investigate early, mid and late term attraction of immune cells to the vessel wall in the presence of MNPs.

16. Leveraging xenopus to assess the risks of microplastic exposure on development and immunity

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Microplastics (1µm-5mm) are ubiquitous in the environment and possess a variety of different shapes and compositions. While bioaccumulation and biological effects of pristine microspheres at high concentrations have been extensively investigated, less is known about effects of low concentration of more realistic microplastics with variable sizes (1-20 um) and irregular shapes (I-MPs). To investigate the immunotoxicology and longterm developmental perturbations of exposure to I-MPs, we have leveraged a comparative biology approach using the amphibian Xenopus. Fully aquatic tadpoles are ideal experimental organism because their post-embryonic development including the immune system is external and not protected by the maternal environment, which make them are especially sensitive to perturbations by water pollutants. Furthermore, the development and physiology of Xenopus are remarkably similar to those of humans. Accumulation rate in tadpole of two types of I-MPs (Polyethylene terephthalate [PET] and Nylon) fluorescently labeled with Nile red was evaluated by fluorescence microscopy on whole mounted tissues and by situ enzymatic digestion followed by filtration using silicon nanomembranes. Upon exposure at concentrations as low as 0.1 mg/L, I-MPs rapidly accumulated within tadpole intestine, liver, kidneys, and brain, persisting over a week. Furthermore, this accumulation led to macrophages disfunction, compromised antiviral immunity and diminished resistance against infections by the ranavirus FV3, but did not induce marked inflammation. Our data also suggest that a brief developmental exposure to I-MPs results in long-term fitness defects such as, weight gain and delay in metamorphosis completion, whereas chronic immune deficits is currently investigated. Finally, we found that mycobacteria pathogens detected in biofilms associated to environmental MPs, can tightly bind to I-MPs in vitro, which may promote their colonization into tadpoles. These findings carry substantial significance, raising developmental immunotoxicity (DIT) concerns not only for aquatic vertebrates but also for human health.

17. Neonatal Brain Exposure to Nanoplastics via Oral Route: Size-Dependent Uptake and Regional Localization

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Environmental nanoplastics (NPs; diameter < 1 μm) are increasingly recognized for their ability to traverse biological barriers—such as the intestinal epithelium, placenta, and blood–brain barrier—and accumulate in sensitive tissues, including the brain. During neonatal development, when these protective structures are not fully formed, NPs may gain access to the brain, raising critical concerns about early-life exposure and its potential to disrupt neurodevelopmental processes. To address this, we employed advanced imaging techniques to investigate the size-dependent accumulation of polystyrene NPs (PS-NPs) in neonatal mice, with a particular focus on brain accumulation following oral exposure. Neonatal mice (P0) received a single oral gavage of 30 μl fluorescent yellow-green (excitation/emission: 441/486 nm) labeled PS-NPs (PS-YG) at varying diameters (50 nm, 500 nm) and concentrations (2.5-12.5 mg/ml), alongside double-distilled water as a control. Oral administration was selected to reflect a plausible environmental exposure route, particularly relevant to early-life ingestion scenarios. Fluorescence stereomicroscopy revealed distinct PS-YG distribution across multiple organs—including intestine, liver, kidney, and brain—within 24 hours post-administration. Notably, 50 nm PS-YG demonstrated significantly higher tissue uptake than the 500 nm group, underscoring the critical role of particle size in bioavailability and translocation. To resolve regional localization within the brain, we applied tissue-clearing and lightsheet microscopy. This approach allowed for intact volumetric imaging without sectioning, preserving spatial context and minimizing distortion. High-resolution 3D visualization revealed PS-YG distribution in the cortex, thalamus, hindbrain, and cerebellum. These observations suggest that neonatal biological barriers exhibit increased permeability to nanoscale particles, potentially heightening susceptibility to neurodevelopmental perturbation. This study demonstrates the utility of advanced imaging techniques for tracing NP accumulation. The observed rapid and region-specific accumulation of PS-NPs in neonatal brains provides foundational evidence for potential long-term neurotoxic outcomes. These findings support the urgent need for precautionary regulatory frameworks to mitigate environmental NP exposure during early life and inform future risk assessment strategies targeting vulnerable developmental stages.

18. Investigating the impact of Polystyrene Nanoplastics in liver using hepatic cell lines and human precision-cut liver slices

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Large plastic products degrade during use and after disposal into small particles described as microplastics (<5 mm, MP) and nanoplastics (<1μm, NP). These MP/NPs accumulate in the environment and can enter the human body via ingestion, inhalation or dermal contact. Several studies have reported MP/NP in human tissue, raising concerns about potential adverse health outcomes. Existing research on NP toxicity is variable and lacks sufficient understanding of the liver-associated pathophysiology. To understand the impact of NP on the liver, we determined the uptake and effects of commercially available carboxylate-modified 20 nm polystyrene nanoparticles (PS NPs) in three hepatic models: human carcinoma hepatocytes (HepG2), immortalised human hepatocytes (IHH), and human precision-cut liver slices (hPCLS). We visualised and quantified PS NPs uptake using confocal microscopy and flow cytometry, and analysed cytotoxicity post-exposure. Further, we examined the subtle physiological effects of PS NPs on the redox state and mitochondrial respiration in HepG2 cells.

Exposure experiments show a model and dose-dependent uptake of PS NPs after 24 and 48 hours of exposure in all three hepatic models. 63.0 ± 31.5% IHH cells showed PS NPs uptake at a concentration of 0.1 μg/mL, which is considerably lower than the measured plastic concentration in human blood (1.8 -4.7 μg/mL). Cell viability of IHH cells decreased from 95.2 ± 2% in the control group to 9.7 ± 7.1% at 100 μg/mL after 48 hours of exposure. Early signs of cell injury were observed with high levels of AST enzyme in the media of IHH and hPCLS at high PS NPs concentrations. Additionally, HepG2 cells showed no changes in cell viability, redox state, or mitochondrial respiratory parameters after exposure to PS NPs. In conclusion, the

study demonstrates that PS NPs can readily accumulate in hepatocytes, even at a concentration as low as 0.1 µg/mL in IHH cells, and cause cell damage and a decrease in viability at a high dose of 100 µg/mL. The effect of PS NPs is model-dependent, highlighting the need for physiologically relevant toxicity models to study the underlying mechanisms of NP cytotoxicity. These findings emphasise the urgent need to investigate the health effects of NP pollution on human health, utilising environmentally relevant plastic particles and humanised toxicity models.

19. Sexually Dimorphic Metabolic Dysfunction in Sprague-Dawley Rat Offspring after Gestational Exposure to MNP aerosols

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Micro- and nanoplastic (MNP) exposure occurs throughout the life span. Human studies have revealed MNP deposition within the placenta and meconium, highlighting maternal and fetal exposure during pregnancy and development, respectively. Our laboratory has identified that MNP exposure during pregnancy leads to deposition within the fetal tissues, an outcome maintained in the postnatal period. Unfortunately, the health effects of these prenatal exposures in adulthood remain undefined. The purpose of this study was to provide an initial assessment of offspring metabolic health. Pregnant Sprague-Dawley rats were exposed to polyamide (nylon) MNP at a target concentration of 10 mg/m3 from gestational day (GD) 5 through GD 19 (n=6) or remained as naïve controls (n=6). Rats delivered in-house and remained with their mother until weaning at postnatal day 25. Rats were weighed throughout the postnatal and adult periods. Offspring were housed with same-sex siblings and provided normal chow and water ad libitum. A single male and female rat were randomly selected as representatives from each litter. Rats were fasted for 5 hours at 15 weeks and injected i.p. with 2mg/kg of glucose for glucose tolerance tests; rats were fasted for 4 hours at 17 weeks and injected i.p. with 0.75U/kg insulin for insulin tolerance tests. Blood glucose was measured via glucometer at 15, 30, 60, 90, 120, and 180 minutes for both assessments. Mean arterial pressure (MAP) was assessed at 22 weeks of age, followed by sacrifice and tissue collection. Multiplex analyses of inflammatory and metabolic markers were conducted. There were no significant difference in pup number or sex between litters. Pup weights, representative of growth, were not different at any time point measured. MAP was not different between groups. Glucose tolerance tests revealed a significant elevation of glucose in the female-exposed pups at approximately 120 minutes post glucose injection, indicative of insulin resistance. No differences were identified after insulin challenge between groups. Multiplex assessments are pending at the time of abstract submission. The impacts of MNP exposures are under evaluation. Given the estimated exponential increase in plastic production and current evidence of fetal exposures, it is vital to identify the current and future health concerns pertaining to MNP exposure.

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20. Microplastic contamination in commercially available table salts of Pakistan

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Microplastics (MPs) are widespread across the globe, in every part of the environment. Their presence is expected to triple by 2060, posing risks to both human and environmental health. The present study investigated microplastic contamination using a stereomicroscope and GC-MS in table salts of Pakistan from different origins – sea, rock, and lake. Seventeen branded and 2 unbranded salts showed about 30 to 35 microplastics were present per kilogram of salts on average with the highest 125 MPs/Kg and lowest 30 MPs/Kg. Morphologically, black-coloured microplastic fibres were found to be predominant, and polyethylene was the most abundant chemical component. This study showed that assuming 30–35 MPs per kilogram of salts are found on average, people in Bangladesh are ingesting more microplastics through table salts compared to other regions, and Pakistan ranks lowest because of its lower salt consumption.

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21. Investigation of hazardous effects by nanoplastic particles on intracellular signaling dynamics and respiratory functions

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Nanoplastic particles (NPs) enter the human body mainly through ingestion or inhalation and can cross the epithelial barrier to enter circulation. Recent studies have revealed hazardous effects of NPs on various functions including immunity, metabolism, and cognition, and production of reactive oxygen species (ROS) is often considered to be the cause of cellular toxic effects by NPs. However, intracellular mechanism in which NPs induce ROS production and lead to cytotoxicity is largely unclear. In addition, inhaled NPs can affect the olfactory system and even brain functions, but the precise effects on the tissues are yet to be clarified. Here we investigated the effects of NPs on intracellular signaling pathways in vitro and also assessed the biodistribution and potential hazardous effects of inhaled NPs in vivo. First, we developed a cellular screening system using fluorescent protein-based indicators that visualize the intracellular dynamics of second messengers and metabolism-related molecules. We established human osteosarcoma-derived cell line U-2OS cells which stably express red fluorescent cAMP indicator Pink Flamindo, the red fluorescent glucose indicator Red Glifon 300, the green pyruvate indicator Green Pegassos, and the red fluorescent ATP indicator MaLionR. When we exposed the U-2OS cells to 0.2 μg/mL of polystyrene (PS) or low-density PE (LDPE) NPs with diameters of 50 nm or 400 nm for 24 hours in the medium, we did not observe significant difference in the kinetics of the fluorescence intensity in Red Glifon 300 or Green Pegassos by glucose, or Pink Flamindo by forskolin. Next, we exposed mice to the aerosols of 50 nm PS NPs in a nose-only inhalation chamber for 2 hours once a week for 7 weeks. We found accumulation of NPs in the lung of mice, and most NPs were colocalized with alveolar macrophages. Whole-body plethysmography analysis revealed that the NP-exposed mice exhibited airway hyperresponsiveness. Levels of tested cytokines in bronchoalveolar lavage (BAL) fluid 2 days after the final inhalation were unchanged. Although neutrophil infiltration was not observed, foamy macrophages were detected in BAL fluid. Furthermore, RNA-seq analysis showed upregulation of genes related to response to viruses in the olfactory bulb of the NP-exposed mice. Therefore, while repeated inhalation exposure can trigger harmful effects on respiratory functions and even affect the olfactory bulb, the underlying molecular mechanism is still unclear under in vitro analysis. To further clarify the precise mechanism, experimental methods which can quickly detect the cellular effects leading to chronic toxicity will be required.

22. Smaller Plastics, Bigger Risks How Sub-micron IR (O-PTIR) Reveals the Invisible Threat of Nanoplastics and Microplastics

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Vibrational spectroscopic techniques such as Infrared (IR) and Raman spectroscopy hold great promise as label free imaging and broad chemical characterizing techniques, however both IR and Raman suffer from major limitations. Traditional IR spectroscopy (FTIR/QCL) has been held back from greater adoption in life sciences due issues such as poor spatial resolution (10-20 micron), poor reflection mode operation and major water interferences. Raman suffers greatly from limited sensitivity for important functional groups and autofluorescence interference of weak Raman scatter. These issues have now been overcome with the breakthrough technique of Optical Photothermal IR (O-PTIR) spectroscopy, providing for submicron IR spatial resolution, improved water compatibility and high-quality spectra in reflection mode. Furthermore, and in a world first, the optical microscopy platform provides for submicron simultaneous IR+Raman - measurements at the same time, from the same spot with the same resolution.

O-PTIR is being used to investigate various tissue types for micro-nano plastic contamination. We will highlight how this multimodality system helps to isolate microplastics in tissues, using Fluorescence guidance. Followed by submicron IR spectroscopy which can be used to identify MP/NP's in tissues. From this identification additional measurements of surrounding tissue can be taken to look for changes in the areas near and away from the MP contamination. Changing the focus and understanding of human health impacts caused by the ingestion, inhalation and then circulation of MP/NP's in the human body.

23. Feeding consumer interest in reducing microplastic exposure: a review of food contamination studies

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Environmental Working Group (EWG)

Ingestion is now recognized as a primary route of human microplastic (MP) exposure, motivating a clearer understanding of MPs present in foods regularly consumed. To address this need, we conducted a targeted review of studies reporting MPs in foods intended for human consumption, limiting inclusion to studies that applied spectroscopic polymer identification to ensure analytical reliability. The review focused on MPs present within the food matrix itself, though many studies also noted contributions from food packaging.

Across all included studies, every food item contained detectable MPs. Concentrations were consistently higher in highly processed and heavily packaged foods compared to fresh or minimally processed items. Contamination was generally attributed to a combination of agricultural and environmental inputs, processing equipment, airborne deposition, and from food additives. Foods most frequently contained the major commercial polymers, PE, PP, PET, PS, PVC, and PA/nylon, reflecting their widespread use. Some studies also reported less common polymers such as rubber particulates in processed proteins and thermoplastic sulfone materials in dairy products subjected to ultrafiltration.

To translate these findings for public use, we developed a consumer-oriented guide encouraging choices that may reduce some dietary MP exposure, emphasizing fresh, locally sourced, and package-free foods where accessible. This synthesis underscores the ubiquity of MPs in food and the need for systemic interventions across agricultural, industrial, and consumer sectors.

24. Precision Probiotics Regulate Blood Glucose, Cholesterol, Body Fat Percentage, and Weight under Eight-Week High-Fat Diet

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Background/Objectives: Poor glycemic control is reaching an epidemic prevalence globally. It is associated with significantly morbid health concerns including retinopathy, neuropathy, nephropathy, cancer, and cardiovascular disease. Probiotics have shown promise in reducing health complications associated with poor blood glucose control. We tested a novel approach to designing a precision probiotic cocktail for improving blood glucose homeostasis.

Methods: We tested the in vitro glucose consumption rate of twelve mouse microbiome bacterial strains and selected three with the greatest glucose consumption for the probiotic cocktail. The in vivo metabolic impact of ingesting the selected probiotic cocktail was evaluated in twelve C57BL/6J male mice fed a high-fat diet for eight weeks.

Results: Compared to a control group, the probiotic group (L. rhamnosus, L. reuteri, and L. salivarius) exhibited significantly lower blood glucose levels, body weight, and body fat percentage. Moreover, the probiotic cocktail also demonstrated the ability to reduce serum insulin, total cholesterol, very low-density lipoprotein/low-density lipoprotein cholesterol ratio, and total cholesterol to high-density lipoprotein ratio. For further mechanistic investigation, untargeted metabolomics analyses

uncovered overall downregulations in energy substrates and producing pathways like gluconeogenesis, acylcarnitine synthesis, glycolysis, the mitochondrial electron transport chain, the TCA cycle, and the building blocks for ATP formation. Partial least squares-discriminant analyses also confirmed clear group differences in metabolic activity. 16S rRNA sequencing from extracted gut microbiota also showed significant increases in Faith's phylogenetic diversity, Lachnospiraceae bacterium 609-strain, and the genus Muribaculaceae as well as group β-diversity differences after probiotic intake.

Conclusions: As such, we successfully developed a blend of three probiotics to effectively reduce blood glucose levels, which could further mitigate adverse health effects in the host.

25. The Effects of Nano-Microplastics Exposure on Alzheimer's Disease Pathology Characterized in APP/PSEN1 Mice

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Alzheimer's disease and related dementias (AD/ADRD) are one of the most prevalent cognitive disorders, affecting more than 6 million Americans over the age of 65. While the exact cause of AD and ADRD is still unknown, several risk factors have been identified, including exposure to environmental toxins. In recent years, nano- and microplastics (NMPs), defined as particles ≤ 1 μm and ≤ 5 mm in size, respectively, have emerged as pervasive environmental pollutants. Previous studies have shown NMPs are able to accumulate in peripheral tissues throughout the body of both humans and mice, raising concerns regarding their potential health impacts. Furthermore, NMPs have been demonstrated to cross the blood-brain barrier to accumulate through the brain, resulting in alterations in cognitive behavior and immune markers consistent with neurological disease. We recently demonstrated that polystyrene (PS)-NMPs exposure in transgenic mice carrying the APOE4 variant, the largest known risk-factor for developing AD, resulted in marked sex-dependent alterations in locomotion and recognition memory, as well as changes to astrocytic and microglial markers in the brain. Building on these results, we are now examining the effects of NMPs exposure in a mouse model of Alzheimer's disease pathology (APP/PSEN1). Specifically, this study aims to determine whether chronic exposure to 0.1 μm and 2 μm polystyrene NMPs influences the onset and/or progression of amyloid-beta plaque deposition, alters neuroimmune markers, and affects cognitive function. Preliminary results indicate that chronic exposure to PS-NMPs in APP/PSEN1 mice worsens cognitive impairments, while plaque accumulation was observed to increase taking into account the plaque variability of the family line. Ongoing analyses are also investigating the histological, biochemical, and immunological changes resulting from PS-NMPs exposure.

26. Microplastics Identified in Human Urinary Lithiasis: First Evidence

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Purpose. Microplastics and nanoplastics are emerging environmental contaminants increasingly recognized for human tissue deposition. The University of New Mexico has previously demonstrated microplastics in placenta, testis, and brain tissue. We now report the first known analysis of microplastics within urinary calculi.

Materials and Methods. Urinary stone fragments from eleven patients undergoing ureteroscopy with laser lithotripsy and cystolitholipaxy were collected as discarded operative debris. Samples were immediately placed in sterile containers to minimize environmental contamination. Microplastics were isolated using enzymatic and peroxide-based digestion protocols, followed by density separation. Polymer identification and quantification were performed using Fourier-transform infrared spectroscopy and Raman microscopy. In addition, overall stone composition was characterized with FTIR spectroscopy.

Results. Microplastics were detected in all eleven specimens, yielding a 100% detection rate. The recurrent presence across independent samples suggests a high probability of > 80% systemic exposure with incorporation into stone formation. Polyethylene terephthalate and polystyrene were the most frequently detected polymers and appeared in nearly every sample. Additional polymers, including polyvinyl chloride, polyamide, polypropylene, and polycarbonate, were identified at variable frequencies. Several stones contained multiple polymer types, indicating heterogeneous incorporation during stone formation.

Conclusions. This pilot investigation provides the first evidence of microplastics in human urinary lithiasis. Because urolithiasis reflect urinary filtration and precipitation, these findings raise important questions about the contribution of microplastic exposure to stone pathogenesis. Larger studies analyzing both urine and lithiasis specimens are warranted to clarify mechanisms, establish causality, and assess potential clinical implications.

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27. Polystyrene and polyethylene terephthalate nanoplastics differentially impact mouse ovarian follicle function

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Exposure to micro- and nanoplastics is unavoidable. Foods and beverages contain plastic particles from environmental contamination and processing and packaging materials, which are frequently made of polyethylene terephthalate (PET). Micro- and nanoplastics have been detected in human tissues such as the brain, liver, and placenta, as well as in ovarian follicular fluid, but little is known about the effects nanoplastics have on the female reproductive system. In addition, few studies on the health impacts of nanoplastics have been performed using environmentally relevant plastic types and concentrations. Thus, this research tested the hypothesis that nanoplastics made of spherical polystyrene (PS), a common model nanoplastic, would have different effects on cultured mouse ovarian follicles compared to secondary PET nanoplastics at environmentally relevant doses. The ovary is a highly sensitive reproductive organ responsible for the development of follicles, which contain the oocyte, and production of steroid hormones. Follicles were harvested from adult mouse ovaries and cultured for 96 h with vehicle, spherical commercially available 220 nm PS nanoplastics (1–100 µg/mL), or lab-generated 240 nm PET nanoplastics (0.1–10 µg/mL). PS and PET nanoplastic exposure inhibited follicle growth and altered expression of genes related to steroid synthesis, cell cycle, and oxidative stress. PET nanoplastics increased levels of pregnenolone and decreased expression of Cyp17a1. Overall, both plastic types altered ovarian function, but they impacted different genes in similar pathways. These findings suggest that nanoplastic exposure at environmentally relevant concentrations may pose a risk to female reproductive health by disrupting hormonal and molecular pathways. In addition, environmentally relevant plastic types and doses are necessary for studying health impacts of nanoplastics.

28. Chronic Dietary Microplastic Exposure Weakens Skeletal Integrity

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Humans are estimated to ingest up to 5 grams of microplastics (MPs) weekly through diet, yet the physiological consequences of chronic exposure remain poorly understood. Emerging evidence suggests MPs can disrupt endocrine function and accumulate in various systemic tissues, but the effects on the skeletal system remain unclear, particularly regarding the gut–bone axis. To investigate this, we exposed C57BL/6J mice to polystyrene MPs (0.5–5 µm) incorporated into standard diet pellets for 12 weeks. Although no significant differences were observed in body weight, fat mass, energy intake, or inflammatory markers (serum TNFα, fecal LCN-2 and sIgA) compared to controls, microCT analysis revealed sex-

and site-specific skeletal changes following chronic MP exposure. In females, MP exposure reduced spinal trabecular thickness without altering connectivity density and caused reductions in femoral cortical area, cortical thickness, trabecular bone volume fraction (BV/TV), along with increased trabecular separation. In males, spinal BV/TV was preserved, but trabecular thickness increased while connectivity density declined. Male femurs showed reduced BV/TV and increased trabecular separation. Interestingly, serum serotonin levels were elevated in exposed mice. In vitro, serotonin as well as MP exposure significantly reduced osteoblast mineralization, indicating a direct cellular mechanism underlying the in vivo bone loss. Lastly, MPs were detected in human femoral bone tissue supporting a role for hormonal and environmental factors in disrupted bone homeostasis. These findings suggest chronic MP exposure induces skeletal degradation in a sex- and site-dependent manner. The architectural pattern observed, particularly reduced connectivity with compensatory thickening in male spines, resembles osteoporotic bone. Our findings highlight dietary MPs as a novel risk factor for compromised skeletal integrity, with implications for long-term musculoskeletal health in exposed populations.

29. Visualization of micro/nanoplastic (MNP) particles within historical and modern tissue samples of Dipodomys ordii via transmission electron microscopy

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Multiple studies have demonstrated that micro/nanoplastic particles are present in a variety of vital organs within humans and other organisms. However, the visualization of the particles within the tissue has been limited. Additionally, no studies exist that determine if these same particles can be found within historical samples collected from a period where environmental plastic is absent. Our study aims to test historical samples against modern samples to provide confirmation that the particles visualized within tissue are MNP particles. The Museum of Southwestern Biology maintains a collection of fluid-preserved historical samples. From their collections, kangaroo rats (Dipodomys ordii) from 1966 were obtained. Samples were then collected in 2025 from the same locality and preserved using the same methods as the historical samples. Brain, kidney, and liver samples were obtained, digested with KOH, and processed for transmission electron microscopy (TEM) imaging. From TEM imaging, we identified shard-like particles roughly 200nm in size within brain, kidney, and liver tissue from 2025 samples of kangaroo rat tissue. These particles were present in high amounts throughout the prepared samples, especially within the brain tissue. Within the 1966 tissue, these particles were almost entirely absent. These images suggest that the particles identified within the tissue are MNP particles due to their absence in the historical samples.

30. Placental Microplastics and Child Neurodevelopment: A Scoping Review of Emerging Evidence

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Background: Micro- and nanoplastics (MNPs) are emerging contaminants of global concern, increasingly detected in human tissues including placenta, meconium, breast milk, lung, blood, and brain. Experimental studies demonstrate that MNPs cross biological barriers, disrupt the gut–brain axis, induce oxidative stress, and provoke neuroinflammation—mechanistic pathways also implicated in autism spectrum disorder (ASD). However, evidence in humans, particularly during pregnancy, remains limited and fragmented.

Methods: We conducted a scoping review of peer-reviewed studies (2010–2025) that measured MNPs in human biological matrices relevant to maternal and child health. Databases searched included PubMed, Web of Science, and Scopus. Studies were extracted for sample type, detection method, sample size, prevalence, polymer types, and health outcomes assessed. Particular attention was given to studies involving pregnancy, placental transfer, and neurodevelopmental endpoints.

Results: Twenty-one studies met inclusion criteria. Placental studies consistently detected MNPs (100% detection across 4 independent cohorts), with polyethylene, PVC, and nylon as the predominant polymers. Meconium and breast milk studies confirmed early-life exposure pathways, while recent autopsy work revealed MNPs in human brains. Analytical methods varied widely; spectroscopic approaches (FTIR/Raman) often lacked sensitivity below 5 µm, whereas pyrolysis–GC/MS provided polymer-specific quantification. No study directly examined MNPs in relation to ASD or child neurodevelopment, representing a critical knowledge gap. Experimental literature, however, shows prenatal MNP exposure induces ASD-like behaviors in mice and alters maternal immune and gut microbiome pathways relevant to ASD.

Conclusion: Human biomonitoring confirms maternal–fetal exposure to MNPs, but epidemiologic evidence linking these exposures to child neurodevelopment is absent. Placental MNPs are promising biomarkers for in utero exposure, offering opportunities to integrate exposure science with developmental neurotoxicology. Addressing this gap is essential to evaluate MNPs as potentially modifiable risk factors for ASD and to guide public health strategies aimed at reducing early-life plastic exposures.

31. Inhalable Microplastics as Vectors of Co-Contaminants: Quantification by Pyrolysis-GC/MS and Implications for Human Health

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This study reveals the levels of inhalable microplastics (iMPs, < 10 µm), a notorious subset of airborne microplastics (AMPs, < 5mm). In urban areas of four major Indian cities, the quantitative detection of iMPs was performed using Pyrolysis Gas Chromatography-Mass Spectrometry, at human-breathable heights (~1.5m). The research found that around 9 µg/m3 of iMPs will be inhaled by the residents and daily commuters of these cities. The Lifetime lung load of AMPs approaches 3 grams per person in urban spaces of India. Also, the levels of particulate matter 10 & 2.5 were found to be approximately 10 times higher (~290 µg/m3) than the WHO's guidelines. Apart from estimating the levels of iMPs, this comprehensive research tries to delineate hidden risks associated with the inhalation of iMPs. Additionally, based on morphological characters and libraries, their probable source apportionment was done. Our findings reveal AMPs role as carriers of various pollutants such as microbes, toxic metals, endocrine disruptors, etc. Numerous bacterial and fungal strains were detected in iMPs samples collected during the mass gatherings (festivals), highlighting their role as carriers of these pathogens. More than 20 species of fungi were found laden to the surface of iMPs, including a few pathogenic immunosuppressing fungal species. The detection of antibiotic resistance genes (multidrug resistance) and virulence factor genes in the iMPs-attached bacterial strains also intensifies the problems. Furthermore, their role in the incidence of diseases when burned unintentionally in an open dumping site is explored. Various up-to-date toxicological databases linked these emitted chemicals with cancer, gut, respiratory, breast, and endocrine-like diseases.

32. Comparison of Digestion Protocols for Crop and Food Matrices Prior to Micro(nano)plastic (MNPs) Analysis and Quantification

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Microplastics and nanoplastics (MNPs) are now recognized as widespread environmental contaminants, with increasing evidence pointing to their presence in agricultural soils and food chains. Despite their growing detection, little is known about the extent to which MNPs accumulate in plant-based food sources that are regularly consumed by people worldwide. Rice and beans—staple crops in many global diets—have shown potential for MNP uptake, but current studies fall short of quantifying the levels humans might be exposed to through consumption. One of the significant roadblocks to accurate analysis lies in sample preparation: plant cell walls are difficult to break down using traditional MNPs digestion protocols, which employ lightly destructive chemical methods to preserve the structural integrity of MNPs. This study investigates the use of surfactants, specifically Cetrimonium bromide (CTAB), enzymatic digestion, and diluted nitric acid (HNO_3), as pre-digestion methods, aiming to enhance the breakdown of plant tissues while preserving MNP integrity. We found that nitric acid was sufficient to break down rice, but beans required the introduction of enzymes (amylase, protease, cellulase, and pectinase). Initial data reveal the occurrence of polyethylene, polystyrene, polyvinyl chloride, and Styrene-Butadiene Rubber in estimated total mass concentrations above 100 mg/kg per dry weight. By developing a more effective pre-treatment approach and quantifying MNPs in rice, beans, fruits, and vegetables, this research aims to offer a clearer picture of human exposure through diet.

33. Nanovib: particle analysis with chemical specificity and nano sensitivity

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Nanovib

Accurate detection and characterization of micro- and nanoplastics in complex samples remains a major analytical challenge. Conventional techniques often struggle to simultaneously identify and quantify nanoscale particles, while also being limited by low throughput and time-intensive workflows.

Nanovib, a technology startup specializing in nanoscale particulate analysis, has developed a high-throughput imaging service purpose-built for micro- and nanoparticle detection in liquids. Our proprietary platform integrates stimulated Raman scattering (SRS) microscopy optimized for nanoplastics with a custom algorithm that enables automated image processing and multidimensional particle characterization. This allows for quantitative particle counting down to 100 nm, while simultaneously extracting chemical composition and morphological features such as size and shape at single-particle resolution.

Nanovib's service provides comprehensive statistical profiles of particulate contamination, helping clients pinpoint sources of micro- and nanoparticles and gain a deeper understanding of their samples. Depending on the application, we offer fast and cost-effective routine testing for quality control, or in-depth analytical studies tailored to R&D and product development needs.

By delivering previously inaccessible nanoscale insights, Nanovib empowers researchers, industry partners, and regulatory bodies to make informed decisions about product safety and environmental impact. Our mission as a startup is to make advanced nanoscale analysis accessible, supporting innovation and promoting a cleaner and safer products for our community.

34. A Multifaceted Thermal Desorption-GCMS Approach for Simultaneous Profiling of Phthalate Leachates and Polymer-Specific Fragments from PET and PVC

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We studied the release of phthalates from polyethylene terephthalate (PET) and polyvinyl chloride (PVC) subjected to thermal aging. Phthalate leaching from plastics into aquatic systems is a growing concern due to their persistence and bioaccumulation potential during polymer degradation. PET and PVC, both non-oxidized and thermally oxidized at 100 °C and 250 °C, were incubated in 1 L of deionized water and synthetic freshwater for 60 days. At defined intervals, liquid samples were taken, filtered, and analyzed for initial dissolved organic carbon (DOC) using total organic carbon (TOC) analysis. Phthalates were extracted from the leachate via solid-phase extraction (SPE) and quantified using gas chromatography–mass spectrometry (GC-MS). Additionally, polymer-specific degradation products were also profiled using pyrolysis-GC-MS (pyr-GC-MS) and thermal desorption to complement phthalate quantitation and characterize polymer breakdown behavior. Thermal oxidation was found to reduce the abundance of polymer-bound plasticizers, likely due to volatilization or degradation, while others remained relatively stable. A 250°C treatment of PET led to a 3.7-fold increase in benzophenone levels, suggesting enhanced release or in situ formation from the polymer matrix. In contrast, dibutyl phthalate (DBP) decreased by approximately 10%, likely due to volatilization or degradation, while bis(2-ethylhexyl) phthalate (DEHP) remained relatively stable, consistent with its lower volatility and greater thermal resilience. These findings underscore the value of thermal desorption for selectively detecting semi-volatile additives that may be underestimated during full pyrolysis. However, the elevated benzophenone levels after thermal aging suggest that this compound may not reliably reflect total PET content under varying oxidative conditions. Therefore, further investigation into more stable and oxidation-resistant PET and PVC pyrolysis markers is warranted to ensure accurate quantitation and normalization in thermal degradation studies. This dual analytical approach enables a more comprehensive assessment of thermal aging dynamics and contaminant mobility, improving assessment of microplastic-associated risks across environmental conditions.

35. Airway Exposure to Polyethylene Terephthalate Micro/Nanoplastics Disrupts Blood–Brain Barrier Integrity and Glymphatic Function in Mice

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Micro- and nanoplastics are increasingly recognized as pervasive environmental pollutants with potential neurotoxic effects. These particles comprise diverse polymer types, including polystyrene (PS), polypropylene (PP), polyethylene (PE), and polyvinyl chloride (PVC). Among them, polyethylene terephthalate (PET) is widely used in textiles and consumer products and has been reported in indoor and outdoor air as fibers and fragments. This study aimed to determine whether the neurotoxic mechanisms previously described for PS also extend to polyethylene terephthalate (PET), an environmentally relevant and commonly encountered plastic type. To simulate real-world respiratory exposure, we established a murine airway exposure model by intratracheal instillation of PET plastic suspensions and investigated neurovascular integrity. PET exposure caused marked leakage of fibrinogen and immunoglobulin G (IgG) into the brain parenchyma, indicating significant blood–brain barrier (BBB) disruption, particularly around cortical microvessels. In parallel, perivascular aquaporin-4 (AQP4) coverage was notably reduced, suggesting early impairment of astrocytic endfoot polarity and glymphatic function. While overt neuronal damage remains under investigation, these findings provide clear evidence that PET plastics compromise vascular and perivascular homeostasis. Understanding how environmentally relevant PET particles perturb BBB integrity and glymphatic pathways will be essential for assessing real-world plastic exposure risks and their potential contribution to neurovascular dysfunction.

36. Trace Level Quantitation of Micro- and Nanoplastics Utilizing Thermal Desorption and Pyrolysis–GC/MS Coupled with Selective Ion Monitoring: Development and Validation

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Micro- and nanoplastics (MNPs) are now ubiquitous across atmospheric, aquatic, terrestrial, and biological systems, creating urgent challenges for environmental monitoring and risk assessment. Conventional techniques such as ATR-FTIR and SEM are constrained by particle size limits and surface dependence, while existing pyrolysis–gas chromatography mass spectrometry (py–GC/MS) workflows suffer from matrix-driven interferences, co-elution, signal inflation, and unstable detection limits. These limitations undermine reproducibility and routine trace-level monitoring, particularly in studies with limited sample mass such as bioaccumulation in tissues where trace level analysis is required for high-throughput routine analysis. We present an enhanced thermal desorption-pyrolysis-GC/MS (TD-py-GC/MS) workflow explicitly designed to stabilize performance and improve sensitivity and resolution for MNP analysis. A dual stage thermal desorption (TD) sequence removes volatile and semi-volatile interferences prior to pyrolysis, yielding cleaner chromatograms, reduced false positives, and additive-specific profiles that support source attribution to quality control. To streamline calibration, we developed a microwave-assisted digestion protocol for preparing multi-polymer standards, allowing trace level measurements aimed at creating high throughput calibration resources while reducing the reliance on current labor-intensive microbalance methods. Using selective ion monitoring (SIM) to target diagnostic fragments, we achieved approximately 6-10 times lower method detection limits relative to full-scan acquisition across ten environmentally relevant polymers (PE, PET, PVC, PS, PP, PMMA, ABS, SBR, N6, and N66). The combined strategy mitigates matrix effects, improves quantitative robustness, and supports standardized, scalable deployment in environmental screening, regulatory monitoring, and mechanistic studies of plastic occurrence. Overall, Dual TD-py-GC/MS with SIM offers a practical, reproducible, and trace-sensitive solution to advance analytical quantitation of MNP research.

37. When lipids and micro(nano)plastics co-aggregate: Mass Spectrometry challenges for exposures and toxicity research

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Micro(nano)plastics (MNPs) are ubiquitous in the environment and have recently been detected in human tissues, including the brain. Their ability to infiltrate biological systems raises concerns about toxicity and long-term health consequences. MNP exposure has been associated with organ dysfunction, reproductive and developmental toxicity, and neurotoxicity. Within the brain, lipids such as cholesterol, sphingomyelin, and docosahexaenoic acid (DHA) are critical for neuronal function. Alternations in lipid turnover or disruption of lipid balance are increasingly recognized as contributors to neurodegenerative disease. This study aims to simulate potential molecular interactions between brain lipids and plastics by spiking cholesterol, sphingomyelin, and DHA with a mixed polymer standard. We investigate how lipid-polymer interactions influence molecular detections and how extraction techniques can be optimized to re-separate these components for accurate quantification by mass spectrometry. Our methodological approach employed sequential digestion using potassium hydroxide (KOH) followed by solvent washes (cyclohexane or nitric acid) to degrade lipids while preserving polymer integrity. Samples are then analyzed by pyrolysis gas chromatography-mass spectrometry (Py-GC/MS). Preliminary findings demonstrate that pure sphingomyelin generates up to 56% false-positive recovery of polyethylene (PE), which decreases to 7% following KOH digestion. Pure cholesterol produces ~6% false-positive recovery, which decreases to 0.7% after KOH digestion. In contrast, DHA increases from 1% false positive to 4% after digestion. Together these results illustrate how endogenous brain lipids may interfere with MNP detection in biological matrices and provide a methodological framework for improving the reliability of polymer quantification in toxicological studies.

38. Optimizing Digestion Strategies for Accurate Microplastic Quantification in Human Blood Samples

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Quantifying microplastics (MPs) in human biological matrices remains a critical challenge due to the lack of standardized, high-throughput protocols. Current methods utilize enzymatic digestion, which, although effective, requires processing times of up to 48 hours. From this, we evaluated whether alternative digestion strategies can deliver comparable accuracy while retaining particle integrity. Moreover, we compared a widely used enzymatic protocol with a soft alkaline hydrolysis method under controlled conditions. This assessment included digestion efficiency, matrix interference, and polymer recovery using pyrolysis-gas chromatography-mass spectrometry. Although alkaline hydrolysis offers the advantage of rapid processing within hours, its impact on microplastic stability and sample compositions remains unexplored. Outcomes from this study can provide insights into the feasibility of alkaline hydrolysis as a robust alternative for microplastic analysis in blood, paving the way for scalable and time-efficient methodologies for MP quantitation in human exposure research.

39. Toxins in Tandem: Dissecting the Combined Nephrocardiac Impact of Microplastics and Arsenic

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Micro- and nano-plastics (MNPs) are polymer particles. Microplastics are between 1 µm and 5 mm in diameter, while nanoplastics are less than 1,000 nm in diameter. The growing threat that MNPs present to both the environment and human health is troubling, considering plastic production is on the rise. MNPs will continue to accumulate in ecosystems, where they enter the food chain and pose serious health risks. The aim of this study was to determine how arsenic (As) co-exposure with polyethylene (PE) MNPs affects renal health in rats. It is possible that the combination of both contaminants may lead to more serious health effects than either would in solitude. Male and female rats were exposed to As, PE MNPs, or both for three months. Co-exposure in both male and female rats led to impaired growth. Organs and fluids (urine, plasma) were collected and analyzed with pyrolysis gas chromatography mass spectrometry (Py-GC/MS). PE accumulation was confirmed in both cardiovascular and renal tissues, with the co-exposed tissue having reduced levels of MNP retention. Additionally, creatinine, blood urea nitrogen (BUN), and estimated glomerular filtration rate (eGFR) were analyzed, finding that MNPs alone have a similar effect on kidney stress as As alone. A renin assay and Py-GC/MS analysis of the plasma and livers are currently ongoing.

40. Polymer characterization in kidney and urine

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Previous research demonstrates that microplastics and nanoplastics (MNPs) accumulate in human kidneys. In these samples, the most abundant type of polymer was polyethylene, with at least 11 other polymers present at significant levels. However, it is currently unknown where within the kidney MNPs accumulate, and what concentrations of polymers are excreted in the urine. This work aims to explore these two questions. Specifically, we aim to 1) dissect different regions of porcine kidneys to characterize MNP accumulation in the cortex and medulla and 2) compare the efficacy of different methods to characterize MNPs in human urine. The two methods compared will include urine concentration in centrifugal filters, and filtration with 13uM quartz filters. For each of these methods, we also aim to determine whether digestion of urine with KOH aids in MNP characterization. We plan to characterize MNPs through visualization techniques including transmission electron microscopy (TEM), nanoparticle tracking analysis (NTA), and Raman spectroscopy/Fourier transform infrared spectroscopy (FTIR). Specific concentrations of polymers in kidney regions and urine will be identified by pyrolysis gas chromatography–mass spectrometry (Py-GCMS). Together, this work will help determine the regions of MNP accumulation in the kidney, and standardize the methods used for characterization and identification of MNPs in urine.

41. Metabolic and physiologic effects of biodegradable microplastics in C. elegans model

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Microplastics are increasingly recognized as a global environmental concern because of their potential adverse effects on ecosystems. As a result, biodegradable plastics are being introduced as a supposedly safer replacement. However, it is not clear how the degradation products of biodegradable polymers may affect cellular metabolism and organismal health. The release of nutrients during the degradation of bioplastics can potentially disrupt metabolic interactions between species, for example, between the host and its microbiome. Here, we use the soil nematode Caenorhabditis elegans as a model to study the role of cellular metabolism and the microbiota in the host response to biodegradable microplastics. To characterize the effect of biodegradable microplastics on C. elegans physiology, we supplemented the C. elegans diet with different types of microplastics and assessed the animals' rate of development. We tested biodegradable microplastics based on polycaprolactone (PCL) and poly-lactic-co-glycolic acid (PLGA), as well as non-biodegradable polystyrene (PS) microplastics. Despite no observable developmental defects I treated animals, their metabolomes, assessed by gas chromatography–mass spectrometry, showed significant differences, with PCL causing the most pronounced shift. This result confirms our original hypothesis that biodegradable microplastics are potent disruptors of C. elegans metabolism. The effects of different microbial diets and the dynamics of microplastics in the bodies of exposed animals are also discussed.

42. From Packaging to Plate: Systematic Review and Meta-Analysis of Nanoplastics and Microplastics Release from Food Packaging

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Increasing evidence indicates that nanoplastics (NPs) and microplastics (MPs) are released from plastic packaging into food, raising concerns about human exposure to these particles. This systematic review and meta-analysis explores the occurrence and release of NPs and MPs from plastic food packaging into food. Our analysis revealed significant variation in reported occurrence and release of NPs and MPs across studies for different packaging types. For example, paper cups were found to release the highest number concentration of particles, up to 5.4 trillion particles per liter, with sizes ranging from 15 nm to 325 nm. In contrast, fish packaging released the lowest concentration, with only 7 particles per liter, ranging from 50 to 500 μm. Interestingly, we found that studies using methods capable of detecting smaller particles reported higher concentrations of NPs and MPs, regardless of the packaging or material types, release conditions, or study location. NPs and MPs detected in plastic packaging predominantly originate from the packaging materials themselves, although airborne sources or chemicals and simulants used in the studies can also contribute. Elevated temperatures consistently increased the release of NPs and MPs from plastic packaging. Longer contact times were also associated with increased NMP release. However, studies limited to detecting only larger NPs and MPs often observed a decrease in release with extended exposure possibly due to particle sedimentation or degradation into smaller, undetectable sizes over time. Repeated use generally reduced NP and MP release as the dominant release mechanism shifts from detachment of loosely attached particles to degradation.

43. Benchmarking the Invisible: Modeling Neurotoxicity of Ingested Micro- and Nanoplastics Through Bayesian Dose–Response Analysis aided by systematic evidence integration

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Despite growing evidence of micro- and nanoplastics (MNP) ingestion through food, no reference doses (RfDs) currently guide human-health risk assessment. To address this, we conducted a systematic review of mammalian oral exposure studies using the PRISMA framework and PICOS model to derive points of departure (PODs) and propose RfDs for MNPs, establishing a transparent framework for regulatory evaluation of emerging hazards.

From 35,046 articles retrieved from seven databases, we removed duplicates, screened titles with a fine-tuned Large Language Model (LLM) model, and manually reviewed abstracts and full texts, yielding 165 eligible studies across multiple biological systems. Due to the volume and complexity of the data, our detailed analysis in the present study focused on neurological outcomes.

Twenty-two studies addressed neurotoxicity. From these 132 statistically or biologically significant dose–response endpoints, spanning behavioral performance, neuroinflammatory cytokines, oxidative stress markers, and neurodevelopmental or structural measures, models and calculations were developed for the Benchmark Dose Lower Confidence Limit (BMDL) in Phase 1 of a three-tiered pipeline. In Phase 2, each paper was reanalyzed by selecting two representative endpoints based on BMDL, precision, biological relevance, and coherence with related endpoints. Phase 3 will integrate expert consensus to identify the most suitable endpoint and BMDL for deriving final POD and RfD values.

Preliminary results indicate that polystyrene NP consistently exhibit lower BMDLs than MPs across sub-chronic and chronic exposure periods, suggesting greater nanoscale toxicity. MPs BMDLs (95%CrI) ranged from 0.3–2.8×10^{2} mg $kg^{-1}day^{-1}$ (sub-acute), 2.5×10^{-2}–0.25 (sub-chronic), and 5.5×10^{-3}–4.8×10^{-2} (chronic), whereas NP values were 0.22–35.6, 9.0×10^{-3}–0.29, and 3.0×10^{-3}–2.3×10^{-2} mg $kg^{-1}day^{-1}$, respectively. Comparable sub-acute BMDLs were observed for other MP polymers, including polyethylene terephthalate (4.7–10.6mg $kg^{-1}day^{-1}$), polypropylene (2.1–22.5), polylactic acid (0.23–6.98), and low-density polyethylene (0.10–0.84mg $kg^{-1}day^{-1}$). These estimates should be interpreted with caution while Phases 2 and 3 are completed, as this initial analysis is purely statistical and may change with expert inputs.

In addition, consistent with our second objective, these findings demonstrate that study design, specifically exposure duration, dose spacing, and endpoint selection, can significantly impact BMDL values and, consequently, influence POD and RfD estimates, underscoring the importance of an evidence-synthesis approach rather than reliance on individual studies and the need for ongoing evidence collection to keep risk assessments current and robust for decision-making. Together, these efforts provide an essential first step toward establishing science-based regulatory thresholds for MNP ingestion and demonstrate a scalable framework for future risk assessment and policy development.

44. Particle deposition in the human lung as a function of microplastics' shape, size, orientation, and type

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The widespread use and poor end-of-life management of single-use plastics has created a global pollution problem with emerging health concerns. Weathering produces micro- and nanoplastics that become airborne and can be inhaled. Some are cleared; others persist, provoke inflammatory or oxidative responses, and carry intrinsic additives or adsorbed or

absorbed pollutants creating combined particle–chemical hazards. Because airborne microplastics are often fibrous with non-spherical aerodynamics, we examined how fiber size, shape (aspect ratio), density, and orientation govern regional lung deposition. We estimated deposition in the nasopharyngeal, tracheobronchial, and alveolar regions using the ICRP respiratory tract model with fiber-specific corrections. Fiber length and diameter were converted to aerodynamic-equivalent diameters via dynamic-shape-factor adjustments that incorporate density and orientation. We evaluated fibers 10–50 μm long and 0.75–5 μm in diameter under parallel, perpendicular, and random orientations to bound realistic inhalation. Under random orientation, nasopharyngeal deposition peaked at ~0.87 for fibers with aerodynamic diameters ~5–7 μm, where inertial impaction dominates. Alveolar deposition peaked at 0.13 for ~0.75 μm diameter fibers up to ~35 μm long, where low inertia permits deep penetration and sedimentation competes with diffusion. Tracheobronchial deposition was intermediate; parallel alignment favored deeper penetration, whereas perpendicular alignment increased proximal capture. We provide predictive curves and closed-form relationships linking geometry, density, and orientation to regional deposition, enabling scenario-specific exposure estimates. Implications are twofold: elongated microplastics in the 5–7 μm aerodynamic range are efficiently intercepted in the upper airways, while small-diameter elongated fibers can reach the alveoli, where clearance is slower and tissue interactions may be more consequential; orientation and flow regime strongly modulate both outcomes. Limitations include reliance on a modified ICRP framework not yet validated experimentally for microplastic fibers; idealized assumptions about orientation and density; a restricted size window (10–50 μm length; 0.75–5 μm diameter); and omission of hygroscopic growth, electrostatics/aggregation, co-contaminants, and post-deposition clearance/translocation. Future work should pair harmonized field measurements with controlled inhalation and air–liquid-interface studies to validate deposition and clearance, extend models to nanoplastics and realistic breathing patterns, incorporate polymer aging and additive, absorbed or adsorbed-chemical release, and generate dose–response data for quantitative risk assessment.

45. Combined impacts of PFAS and Micro/Nanoplastics on early neural development and behavior in zebrafish

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North Carolina Central University

Environmental exposure to persistent pollutants poses growing health concerns, particularly for chemicals that are ubiquitous and bioaccumulative, such as micro- and nanoplastics (MNPs) and per- and polyfluoroalkyl substances (PFAS). Both classes are prevalent in household products, with ingestion occurring primarily through our food and water sources. MNPs have been detected in multiple organs, including the brain and liver, with accumulation increasing over time and independent of age or sex when measured. Similarly, different types of PFAS exhibit tissue-specific accumulation patterns, with several studies linking prenatal exposure to developmental delays, neurotoxicity, and even childhood leukemia.

Using zebrafish as a model system to study developmental impacts of exposure, we have identified that exposure to PFOA, a type of PFAS still ubiquitous in our environment, disrupts gene expression profiles of several neural tissues during embryonic development. Given that both MNPs and PFAS can independently affect neuronal systems, and that a recent study in Daphnia reported additive toxicity under combined exposure, we aim to investigate their joint effects on vertebrate development. Specifically, we will assess how PFOA and polyethylene particles (ranging from ~3 mm microspheres to ~40 μm particles, and known to accumulate in human brains) alter early developmental pathways.

We have established a behavioral assay to quantify zebrafish larval movement and have observed increased anxiety-like behavior following PFOA exposure. Our ongoing work examines the individual and combined effects of PFOA and polyethylene on both gene expression and behavioral outcomes, assessing whether MNPs disrupt the same molecular pathways as PFAS and whether co-exposure amplifies PFAS-induced toxicity. This study aims to provide an integrated understanding of how these pervasive contaminants jointly influence neural development and behavior, offering critical insights into the mechanisms of environmental toxicity at the organismal level.

46. The Effect of Environmental Micro- and Nanoplastics on Human Joint Health

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A.T. Still University

Introduction: With 460 million tons of plastic produced in 2024, environmental microplastics, <5 mm, and nanoplastics, <100 nm, (eMNP) are ubiquitous in air, food and water. eMNPs contain endocrine-disrupting chemicals (EDC) that may cross biological barriers to organs like the brain and fetus, potentially resulting in inflammation, oxidative stress and altered cellular apoptosis signaling. To date, the effects of eMNPs on human musculoskeletal tissue remain unknown. A scoping review on the impact of eMNPs on musculoskeletal health was performed to assess the current knowledge.

Methods: A literature review using the PRISMA-SCR protocol identified 124 publications on eMNP effects on musculoskeletal tissues. Studies on joint replacements and those using animal or in vitro models were excluded. 22 articles met inclusion criteria; ten were review articles referencing data from in vitro and animal studies but providing insight into the biochemical and physiological effects of eMNPs. Data on eMNP, tissue, arthritis, methods used and study design were extracted from the remaining 12 articles.

Results: Six articles found eMNPs in human tissues (cartilage, bone, synovium, synovial fluid, muscle, intravertebral discs and bone marrow) resected during planned surgeries. Of these, only three used plastic-free sample extraction and analysis protocols. Five cross-sectional studies correlating urinary phthalate metabolite levels with arthritis and a case study of arthritis in a deceased plastic sculpture artist were identified. Mentioned plastics included polypropylene, polyethylene, polyvinyl chloride, and polystyrene. eMNP and EDC presence correlate with elevated inflammatory markers (IL-1b, TNF-α and IL-6), oxidative stress and anti-androgenic activity. Smaller nanoplastics were more toxic, crossing biological barriers more easily.

Conclusions: This scoping review found evidence that eMNPs migrate into human musculoskeletal tissues. Currently, existing studies are primarily in vitro or animal models using spherical lab-made MNPs, unlike the irregular contours of eMNPs, making correlation unknown. No studies have quantified the absorption, distribution, metabolism or excretion of eMNPs in humans. Inconsistent use of plastic-free laboratory protocols may limit results; but, evidence suggests that eMNPs may contribute to joint degeneration and arthritis. Due to the increasing global burden of arthritic disease, future research should be performed to quantify musculoskeletal effects of eMNPs on humans.

47. Tire Particles as Emerging Aquatic Pollutants: Detection, Composition, and Ecotoxicological Impacts

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Tire particles (TPs) represent a growing concern in aquatic environments as a major source of micro- and nanoplastic pollution. Generated from tire wear and the recycling of end-of-life tires, these particles enter waterways through stormwater runoff from road surfaces, playgrounds, and artificial turf fields. Advances in analytical detection have enabled TP identification through chemical markers such as benzothiazole, 4-vinyl cyclohexene, and dipentene, as well as morphological characterization of irregularly shaped fragments and fibers ranging from the nano- to microscale. Tire rubbers comprise complex mixtures of synthetic and natural polymers, containing thousands of chemical additives including polycyclic aromatic hydrocarbons, antioxidants, plasticizers, and metals. These constituents leach into aquatic environments, contributing to mixture toxicity. Our recent studies demonstrate that both micro- and nano-sized tire particles, as well as their leachates, induce significant adverse effects in Daphnia magna and zebrafish, including reduced hatching success, impaired growth, and altered feeding behavior. These findings are supported by other studies showing similar toxicity in fish, algae, and invertebrates, emphasizing the broad ecological risk of tire-derived contaminants. Understanding how chemical composition, particle size, and source influence toxicity remains critical for predicting ecological risks and guiding mitigation strategies for tire particle pollution.

48. Evaluating EpiIntestinal® Tissue as a Physiologically Relevant In Vitro Model to Assess Nanoplastic Transport

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Exposure to micro- and nanoplastics (MNPs) has become a critical area of investigation and public health concern. Increasing evidence demonstrates that MNPs are ubiquitous in the environment and are present in our food chain and water supply. Despite the growing literature on their presence in human biological matrices, including the brain, liver, and kidney, the mechanisms by which these particles are absorbed and transported across the intestinal barrier are still being explored. Currently, the limited studies related to physiologically relevant in vitro models to assess the intestinal absorption of nanoplastics represent a significant limitation in advancing the understanding of human health risk assessment.

The primary aim of this study is to evaluate the feasibility of using EpiIntestinal® tissue, a 3D human-derived intestinal model, to assess nanoplastic permeability across the intestinal epithelium. EpiIntestinal tissue incorporates specialized cell types of the human small intestine and replicates key biological functions, including maintaining tight junction integrity, brush border activity, and responding to inflammatory and metabolic stimuli. These properties make it a promising alternative to traditional cell lines for evaluating nanoplastic transport and toxicity.

In this study, EpiIntestinal tissue were mounted onto modified Franz diffusion cells. The receptor compartments were filled with a nutrient-rich maintenance medium and maintained at 37 ± 0.5 °C under continuous stirring. Fluorescently labeled polystyrene nanobeads (25nm and 100nm, 10ug/mL) with and without the perturbant dextran sodium sulfate were applied to the apical surface to mimic luminal exposure conditions. Fluid from the donor and receptor chambers was collected to quantify nanoplastic permeation using fluorescence spectroscopy, and post-exposure tissues were evaluated for integrity and nanoplastic localization through confocal microscopy.

The outcomes of this research determine the reproducibility and sensitivity of EpiIntestinal tissue for assessing nanoplastic transport and establish this proof-of-concept model as a viable platform for MNP absorption studies. This experimental model will allow us to explore the mechanisms of MNP absorption and distribution.

49. Evaluating the Health Effects of Microplastics in Drinking and Bottled Water: OEHHA's Mandate and Considerations for a Regulatory Risk Assessment Framework

Scott Coffin
California Office of Environmental Health Hazard Assessment

California law requires the Office of Environmental Health Hazard Assessment (OEHHA) to evaluate the health effects of microplastics in drinking and bottled water, with the goal of identifying toxicity characteristics and establishing levels that are not anticipated to cause adverse health effects- or, where data are insufficient, to identify critical data gaps required to establish those levels. In parallel, the State Water Resources Control Board is implementing a monitoring program for microplastics in drinking water per requirements of the California Safe Drinking Water Act, which includes requirements for four years of testing and public reporting by water systems. This effort will generate high-quality occurrence data, providing a foundation for robust exposure assessment and risk evaluation.

OEHHA is in the early stages of developing a science-based framework for microplastics risk assessment. The poster will briefly review our previous risk assessment framework developed in collaboration with the State Water Resources Control Board and the Southern California Coastal Water Research Project, which was used to derive provisional health-based screening levels for microplastics in drinking water through a tiered process of literature review, expert evaluation, and risk characterization. The poster will also highlight recent advances in microplastics risk assessments that provide means to

address the diversity and complexity of microplastic particles and associated chemicals, e.g. – through probabilistic exposure assessment, hazard characterization, and physiologically based kinetic modelling.

This poster aims to solicit feedback from the scientific community on critical data needs, methodological innovations, and opportunities for harmonization. OEHHA's goal is to foster discussion and collaboration as we work toward a transparent, actionable, and scientifically credible framework for assessing the health risks of microplastics in drinking and bottled water.

50. Micro- and Nanoplastics (MNPs) in the Human Reproductive Tract: Blank-Corrected Polymer Burdens in Follicular Fluid and Endometrium Associate with IVF Endpoints and Path-Confirmed Polyps

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Objective: To quantify micro- and nanoplastic (MNP) polymers in follicular fluid (FF, µg/mL) and endometrium (µg/g tissue) using blank-corrected pyrolysis-GC/MS, and to examine associations with IVF outcomes and endometrial pathology. Design: Cross-sectional analyses of prospectively collected FF and clinically indicated endometrial specimens from a single academic center.

Materials and Methods: Twelve polymers were quantified using Py-GC/MS. QC/contamination control included specimen collection procedural blanks, 0.2-µm filtered solvents, polymer-specific calibration curves, and a positive-pressure hood. Blank subtraction was performed for each batch on a polymer basis; negative values were set to zero and flagged. LOD/LOQ were estimated from blank distributions (LOD≈mean_blank+3SD; LOQ≈mean_blank+10SD). Exposures were log10(x+1)-transformed and scaled by IQR. Outcomes included fertilization and blastulation rates (%) and pathologist-confirmed endometrial polyps (yes/no). Models involved beta regression (logit link) for rates and logistic regression (Firth when needed) for binary variables, adjusted for maternal age and BMI at retrieval (centered), as well as male-factor infertility; race/ethnicity were assessed in sensitivity analyses. Multiplicity was controlled through permutation-FDR (q_perm<0.10 as primary) within outcome families; BH-FDR and nominal p-values are presented additionally.

Results: FF cohort (n=40 fertilization; n=39 blastulation). Higher nylon-6 (N6) was associated with lower fertilization (Δ=−6.29 percentage points (pp) per IQR, 95% CI −11.3 to −1.3; p=0.0168; q_perm=0.033) and lower blastulation (Δ=−7.71 pp, 95% CI −14.3 to −1.1; p=0.0228; q_perm=0.085). Higher polyethylene terephthalate (PET) was linked to lower fertilization (Δ=−12.16 pp, 95% CI −22.2 to −2.1; p=0.0200; q_perm=0.033). Endometrium cohort (n=26; 11 path-confirmed polyps/15 controls). Polyvinyl chloride (PVC) burden was tied to path-confirmed polyp (ORIQR=2.80, 95% CI 1.03–7.61; p=0.043; q_perm=0.011). PU (ORIQR=3.50; q_perm=0.066) and styrene-butadiene rubber (SBR) (ORIQR=3.67; q_perm=0.069) were flagged by permutation-FDR. Findings remained consistent after subtracting blanks, handling LOQ, and using different covariate sets.

Conclusions: After thorough blank correction and permutation-FDR control, FF PET and N6 are linked to reduced fertilization rates (with N6 also associated with lower blastulation), and endometrial PVC is connected to path-confirmed polyps. Results support a comprehensive, polymer-specific exposure framework for REI outcomes.

Impact Statement: To our knowledge, this is the first REI study to combine blank-corrected, polymer-resolved Py-GC/MS with outcome-focused modeling across both FF and endometrium. Using contamination control and permutation FDR provides a rigorous framework for future human MNP health outcome research.

51. Accumulation of Micro- and Nanoplastics in Human Cerebral Spinal Fluid

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Plastics are emerging pollutants of growing concern due to their ubiquitous presence and potential toxicity to human health, but remain poorly understood. As plastics degrade, they release microplastics (<5 mm) and nanoplastics (<1μm), collectively referred to as MNPs, which can enter the human body through ingestion, inhalation, and dermal contact. Recent studies suggested that MNPs may have the ability to cross biological membranes such as the blood–brain barrier (BBB). A recent study detected MNPs in the cerebrospinal fluid (CSF) of 28 participants using pyrolysis-gas chromatography mass spectrometry (Py-GC/MS) and laser direct infrared imaging (LDIR), confirming that PS, PE, PP, and PVC can reach the central nervous system (CNS). Participants with CNS infections had elevated interleukin-6 (IL-6) and interleukin-8 (IL-8) levels, suggesting a connection between MNPs accumulation and BBB integrity. We used stimulated Raman spectroscopy (SRS) to quantify MNPs and identify plastic types. Compared to LDIR's detection limit (10 μm), SRS' greater sensitivity (0.2 μm) allows the quantification of not only micro, but also nanoplastics. Particle size plays a crucial role in toxicity since smaller particles may have a greater ability to cross biological barriers. Our preliminary data from 10 participants without biomarkers of BBB disruption showed that MNP concentrations in CSF increased with age, but this trend may not persist with a larger sample size. Participants over 70 had an average of ($1.04 \times 10^6 \pm 4.77 \times 10^5$), while those under 70 had ($2.42 \times 10^5 \pm 4.72 \times 10^4$) MNPs per mL. Both groups had higher levels than artificial CSF controls, which averaged ($3.68 \times 10^4 \pm 1.29 \times 10^4$ MNPs/mL). Detected polymers included PVC, PE, PMMA, PA66, PP, and PS, with PVC being most abundant. Nanoplastics accounted for 88% of the total particles with the remaining (12%) being microplastics. Further research is needed to understand MNP accumulation, entry pathways, and neurotoxic effects.

52. Human Inhalation of Microplastic and Nanoplastic from E-cigs

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Electronic cigarettes (e-cigs), which heat liquids to generate inhaled aerosol vapors, have become increasingly popular worldwide, particularly among younger populations. While plastics account for up to 80% of the device's main material besides metal, the potential release and inhalation of microplastics (MPs) and nanoplastics (NPs) during e-cig use remains poorly understood. Inhalation exposure is especially concerning, as the respiratory tract may serve as a direct entry pathway for these small plastic particles into the human body, raising potential health risks. In this study, we systematically investigated the occurrence and characteristics of MPs and NPs released from aerosols of different commercial e-cigarette brands (e.g., Vuse and Eleaf) under varying heating conditions. Aerosol samples were collected and analyzed using a combination of stimulated Raman scattering (SRS) microscopy and pyrolysis–gas chromatography–mass spectrometry (py-GCMS), providing complementary information on particle morphology and polymer composition. Prior to analysis, aerosol aliquots (200 μL) were dispersed with Milli-Q water (900 μL) and menthol (900 μL), then filtered through 0.2 μm Anodisc or silver membranes. Our results revealed that the abundance of NPs in Vuse aerosols was approximately three times higher than in Eleaf aerosols, highlighting brand-specific differences in material release. In agreement with previous studies

showing the use of polycarbonate in casings and nylon in wicks (Turner et al., 2024), we identified PA66, PMMA, and PE as the dominant polymer types among the detected NPs. Moreover, more than 90% of the particles detected across all brands were smaller than 1 µm, underscoring the predominance of nanoscale plastics in the inhalable fraction. These findings provide the first detailed evidence that e-cigarettes can be a significant source of inhaled NPs. Given their small size, such particles may penetrate deep into the respiratory system, potentially exerting toxicological effects. This study highlights the urgent need for further toxicological evaluation and regulatory attention to assess the implications of e-cigarette-derived NP exposure on human health.

53. Micro- and Nanoplastics in the Environment: Insights from the Degradation of Fossil fuel- and Bio-Based Plastics

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Plastic pollution is a widespread environmental issue, and significant attention has been given to breakdown into micro- and nanoplastics (MNPs). While several valid methods have been developed for detecting microplastics in the environment, the detection of nanoplastics remains a significant challenge. This leads to uncertainty about realistic concentrations and properties of nanoplastics in the environment. Our current method for creating MNPs involves the use of a cryogenic mill, which produces both micro- and nanoplastic particles in a matter of hours. However, it is important to consider the environmental realism of the shape, size, and concentration of these particles. Here, we compare particles created from cryogenic milling to those generated through degradation in a simulated freshwater environment. We hypothesize that bioplastics generate more micro- and nanoparticles compared to fossil-fuel-based plastics across all three degradation techniques. Thus far, we have observed that PHB (bioplastic) produces more microplastic particles compared with polypropylene (fossil-fuel based plastic) and polylactic acid (bioplastic) after 170 days in a simulated freshwater environment. Future work will involve conducting 72-hour algal assays using Raphidocelis subcapitata comparing the ecotoxicity of particles generated by the three techniques, as it is well known that particle shape and size often influences toxicity.

54. Role of ApoEε3/4 variants in modifying endothelial uptake and toxicity of microplastics derived from the Pacific Gyre

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Micro- and nanoplastics (MNPs) are emerging environmental pollutants with the potential to affect human health and contribute to diseases. Increasing evidence shows that MNPs accumulate in human organs, especially the brain, and their levels are rising over time. MNPs can cross the blood-brain barrier and stay as nanoscale fragments within brain tissue. Notably, concentrations of MNPs are higher in the brains of people with dementia, including Alzheimer's disease, compared to those without neurodegenerative conditions. This specific buildup may disrupt cerebrovascular walls and impair immune cell function, raising important questions about the role of environmental exposure in disease development. There is an urgent need to understand how MNPs enter brain cells, a process that is still being clarified. ApoEε4, the strongest genetic risk factor for Alzheimer's disease, not only disrupts lipid metabolism but also decreases the clearance of amyloid-beta and promotes neuroinflammation. Over recent decades, research has focused on how ApoEε4 interacts with lifestyle factors, but there is a lack of studies on how MNPs interact with ApoEε4. Aim of the Study: The objective of the study is to investigate the effect of aged and unaged microplastics on primary human brain microvascular endothelial cells and how ApoEε3 or ApoEε4 proteins may modify these interactions. Methods: Environmental micro-nanoparticles (MNPs) derived from plastics obtained from the Pacific Gyre were labeled with Rhodamine B dye. Primary human brain microvascular endothelial cells were exposed to 10 µg/ml of either UV-aged and unaged MNPs, with or without dispersion media containing ApoEε3 or

ApoEε4 lipoproteins. After 24h exposure, the integrity of the cell barrier and wound healing were monitored using the Electrical Cell Impedance System (ECIS). Localization of the MNPs was confirmed with confocal microscopy using Z-Stack analysis. The cellular uptake of Rhodamine B-dyed MNPs was quantified using the AMNIS flow cytometry imaging system. Results: Confocal imaging showed that cells uptake Rhodamine B-dyed microplastics, and Z-stack analysis verified their presence inside the cells. The cell behavior analysis indicated that aged microplastics in the presence of ApoEε4 impaired cell migration in the wound healing assay than microplastics with ApoEε3 or microplastics alone. Additionally, the uptake of aged microplastics was higher in the presence of ApoEε4 compared to either ApoEε3 or microplastics alone in primary human brain microvascular endothelial cells. Conclusions: This study concludes that the ApoEε4 apolipoprotein, which likely carries microplastics in the circulation, may influence the biological effects of MNPs on neurovascular endothelial cells as well as the passage into the brain itself. This creates a novel Gene-environment interaction (GxE) paradigm that could, in part, explain the dementia risk incurred by the ApoEε4 variant.

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55. Chylomicron-Mediated Translocation of Oxidized Nano- and Microplastics into the Circulatory System and Human Heart Tissue and Arteries.

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Rising global concentrations of environmental microplastics and nanoplastics (MNPs) raise significant concerns regarding human exposure and long-term health outcomes. Previous studies from our group demonstrated widespread MNP deposition across multiple organs. In this study, we investigated intestinal absorption and systemic transport pathways that enable MNP entry into the circulatory system and subsequent accumulation of distinct MNPs in the human heart and cardiovascular system.

MNPs primarily enter the human body through ingestion of contaminated food and water. We hypothesized that nanoplastics, which have comparable chemical structure to free fatty acids and bind to monoglycerides, will become packaged within the small intestine into chylomicron complexes by enterocytes. Using fluorescently labeled MNPs of varying sizes, we observed that gavaged 500 nm polystyrene particles could be found co-localized in the chylomicron fraction of serum but not in VLDL/IDL/LDL fractions 4h post exposure. Interestingly, 1 µm particles were not detected in any fraction of the serum. These findings suggest a size–dependent mechanism of MNP trafficking within chylomicrons.

Further work in human cadaver samples has been initiated to confirm that MNPs enter lacteals, pass through mesenteric lymphatic vessels, and merging into the thoracic duct before finally draining into the left subclavian vein, the gateway to the circulatory system. We quantified the MNP burden and confirmed their presence within lipid-dependent cardiac tissue samples obtained from 24 different human hearts and 37 different human heart arteries using pyrolysis gas chromatography–mass spectrometry (Py-GC/MS). MNPs were further confirmed by complementary analytical techniques including Fourier-transform infrared (FTIR) spectroscopy, Raman spectroscopy, and transmission electron microscopy (TEM).

Collectively, our data supports a novel mechanistic model in which oxidized nanoplastics exploit lipid absorption pathways to reach systemic circulation and partially accumulate in cardiac tissue. These findings underscore the need for further investigation into MNP–lipid interactions and their implications for cardiovascular health.

56. Multi-Omic Evidence of Respiratory Toxicity from Tire-Derived Microplastics

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Microplastics (MPs) have become a pervasive and persistent contaminant across freshwater, marine, soil, and atmospheric environments. Humans rely on these resources for clean food, water, and air, yet they now contribute to increased MP exposure. Due to the increasing studies demonstrating MPs in various compartments of the body (lung, brain, heart, placenta, etc.), the need to understand the human health effects of microplastics is imperative. Health concerns from MPs include their ability to transport to different parts of the body, physical characteristics, potentially toxic chemical additives released, and ability to harbor bacteria and viruses that may evade immune defenses. One of the largest but often overlooked sources of MPs is tire wear particles from automotive vehicles, estimated to contribute 26–74% of total global MP pollution. Recycled tire crumbs used in athletic fields, recreational areas, and playgrounds also represent an important exposure source. Tire particles contain additives such as carbon black, plasticizers, vulcanizers, antioxidants, and activators—many with poorly

In this study, we applied a multi-omic approach to investigate the impacts of tire-derived microplastics (MPs) in two upper-respiratory human cell models. Tire particles (<45 µm) were leached in culture media for 24 hours and subsequently administered at concentrations of 0, 50, 100, and 150 µg/mL to human alveolar carcinoma cells (A549) and human bronchial epithelial cells (BBMs). Over a three-day period, we assessed cell proliferation, viability, and reactive oxygen species (ROS) generation using live-cell imaging, as well as inflammatory cytokine release using a multiplex assay. Exposure to tire particle leachates induced concentration- and cell type–dependent increases in proliferation, ROS production, and cytokine release. Furthermore, Media and cell extracts were analyzed using a Thermo Fisher Scientific Vanquish Flex UHPLC coupled to an Exploris 480 Orbitrap High Resolution Mass Spectrometer. Non-targeted analysis revealed cellular uptake of diverse tire additives, including corrosion inhibitors, process regulators, antioxidants, adhesives, and transformation products. Notably, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine quinone (6PPD-quinone)—a toxic environmental transformation product of a common tire antioxidant—was detected in exposed cells. Additional structurally annotated chemicals were linked to hazards such as acute toxicity, skin irritation, and reproductive harm. In addition to upregulation of specific cellular metabolites with tire leachate dosing, bottom-up proteomic analysis identified a novel protein biomarker of airway exposure to quinone-derived tire-associated chemicals. Collectively, these findings underscore the potential human health risks posed by tire-derived microplastics as an emerging global and regional air pollutant.

57. An exposomic analytical framework for measuring micro- and nano- plastic in human biospecimens.

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Objectives: Micro- and nanoplastics (MNPs) are an emerging concern for human health that have been reported in a wide range of human tissues and biological fluids. Despite growing evidence of their exposure in human populations, standardized methods for detecting MNPs are still lacking. Existing detection strategies typically focus on a limited set of polymers or additives, failing to capture the full diversity of nanoplastics and associated compounds, and are limited by throughput and sensitivity for detecting a wide range of particle sizes.

Materials and Methods: In this work, we present a comprehensive analytical framework for MNP biomonitoring in human specimens that integrates sample pretreatment, microplastic separation and enrichment, and MNPs measurement using Pyrolysis-GC/HRMS. This framework enables a detailed and reliable characterization of polymers present in biological samples.

Results: Three major highlights of this work are: (1) Exposomic analytical framework: Established a comprehensive framework for measuring MNPs in human biospecimens. Method validation confirmed reliable recovery of MNPs at various analytical stages, providing a robust basis for improving and quantitatively evaluating MNP measurement in human samples. (2) Quantitative accuracy and efficiency: Achieved accurate and efficient detection and quantification of 12 types of MNPs: PMMA, N66, PP, PVC, PE, N6, PET, PU, PC, ABS, PS, and SBR, with corresponding limits of detection of 0.005, 0.020, 0.048, 0.255, 0.337, 0.007, 0.013, 0.009, 0.156, 0.016, 0.020, and 0.020 µg, respectively. (3) Comprehensive chemical monitoring: Demonstrated the ability to simultaneously monitor and detect more than 10,000 plastic-associated additives and chemicals.

Conclusions: This platform represents a significant advancement in the detection of MNPs and offers a scalable solution for assessing plastic exposure in human populations.

Keywords: Microplastics, Exposome, Assay Development, Biomonitoring, Reproductive Health.
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58. Detection and Quantification of Microplastics in Human and Murine Lung Tissue

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Micro and Nanoplastics (MNPs) are a persistent environmental pollutant which have been detected in several human tissue types, and notably, in the human lungs (Amato-Lourenço et al., 2021). Rising concentrations of these polymers suggest new concerns for human health outcomes considering the increase in chronic pulmonary disease diagnoses (Boers et al., 2023). Due to the extremely expansive surface area and large air volume expected to be filtered by the lungs, pulmonary MP accumulation remains a highly interesting and understudied topic (Ananda Rao & Johncy, 2022). A variety of quantitative and qualitative methods have demonstrated the presence of MNPs of varying polymer types, with the largest fraction typically being polyethylene (Nihart et al., 2025). While qualitative methods allow for rapid identification of individual fibers, Py-GC/MS specifically allows for total-tissue MNP recovery, as many of the suspected particles are below the size of detection for µFTIR/Raman spectrometry. Questions remain regarding the relative accuracy of Py-GC/MS data, given the potential difficulty in matrix-plastic separation. Several steps are taken to validate the prescence of MNPs, as well as establishing novel benchmark polymers which are resistant to lipid-polymer contamination. Among lung tissue, relative concentrations of Styrene-Butadiene Rubber (SBR) appear to be higher compared with findings of other tissue types, suggesting an alternative uptake mechanism. SBR may also serve as a benchmark polymer for lung analysis, due to its persistence throughout lipid-eliminating procedures. In comparing 2016 ($\bar{x}$=143.3 µg/g) and 2024 ($\bar{x}$=287.5 µg/g), Polyethylene remains the most abundant polymer, which was significantly higher in 2024, compared with 2016 (95% CI, 32.14–256.3; P=0.0133). Relative to other human tissue types (brain, kidney, liver), lung tissue has a higher percent SBR by mass when compared with the brain and kidney (mean difference 4.044, 4.149; 95% CI, 1.395–6.692 and 1.379–6.920; P = 0.0009, 0.0012). Mouse lung samples demonstrated similar concentrations by mass of SBR compared with human lungs, with a greater proportion in human lungs (95% CI, -3.887– -0.08832; P = 0.0405). Polyvinyl Chloride (PVC) was found to be significantly elevated in mouse lungs compared with human lungs (95% CI, -17.12 – -13.57, P<0.0001). Finally, Cyclohexane, a nonpolar solvent is introduced with the intent to remove any lipid matrix interference. Post-solvent extraction demonstrated significant

reduction only with polyethylene, with all other polymers remaining as non significant reductions after filtration (95% CI, 222.7–343.6, P<0.0001).

59. Source apportionment and risk assessment of microplastics and nanoplastics in the glaciers of the North-Western Himalayas

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Microplastics (MPs) and nanoplastics (NPs) have been largely studied in marine environments, but there lies a significant gap in assessing their occurrence and impacts in glacier environments. This study investigates the occurrence and pollution risks of MPs and NPs in glaciers, suspended air, and dry deposition across the northwestern Himalayas. MPs concentration ranged from 1000 particles m-3 in Kolahai glacier to 151000 particles m-3 in Thajwas glacier. In suspended air, MPs occurred at 5 particles m-3, while dry deposition samples showed a concentration ranging from 1-13 particles m-2 d-1. Dynamic light scattering (DLS) confirmed the presence of NPs in all glaciers, with sizes varying between 31-689 nm in Thajwas glacier and 360-953 nm in Harmukh glacier. HYSPLIT modelling revealed that air masses reaching Himalayan glaciers predominantly originate from global sources (75%). The pollution load index (PLI) ranged from 3.9 (hazard category I) to 40 (hazard category IV), indicating moderate to excessive pollution of glaciers. While as polymer hazard index (PHI) ranged from 10 (hazard category II) to 1987 (hazard category V), indicating medium to extreme danger due to presence of polyvinyl chloride (PVC) and polyacrylonitrile (PAN). The presence of MPs and NPs accelerate glacier melting due to their light absorbing properties underscoring need for further studies.

60. DIY Microplastic Detectives: Visualizing plastics with fluorescence

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Oglala Lakota College

The purpose of this project is to design low cost DIY methods for citizen science detection of microplastics in the environment. The research includes classification of the properties of different types of plastics and modeling the fluorescence of plastics using, Red Nile Dye, as well as a DIY light box that uses blue light and an orange filter.

61. From Dogs to Humans: Micro-Nanoplastic Bioaccumulation in Testes and Semen and Its Impact on Sperm Quality

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Background: The global decline in sperm counts, rising rates of testicular dysgenesis syndrome, and the rising prevalence of male infertility raise urgent questions about environmental contributors to reproductive dysfunction. Micro-nanoplastics (MNPs) may penetrate the blood–testis barrier and bioaccumulate in reproductive organs, potentially impairing fertility.

Objectives: This study aimed to quantify and characterize MNPs in sentinel canine models and human reproductive tissues and assess their resulting impact on sperm quality.

Methods: Reproductive tissues (47 canine; 23 human testes) were analyzed using pyrolysis gas chromatography/mass spectrometry (Py-GC/MS) for polymer identification and quantification. Semen samples from fertile (n=8) and infertile (n=8) men underwent Py-GC/MS and functional assessments, including sperm motility, morphology, and mitochondrial ultrastructure.

Results: MNPs were detected in all canine and human testes examined, with concentrations ranging from 126 µg/g in dogs to 696 µg/g in humans. Polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polyethylene terephthalate (PET) were dominant polymers, reflecting diverse environmental sources. In canines, higher MNPs tissue burdens correlated with reduced testis weights, altered motility kinetics, and abnormalities in mitochondrial midpiece. Elevated lipid peroxidation was observed in sperm from high MNPs animals, indicating oxidative stress. Human testis samples showed pervasive MNPs accumulation across all ages, suggesting widespread exposure independent of age. While semen contained lower but significant MNPs levels (~109 µg/ml median), preliminary comparisons revealed a trend toward higher microplastic burdens in the infertile group compared to the fertile group although this finding requires further statistical validation with large sample size.

Conclusion: This study provides the first comparative and translational evidence of MNPs bioaccumulation across canine and human reproductive systems, linking plastic burdens to impaired reproductive parameters in canines and suggestive associations in humans. Companion animals may serve as valuable sentinels for environmental reproductive risks. These findings underscore the urgent need for standardized methodologies, expanded cohorts, and targeted mechanistic studies to clarify the role of MNPs in the global declining male fertility.

62. Big conversations about tiny plastics: NGO communication strategies and public perceptions data on microplastics and health

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Natural Resources Defense Council

NRDC works to safeguard the earth—its people, its plants and animals, and the natural systems on which all life depends. With the expertise of scientists, lawyers, and other environmental specialists, our team is working to reduce plastic production, minimize the harm of plastic that is produced, and spark increased public concern about plastic pollution. We have recently published a fact sheet on the potential harms associated with microplastics. The fact sheet is meant to be both a comprehensive and easily accessible summary of the broad landscape of microplastics research for interested media and policy makers. However, with over 70 endnotes it is not likely to be useful for individual consumers, who often ask what they can do to reduce their own exposures. Therefore we also published an accompanying consumer guide with ten ways to reduce your (and your family's) exposure to microplastics. As we were publishing these resources we wanted to better understand the public's concerns related to microplastics. Partnering with Swayable, we surveyed 2,978 people nationally, asking baseline questions about their concerns and knowledge of the science of microplastics. Then, using a randomized control trial design, some participants viewed content from the NRDC consumer guide and others viewed unrelated content. Participants were then asked additional questions to see if their perceptions regarding microplastics changed after viewing content from the consumer guide. Overall, respondents were mostly concerned with the presence of microplastics in drinking water, in food and in the human body (versus in the ocean or consumer products). The majority of people, 81.6%, say they are "very concerned" or "somewhat concerned" about "the chemicals leaching from the microplastics." Exposure to the consumer guide reinforced this concern. Respondents ranked their concern for specific health impacts related to microplastics exposure on a scale of 0-100 (0 being "Not at all Concerned" and 100 being "Very Concerned"). Respondents were most concerned about the impact microplastics have on the brain (74.1), the heart and cardiovascular system (73.4), the hormone/endocrine systems (70.2), and finally, on fertility and reproduction (67.4). The polling also highlighted that most respondents were not aware of some major sources of microplastics, including clothing

and kitchenware. Furthermore, when asked who they thought was most responsible for microplastics, respondents ranked the oil and gas industry as most responsible (25%), followed by retailers (23.7%), consumers (22.6%), and governments (20%). Overall, our polling reinforces that the general public is very concerned about the presence of microplastics. It also highlighted that the consumer guide was effective in educating the public about sources of microplastics they had not previously considered. We will use this feedback to inform our future science and policy resources.

63. Using narrative portraiture to understand experiences of plastics in the UNESCO Biosphere Reserve of Menorca (Spain)

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At this point, the harms of plastics-derived pollution throughout the plastic life cycle are well documented in the peer-reviewed literature. When it comes to humans, plastics' impacts range from the cellular to the socio-cultural. Plastics pollution is a global environmental injustice given the inequitable distributions of its harms and benefits. Plastics pollution is now considered to be ubiquitous in the global environment, and for all the awareness of plastics pollution and policies to ban or regulate plastics in certain applications, plastics production shows no sign of slowing. This research draws from 15 years of a transdisciplinary action research process called Zero Plastic in Biosphere Reserves, and presents findings from an innovative arts-based method for exploring ways in which people are impacted by and responding to plastics pollution as individuals and collectives, with the intention of answering the question: “What do we do about plastics pollution?” We will share our findings from developing and applying the draMatIzed naRRative pORtraiture (MIRROR) method to understand experiences of rapid global change through the case study example of plastics on the island and UNESCO Biosphere Reserve of Menorca (Balearic Islands, Spain). Through the resulting narrative portraits of 11 study participants, we gain insights into the stories that allow them to "hold their own" in their efforts to address plastics pollution and live with ongoing socioecological changes to their island, their well-being, and their way of life.

64. Paths and Perils of Communication: Talking to the Public about Microplastics Research

Megan J. Wolff, Emily Sbiroli, Samantha Romanick, Julia Cohen
Physician and Scientist Network Addressing Plastics and Health (P-SNAP)

The presence of microplastics in human tissue is a prominent feature of the news cycle, and has been received with a great deal of public concern. People around the world are looking for guidance, and asking questions of virtually anyone who could be considered an expert, from physicians and researchers to internet influencers. The shape these answers take can have the capacity to influence not only personal behavior and market strategy, but also regulatory policy and even trust in science and medicine themselves.

Therefore, the messages and the messengers matter. Those with medical or scientific training can be among the most influential voices in this discussion. Even in a partisan society, research demonstrates that physicians and researchers are disproportionately trusted. Research – though mounting – is nascent, and interpretations of the data vary. How, then, should communication be framed?

This panel will draw together a range of public-facing professionals to talk about the ways in which they communicate plastics-related research findings to outside audiences. What questions are they being asked? Which audiences do they think are important, and why? Are these different from audiences that researchers might think important? Each panelist will speak briefly about their experience and insight, followed by a moderated group discussion and a question and answer period with the audience.

65. Experimental models to test causal relationships between MNP exposure and Alzheimer's disease pathology

Brandon Pearson
Oregon State University

Experimental models to test causal relationships between MNP exposure and Alzheimer's disease pathology
Emerging research demonstrates that micro- and nanoplastics (MNP) are abundant in human tissues including the brain. Plastics levels were shown to be higher in post-mortem tissue from dementia patients. However, it is not clear if MNP causally contribute to dementia and Alzheimer's and if so, whether it is through actions on core pathological AD features such as amyloid beta plaques and tau tangles or through upstream or generic cellular toxicity pathways. Enhanced Alzheimer's disease (AD) like pathology was elicited with oral administration of MNP in transgenic AD mouse models. MNP facilitate the fibrillization of amyloid beta in vitro. Thus, there is suggestive experimental support that MNP may act on core pathological features of AD. Existing experimental systems almost exclusively rely on pristine polystyrene spheres which limits interpretation and translational relevance relative to environmental MNP made up of other polymers, shapes, adsorbed chemical mixtures and co-exposures, and weathering states. Since many environmental neurotoxicants show low oral bioavailability, we have investigated the potential of nanoplastics to act as carriers to increase their brain bioavailability. We contrasted four neurotoxic pesticides varying in their lipophilic properties (LogP -0.5 – 4.9) and showed that the most liphophilic (rotenone and fenpyroximate) show synergistic toxicity with co-exposure to 50 nm PS spheres as measured by cell death in primary embryonic mouse cortical cells. In contrast, paraquat and endothall did not show synergistic cytotoxicity. Finally, while we have shown that 50 nm PS and PMMA spheres both accelerate beta amyloid fibril formation in cell free assays, we are investigating this phenomenon in cortical cell-based preparations to determine if MNP influence amyloid beta aggregation in more physiological conditions and under in vitro conditions that polymer screening and evaluations of various mixtures, polymers, and particle shapes and sizes.

66. Plastic aging and its impact on fragmentation and additive release

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Plastics often contain a wide variety of chemical additives as well as non-intentionally added substances such as degradation products, reaction by-products and/or impurities. Since these other chemicals are not generally covalently bound to the polymer matrix, they may leach out of the plastic. These leached chemicals include bisphenol A, phthalates, nonylphenols, brominated flame retardants, to name a few. Also, nanomaterials are sometimes incorporated as nanofillers into polymer formulations to enhance existing properties or to add new properties of interest in the products made from these plastic composites.

This presentation presents a modeling framework for describing additive release from plastics that considers the role of plastic fragmentation in increasing surface area and release rates over time and methods for parameterizing the models from plastic abrasion and additive leaching experiments. Derivations of mechanical stresses on plastics as a function of power input are related to rate constants in a population balance on plastic particle number distributions. The leaching of additives from homogeneous plastic spheres is estimated as function of fragment size and environmental conditions and the implications for exposure to additives are discussed. Data of weathering of plastics will be summarized and a framework for modeling weathering and its impact on fragmentation rate will be presented focusing on the impact increased fragmentation rate on additive release.

67. The State of Global Policy on Microplastics

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Plastic Pollution Coalition

Microplastics are an immense planetary challenge, and thus to date hundreds of policies focused on monitoring and reducing both occurrence and environmental impacts have been implemented or proposed at the regional, national, and global levels. This session will include presentations from leaders at several U.S. based NGOs, including the Plastic Pollution Coalition, The 5 Gyres Institute, and The Pew Charitable Trusts, summarizing recent and current policy efforts with a focus specifically on microplastics in the US, local states, and global policy landscape.

Panelists will present on the the Global Plastic Laws database, the #MicroplasticsFreeUS campaign, Pew's Breaking the Plastic Wave 2025 report, as well as efforts by the Scientists Coalition for an Effective Plastics Treaty; and how these activities are linked to recent relevant research developments. The session will close with an opportunity to discuss the future of microplastics research and policy, and how transdisciplinary collaboration can lead to science-informed policy.

68. Integrating Environmental Aging and Cryomilling to Model Realistic Micro- and Nanoplastic Exposure Pathways

Nohi Leyva, Laurissa Barela, Emily Phan, Milad MazloumiBakhshayesh, Eve Rowland, Sakshi Patil, Sumira Phatak, Jessica Begay, Eliane EL Hayek, Matthew J. Campen, Marcus A. Garcia
Department of Pharmaceutical Sciences, College of Pharmacy, University of New Mexico Health Sciences

Plastic pollution has evolved from a visible environmental issue to an invisible and complex global health concern. As larger debris breaks down due to aging, oxidation, and mechanical degradation, millions of tons of plastic debris have fragmented into micro (μm) and nanoscale (nm) particles, yet most toxicological research continues to rely on pristine, laboratory-generated plastics that fail to capture the true complexity of environmental aging. This limitation reduces the ability to assess real-world exposure and health risks. To address this gap, our study advances a new paradigm focused on environmentally relevant micro- and nanoplastics (MNPs) that have undergone natural weathering and degradation within the marine ecosystem.

By harvesting plastics directly from oceanic environments, we preserve realistic aging phenomena including ultraviolet (UV) exposure, oxidation, saltwater interactions, and physical abrasion that laboratory-only approaches often fail to replicate. The collected plastic fragments were subjected to controlled UV aging (continuous exposure) to further mimic months of marine photochemical and mechanical stress. Following aging, fragments were cryogenically ground using a cryomill approach, enabling recovery of particles down to 1 μm and routinely reducing most material to ~500 μm, a size highly relevant for biological uptake. Using these environmentally relevant particles, we are advancing both in vivo and in vitro models to characterize how realistic MNPs behave once introduced into biological systems. These Models enable detailed investigation of particle uptake, biodistribution, and toxicological outcomes across multiple organ systems. Chemical analysis using pyrolysis GC/MS further revealed significant molecular changes associated with environmental weathering, most notably a marked reduction in long chain carbon fragments that are typically abundant in pristine, scientific grade polymers. This provides a clear analytical distinction between environmentally aged particles and their lab generated counterparts.

Our initial findings demonstrate that aged plastics, through prolonged environmental exposure, exhibit increased brittleness and fragmentation, leading to higher yields of fine particles in the nano to micro range, a critical pre-condition for bioavailability. When applied in organ-level studies, these particles demonstrate accumulation within specific organ

systems, aligning with ongoing research performed within our lab as well as when identifying accumulation in human tissues. Ultimately, these findings and utilization of environmentally relevant particles advance our mechanistic understanding of how MNPs enter and distribute within biological systems, thereby informing risk assessment frameworks for biological models and allows for a better understanding of how chronic, real-world exposures may influence overall health.

69. A state-of-the-science review of micro and nanoplastics in water and challenges to better understand their potential impact on human health

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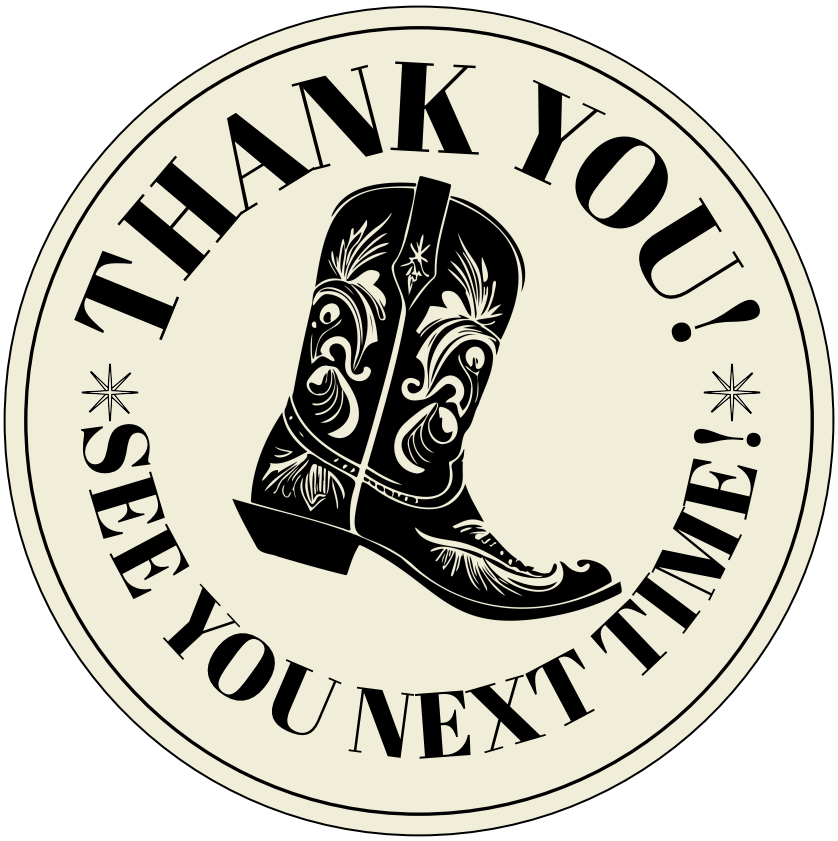
Understanding human exposure to micro- and nanoplastics (MNPs) in water, and other environmental media, is of growing public interest. Findings of multiple studies show that MNPs are present in different water matrices but understanding how MNPs contaminate freshwater and drinking water is important to minimize exposures. Thus, a review team at CDC conducted and published a state-of-the-science review on MNPs in water and potential health effects. Findings of the review indicate that (i) no direct association between human exposure to MNPs in water and health effects, (ii) physical and chemical characteristics of MNPs have the potential to harm human health, and (iii) sampling and analytical methods are diverse and not fully described. These findings revealed that the challenges for advancing our understanding of human exposure to MNPs in water and their potential health effects can be tackled. In the absence of standard methods for sampling and fully characterizing MNPs in environmental and biological samples, detailed description of methods and working collaboratively become of upmost importance.


THANK YOU!
SEE YOU NEXT TIME!