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**AIR POLLUTION AND DEMENTIA SYMPOSIUM**  
**MARCH 15, 2021, 11:00AM – 1:00PM EST**  
Briefing Packet

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## INTRODUCTION

Thank you for participating in *Air Pollution and Dementia: Bridging Disciplines to Identify Mechanisms*, a symposium hosted by the Harvard T.H. Chan School of Public Health and Biogen. We are thrilled that you are able to participate in this important session.

Today marks the beginning of Brain Awareness Week, a global celebration of the ongoing work to advance brain health. Fostering a deeper understanding of brain health is crucial to equipping health systems with the necessary tools to address dementia and cognitive decline. As a result, today's convening of experts serves as a launchpad to explore the current state of the literature on air pollution and dementia. With input based on your expertise, our work will culminate in a scientific consensus paper that will be released in the fall. We appreciate your participation.

In this briefing packet, you will find details on the following:

- Symposium objectives & agenda
- Key questions for consideration
- Speaker biographies & recommended readings
- Host information
- Issue overview
- Further reading

Please do note, while this information is helpful to review, review of this packet is not mandatory for attendance. The symposium will provide background on the issue for all attendees.

## MEETING OBJECTIVES AND AGENDA

### Symposium objectives

- *Cultivate an interdisciplinary understanding of the effects of air pollutant exposures on brain health in older age in humans.*
- *Identify the most critical direction of new research in the near future in order to further our collective understanding of how air pollution affects brain health.*

### Symposium agenda (11:00 am – 1:00 pm)

11:00 am	Introduction by Marc Weisskopf, Harvard Chan-NIEHS Center for Environmental Health
11:10 am	Presentation: <i>“Epidemiology of Air Pollution, Dementia, and Related Outcomes,”</i> Melinda Power, George Washington University Milken Institute of Public Health
11:30 am	Brief Q&A
11:35 am	Presentation: <i>“Causality of Particulate Air Pollution for Mental Illness,”</i> Günter Oberdörster, University of Rochester Medical Center
11:55 am	Brief Q&A
12:00 pm	Presentation: <i>“MODEL-AD: Modeling Environmental Influences in Transgenic Mouse Models of LOAD,”</i> Gareth Howell, The Jackson Laboratory
12:20 pm	Brief Q&A
12:25 pm	Panel discussion
12:55 pm	Closing remarks

## KEY QUESTIONS FOR CONSIDERATION

During and following the session we ask that you consider the following three questions. After the session’s conclusion, based on the discussion and your particular area of expertise, please share any thoughts you may have on the below. Your feedback will be used to inform the consensus paper and future research directions. Please send all feedback and insights to [hatwood@purposecollaborative.com](mailto:hatwood@purposecollaborative.com).

- What questions do you have about the existing data?
- Where do you feel the evidence sits now, what kinds of things would you want to see going forward?
- What do you feel is settled and what needs to happen next?

## SPEAKER BIOGRAPHIES

### Melinda Power, ScD



Dr. Melinda C. Power is an [Associate Professor of Epidemiology](#) at the George Washington University (GWU) Milken Institute School of Public Health. Dr. Power has expertise in statistical analysis of observational data, and a commitment to improving epidemiologic methods in the study of late-life cognition and dementia. Her current research focuses on the role of environmental pollutants in the development of dementia, translation of epidemiologic research to inform clinical trial development, and projects designed to inform clinical practice and health policy around supporting people living with dementia.

Dr. Power is also the founding Director of the GW Institute for Brain Health and Dementia. The Institute aims to promote and support research on cognitive health that will meaningfully impact lives, through promotion of brain health, prevention of cognitive loss, addressing disparities in cognitive health, and improving the quality of life of persons living with dementia and their care partners.

### Recommended Readings

#### [Association Between Cardiovascular Disease and Long-term Exposure to Air Pollution With the Risk of Dementia.](#)

Grande G, Ljungman PLS, Eneroth K, Bellander T, Rizzuto D. JAMA Neurol. 2020 Jul 1;77(7):801-809. doi: 10.1001/jamaneurol.2019.4914. PMID: 32227140; PMCID: PMC7105952.

#### [Traffic-Related Air Pollution and Dementia Incidence in Northern Sweden: A Longitudinal Study.](#)

Oudin A, Forsberg B, Adolfsson AN, Lind N, Modig L, Nordin M, Nordin S, Adolfsson R, Nilsson LG. 2016 Mar;124(3):306-12. doi: 10.1289/ehp.1408322. Epub 2015 Jul 31. PMID: 26305859; PMCID: PMC4786976.

#### [Exposure to air pollution as a potential contributor to cognitive function, cognitive decline, brain imaging, and dementia: A systematic review of epidemiologic research.](#)

Power MC, Adar SD, Yanosky JD, Weuve J. Neurotoxicology. 2016 Sep;56:235-253. doi: 10.1016/j.neuro.2016.06.004. Epub 2016 Jun 18. PMID: 27328897; PMCID: PMC5048530.

#### [The Association of Long-Term Exposure to Particulate Matter Air Pollution with Brain MRI Findings: The ARIC Study.](#)

Power MC, Lamichhane AP, Liao D, Xu X, Jack CR, Gottesman RF, Mosley T, Stewart JD, Yanosky JD, Whitsel EA. Environ Health Perspect. 2018 Feb 16;126(2):027009. doi: 10.1289/EHP2152. PMID: 29467108; PMCID: PMC6066342.

#### [Exposure to particulate air pollution and cognitive decline in older women.](#)

Weuve J, Puett RC, Schwartz J, Yanosky JD, Laden F, Grodstein F. Arch Intern Med. 2012 Feb 13;172(3):219-27. doi: 10.1001/archinternmed.2011.683. PMID: 22332151; PMCID: PMC3622279.

## Günter Oberdörster, DVM, PhD



Günter Oberdörster, DVM, Ph.D., is [Professor Emeritus](#) in the Department of Environmental Medicine at the University of Rochester, has been the Director of an EPA funded University of Rochester Ultrafine Particle Center, PI of a Multidisciplinary Research Initiative in Nanotoxicology and Head of the Pulmonary Core of the NIEHS Center Grant. His research includes the effects and underlying mechanisms of lung injury induced by inhaled non-fibrous and fibrous particles, including extrapolation modeling and risk assessment. His studies with ultrafine particles and engineered nanoparticles influenced the field of inhalation toxicology, raising awareness of the unique biokinetics and toxicological potential of nano-sized particles. He earned his D.V.M. (1964) and Ph.D. (Pharmacology, 1966) from the University of Giessen in Germany. He has served on many national and international committees, and is recipient of several national and international scientific awards. He is on the editorial boards of the *Journal of Aerosol Medicine; Particle & Fibre Toxicology; Nanotoxicology; Toxicology; Nanomaterials and the Environment*, and Associate Editor of *Environmental Health Perspectives*.

### Recommended Readings

[Paraquat Inhalation, a Translationally Relevant Route of Exposure: Disposition to the Brain and Male-Specific Olfactory Impairment in Mice.](#)

Anderson T, Merrill AK, Eckard ML, Marvin E, Conrad K, Welle K, Oberdörster G, Sobolewski M, Cory-Slechta DA. *Toxicol Sci.* 2021 Feb 26;180(1):175-185. doi: 10.1093/toxsci/kfaa183. PMID: 33372994.

[Air Pollution-Related Brain Metal Dyshomeostasis as a Potential Risk Factor for Neurodevelopmental Disorders and Neurodegenerative Diseases.](#)

Cory-Slechta DA, Sobolewski M, Oberdörster G. *Atmosphere.* 2020; 11(10):1098. <https://doi.org/10.3390/atmos11101098>

[Tissue Specific Fate of Nanomaterials by Advanced Analytical Imaging Techniques - A Review.](#)

Graham UM, Dozier AK, Oberdörster G, Yokel RA, Molina R, Brain JD, Pinto JM, Weuve J, Bennett DA. *Chem Res Toxicol.* 2020 May 18;33(5):1145-1162. doi: 10.1021/acs.chemrestox.0c00072. Epub 2020 May 12. PMID: 32349469; PMCID: PMC7774012.

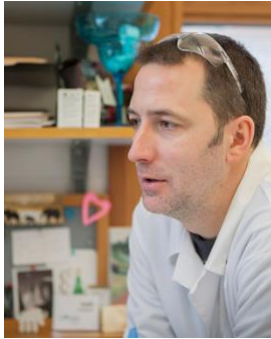
[Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles \[published correction appears in Environ Health Perspect.\]](#)

Oberdörster G, Oberdörster E, Oberdörster J. 2010 Sep;118(9):A380]. *Environ Health Perspect.* 2005;113(7):823-839. doi:10.1289/ehp.7339

[Nanoparticles and the brain: cause for concern?](#)

Oberdörster G, Elder A, Rinderknecht A. *J Nanosci Nanotechnol.* 2009 Aug;9(8):4996-5007. doi: 10.1166/jnn.2009.gr02. PMID: 19928180; PMCID: PMC3804071.

## Gareth Howell, PhD



For almost fifteen years, Dr. Gareth Howell's [research](#) has aimed to understand the contributions of neuroinflammation and vascular health to cognitive aging and neurodegenerative diseases. Trained at The Wellcome Trust Sanger Institute and The Jackson Laboratory (JAX), Dr. Howell initially used genetic and genomic approaches to show neuroinflammation and vascular changes were early components of glaucoma. This work was performed as a Research Scientist in the lab of Howard Hughes Investigator Dr. Simon John. When he established his own lab at JAX in 2012, Dr. Howell expanded his interests and applied similar approaches to identify mechanisms involved in neuroinflammation and cerebrovascular health in the aging brain and in mouse models of Alzheimer's disease. However, it became clear that existing models of both Alzheimer's disease and glaucoma were limited. Therefore, a major aim of his lab has become to work collaboratively to develop models of neurodegenerative diseases that more faithfully recapitulate human forms of the disease. The Howell Lab incorporates these new mouse models to enhance our overarching goals to elucidate the mechanism by which glial cells and immune responses in general contribute to the earliest stages of neurodegenerative disease, particularly glaucoma and Alzheimer's disease.

### Recommended Readings

[Model organism development and evaluation for late-onset Alzheimer's disease: MODEL-AD.](#)

Oblak AL, Forner S, Territo PR, Sasner M, Carter GW, Howell GR, Sukoff-Rizzo SJ, Logsdon BA, Mangravite LM, Mortazavi A, Baglietto-Vargas D, Green KN, MacGregor GR, Wood MA, Tenner AJ, LaFerla FM, Lamb BT; and the MODEL-AD; Consortium. *Alzheimers Dement* (N Y). 2020 Nov 23;6(1):e12110. doi: 10.1002/trc2.12110. eCollection 2020. PMID: 33283040

[Enhancing face validity of mouse models of Alzheimer's disease with natural genetic variation.](#)

Onos KD, Uyar A, Keezer KJ, Jackson HM, Preuss C, Acklin CJ, O'Rourke R, Buchanan R, Cossette TL, Sukoff Rizzo SJ, Soto I, Carter GW, Howell GR. *PLoS Genet*. 2019 May 31;15(5):e1008155. doi: 10.1371/journal.pgen.1008155. eCollection 2019 May. PMID: 31150388

[Translational animal models for Alzheimer's disease: An Alzheimer's Association Business Consortium Think Tank.](#)

Vitek MP, Araujo JA, Fossel M, Greenberg BD, Howell GR, Rizzo SJS, Seyfried NT, Tenner AJ, Territo PR, Windisch M, Bain LJ, Ross A, Carrillo MC, Lamb BT, Edelmayer RM. *Alzheimers Dement* (N Y). 2021 Jan 11;6(1):e12114. doi: 10.1002/trc2.12114. eCollection 2020. PMID: 33457489

[Natural genetic variation determines microglia heterogeneity in wild-derived mouse models of Alzheimer's disease.](#)

Yang HS, Onos KD, Choi K, Keezer KJ, Skelly DA, Carter GW, Howell GR. *Cell Rep*. 2021 Feb 9;34(6):108739. doi: 10.1016/j.celrep.2021.108739. PMID: 33567283

## Marc Weisskopf, PhD, ScD (Symposium Host)



Marc G. Weisskopf, Ph.D., Sc.D., is the [Cecil K. and Philip Drinker Professor of Environmental Epidemiology and Physiology](#) at the Harvard T.H. Chan School of Public Health in the departments of Environmental Health and Epidemiology, Director of the Harvard TH Chan NIEHS Center for Environmental Health, and Director of Epidemiological Studies for the Football Players Health Study at Harvard. Dr. Weisskopf received his Ph.D. in Neuroscience from the University of California, San Francisco, and his Sc.D. in Epidemiology from the Harvard T.H. Chan School of Public Health. He also spent two years as an Epidemic Intelligence Service Officer with the Centers for Disease Control and Prevention working on environmental health issues in the Wisconsin State Health Department. His neuroscience work focused on molecular and cellular aspects of neural signaling and plasticity. His epidemiological work focuses on the influence of environmental exposures on brain health across the life course. In particular, his research focuses on environmental risk factors for outcomes such as autism spectrum disorders, amyotrophic lateral sclerosis, cognitive function and dementia, and psychiatric conditions. Dr. Weisskopf also explores the use of physiologically-based methods for assessing toxicant effects on the brain, and epidemiological methods issues to improve causal inference from observational environmental health studies.

## HOST INFORMATION

### Harvard Chan-NIEHS Center for Environmental Health

The Harvard Chan-National Institute of Environmental Health Sciences (NIEHS) Center for Environmental Health is a coordinated set of resources and facilities supporting environmental health research and training activities throughout the Boston area. Located at the Harvard T.H. Chan School of Public Health, in Boston's Longwood Medical Area, the Center promotes integration between basic and applied environmental science, and fosters collaborations that cross departmental and institutional boundaries. Founded in 1962, the Center is the oldest of 20 core research centers across the country supported by the NIEHS. Center research combines population and patient based studies with mechanistic laboratory investigation to illuminate the pathways by which environmental exposures cause health effects. The Center prioritizes questions that are directly relevant to real human populations, with the goal of re-envisioning the exposure environment and the integrated effects of chemical and non-chemical stressors of people and place to better understand the impact of exposure on human health.

### Biogen

Biogen discovers, develops and delivers worldwide innovative therapies for people living with serious neurological and neurodegenerative diseases as well as related therapeutic adjacencies. Founded in 1978 as one of the world's first global biotechnology companies, Biogen has the leading portfolio of medicines to treat multiple sclerosis, has introduced the first approved treatment for spinal muscular atrophy, commercializes biosimilars of advanced biologics and is focused on advancing research programs in Alzheimer's disease and dementia, among other disease areas. In 2020, Biogen launched [\*Healthy Climate, Healthy Lives™\*](#), a \$200-million initiative to eliminate fossil fuels across its operations and collaborate with leading institutions to address the effects of fossil-fuel driven air pollution on public health.

## ISSUE OVERVIEW: AIR POLLUTION & DEMENTIA

There is a growing body of literature that links air pollution and poor brain health, specifically in vulnerable populations such as children, pregnant women, older people, and people with fewer resources. Last year, [The Lancet](#) classified air pollution as a modifiable risk factor for dementia, based on evidence that exposure to [PM<sub>2.5</sub>](#) and [NO<sub>2</sub>](#) correlate with increased dementia incidents. Meanwhile, [BRAIN](#) published a study that found that PM<sub>2.5</sub> is associated with episodic memory decline and Alzheimer's disease pattern similarity scores. Beyond the academic literature, the [U.S. National Bureau of Economic Research](#) recently concluded that enforcement of the Clean Air Act prevented 182,000 people from developing dementia between 2004 and 2013, saving society over \$214 billion in avoided medical expenses.

There are issues, however, with the human epidemiologic research conducted so far. These issues include misclassification of outcomes and potential biases, such as selection pressures in forming cohorts of older age individuals and selective dropout preferentially related to cognitive health. There is extensive literature that connects a wide variety of air pollutants with the onset of late-life dementia, but there is a limited number of studies on the exact link between dementia and individual pollutants.

To address these limitations, this symposium will convene experts across multiple disciplines, including climate change, air pollution, cognitive decline and dementia, to discuss the established science and existing literature.



## FURTHER READING

[Aging attenuates redox adaptive homeostasis and proteostasis in female mice exposed to traffic-derived nanoparticles \('vehicular smog'\).](#)

Pomatto LCD, Cline M, Woodward N, Pakbin P, Sioutas C, Morgan TE, Finch CE, Forman HJ, Davies KJA. Free Radic Biol Med. 2018 Jun;121:86-97. doi: 10.1016/j.freeradbiomed.2018.04.574. Epub 2018 Apr 27. PMID: 29709705; PMCID: PMC5987225.

[Air Pollution and Dementia: A Systematic Review.](#)

Peters R, Ee N, Peters J, Booth A, Mudway I, Anstey KJ. J Alzheimers Dis. 2019;70(s1):S145-S163. doi: 10.3233/JAD-180631. PMID: 30775976; PMCID: PMC6700631.

[Air Pollution Alters Caenorhabditis elegans Development and Lifespan: Responses to Traffic-Related Nanoparticulate Matter.](#)

Haghani A, Dalton HM, Safi N, Shirmohammadi F, Sioutas C, Morgan TE, Finch CE, Curran SP. J Gerontol A Biol Sci Med Sci. 2019 Jul 12;74(8):1189-1197. doi: 10.1093/gerona/glz063. PMID: 30828708; PMCID: PMC6625599.

[Air pollution & the brain: Subchronic diesel exhaust exposure causes neuroinflammation and elevates early markers of neurodegenerative disease.](#)

Levesque S, Surace MJ, McDonald J, Block ML. J Neuroinflammation. 2011 Aug 24;8:105. doi: 10.1186/1742-2094-8-105. PMID: 21864400; PMCID: PMC3184279.

[Air Pollution Exposure During Fetal Life, Brain Morphology, and Cognitive Function in School-Age Children.](#)

Guxens M, Lubczyńska MJ, Muetzel RL, Dalmau-Bueno A, Jaddoe VWV, Hoek G, van der Lugt A, Verhulst FC, White T, Brunekreef B, Tiemeier H, El Marroun H. Biol Psychiatry. 2018 Aug 15;84(4):295-303. doi: 10.1016/j.biopsych.2018.01.016. Epub 2018 Jan 31. PMID: 29530279.

[Ambient ultrafine particles alter lipid metabolism and HDL anti-oxidant capacity in LDLR-null mice.](#)

Li R, Navab M, Pakbin P, Ning Z, Navab K, Hough G, Morgan TE, Finch CE, Araujo JA, Fogelman AM, Sioutas C, Hsiai T. J Lipid Res. 2013 Jun;54(6):1608-15. doi: 10.1194/jlr.M035014. Epub 2013 Apr 6. PMID: 23564731; PMCID: PMC3646462.

[Are noise and air pollution related to the incidence of dementia? A cohort study in London, England.](#)

Carey IM, Anderson HR, Atkinson RW, Beevers SD, Cook DG, Strachan DP, Dajnak D, Gulliver J, Kelly FJ. BMJ Open. 2018 Sep 11;8(9):e022404. doi: 10.1136/bmjopen-2018-022404. PMID: 30206085; PMCID: PMC6144407.

[Association between air pollution from residential wood burning and dementia incidence in a longitudinal study in Northern Sweden.](#)

Oudin A, Segersson D, Adolfsson R, Forsberg. PLoS One. 2018 Jun 13;13(6):e0198283. doi: 10.1371/journal.pone.0198283. PMID: 29897947; PMCID: PMC5999109

[Association between exposure to air pollution and hippocampal volume in adults in the UK Biobank.](#)

Hedges DW, Erickson LD, Kunzleman J, Brown BL, Gale SD. Neurotoxicology. 2019 Sep;74:108-120. doi: 10.1016/j.neuro.2019.06.005. Epub 2019 Jun 17. PMID: 31220475.

[Association between exposure to air pollution and prefrontal cortical volume in adults: A cross-sectional study from the UK biobank.](#)

Gale SD, Erickson LD, Anderson JE, Brown BL, Hedges DW. Environ Res. 2020 Jun;185:109365. doi: 10.1016/j.envres.2020.109365. Epub 2020 Mar 11. PMID: 3222630.

[Association between Exposure to Air Pollution and Total Gray Matter and Total White Matter Volumes in Adults: A Cross-Sectional Study.](#)

Erickson LD, Gale SD, Anderson JE, Brown BL, Hedges DW. Brain Sci. 2020 Mar 13;10(3):164. doi: 10.3390/brainsci10030164. PMID: 32182984; PMCID: PMC7139378.

[Association between exposure to air pollution and thalamus volume in adults: A cross-sectional study.](#)

Hedges DW, Erickson LD, Gale SD, Anderson JE, Brown BL. PLoS One. 2020 Mar 30;15(3):e0230829. doi: 10.1371/journal.pone.0230829. PMID: 32226035; PMCID: PMC7105117.

[Burden of Cause-Specific Mortality Associated With PM2.5 Air Pollution in the United States.](#)

Bowe B, Xie Y, Yan Y, Al-Aly Z. JAMA Netw Open. 2019 Nov 1;2(11):e1915834. doi: 10.1001/jamanetworkopen.2019.15834. PMID: 31747037; PMCID: PMC6902821.

[Cell-based assays that predict in vivo neurotoxicity of urban ambient nano-sized particulate matter.](#)

Zhang H, Haghani A, Mousavi AH, Cacciottolo M, D'Agostino C, Safi N, Sowlat MH, Sioutas C, Morgan TE, Finch CE, Forman HJ. Free Radic Biol Med. 2019 Dec;145:33-41. doi: 10.1016/j.freeradbiomed.2019.09.016. Epub 2019 Sep 19. PMID: 31542466; PMCID: PMC7207020.

[Combustion-Derived Nanoparticles in Key Brain Target Cells and Organelles in Young Urbanites: Culprit Hidden in Plain Sight in Alzheimer's Disease Development.](#)

González-Maciél A, Reynoso-Robles R, Torres-Jardón R, Mukherjee PS, Calderón-Garcidueñas L. J Alzheimers Dis. 2017;59(1):189-208. doi: 10.3233/JAD-170012. PMID: 28598844.

[Dementia prevention, intervention, and care: 2020 report of the Lancet Commission.](#)

Livingston G et al. The Lancet Commissions. 2020 Aug 8; 396(1024): 413 - 446. doi: 10.1016/S0140-6736(20)30367-6. PMID: 32738937

[Diurnal variation in the proinflammatory activity of urban fine particulate matter \(PM<sub>2.5</sub>\) by \*in vitro\* assays.](#)

Lovett C, Cacciottolo M, Shirmohammadi F, Haghani A, Morgan TE, Sioutas C, Finch CE. F1000Res. 2018 May 15;7:596. doi: 10.12688/f1000research.14836.3. PMID: 30345019; PMCID: PMC6171724.

[Effects of prenatal exposure to air pollutants \(polycyclic aromatic hydrocarbons\) on the development of brain white matter, cognition, and behavior in later childhood.](#)

Peterson BS, Rauh VA, Bansal R, Hao X, Toth Z, Nati G, Walsh K, Miller RL, Arias F, Semanek D, Perera F. JAMA Psychiatry. 2015 Jun;72(6):531-40. doi: 10.1001/jamapsychiatry.2015.57. Erratum in: JAMA Psychiatry. 2015 Jun;72(6):625. PMID: 25807066; PMCID: PMC4456286.

[Exposure to ambient air pollution and the incidence of dementia: A population-based cohort study.](#)

Chen H, Kwong JC, Copes R, Hystad P, van Donkelaar A, Tu K, Brook JR, Goldberg MS, Martin RV, Murray BJ, Wilton AS, Kopp A, Burnett RT. Environ Int. 2017 Nov;108:271-277. doi: 10.1016/j.envint.2017.08.020. Epub 2017 Sep 13. PMID: 28917207.

[Exposure to Nanoscale Particulate Matter from Gestation to Adulthood Impairs Metabolic Homeostasis in Mice.](#)

Woodward NC, Crow AL, Zhang Y, Epstein S, Hartiala J, Johnson R, Kocalis H, Saffari A, Sankaranarayanan I, Akbari O, Ramanathan G, Araujo JA, Finch CE, Bouret SG, Sioutas C, Morgan TE, Allayee H. *Sci Rep.* 2019 Feb 12;9(1):1816. doi: 10.1038/s41598-018-37704-2. PMID: 30755631; PMCID: PMC6372675.

[Glutamatergic neurons in rodent models respond to nanoscale particulate urban air pollutants in vivo and in vitro.](#)

Morgan TE, Davis DA, Iwata N, Tanner JA, Snyder D, Ning Z, Kam W, Hsu YT, Winkler JW, Chen JC, Petasis NA, Baudry M, Sioutas C, Finch CE. *Environ Health Perspect.* 2011 Jul;119(7):1003-9. doi: 10.1289/ehp.1002973. PMID: 21724521; PMCID: PMC3222976.

[Mouse brain transcriptome responses to inhaled nanoparticulate matter differed by sex and APOE in Nrf2-Nfkb interactions.](#)

Haghani A, Cacciottolo M, Doty KR, D'Agostino C, Thorwald M, Safi N, Levine ME, Sioutas C, Town TC, Forman HJ, Zhang H, Morgan TE, Finch CE. *Elife.* 2020 Jun 24;9:e54822. doi: 10.7554/eLife.54822. PMID: 32579111; PMCID: PMC7314548.

[Nrf2-regulated phase II enzymes are induced by chronic ambient nanoparticle exposure in young mice with age-related impairments.](#)

Zhang H, Liu H, Davies KJ, Sioutas C, Finch CE, Morgan TE, Forman HJ. *Free Radic Biol Med.* 2012 May 1;52(9):2038-46. doi: 10.1016/j.freeradbiomed.2012.02.042. Epub 2012 Mar 6. Erratum in: *Free Radic Biol Med.* 2014 Dec;77:388. PMID: 22401859; PMCID: PMC3342863.

[Particulate matter and episodic memory decline mediated by early neuroanatomic biomarkers of Alzheimer's disease.](#)

Younan D et al. *Brain.* 2020 Jan 1;143(1):289-302. doi: 10.1093/brain/awz348. Erratum in: *Brain.* 2020 Mar 1;143(3):e24. PMID: 31746986; PMCID: PMC6938036.

[Particulate air pollutants, APOE alleles and their contributions to cognitive impairment in older women and to amyloidogenesis in experimental models.](#)

Cacciottolo M, Wang X, Driscoll I, Woodward N, Saffari A, Reyes J, Serre ML, Vizuete W, Sioutas C, Morgan TE, Gatz M, Chui HC, Shumaker SA, Resnick SM, Espeland MA, Finch CE, Chen JC. *Transl Psychiatry.* 2017 Jan 31;7(1):e1022. doi: 10.1038/tp.2016.280. PMID: 28140404; PMCID: PMC5299391.

[Prenatal and Childhood Traffic-Related Pollution Exposure and Childhood Cognition in the Project Viva Cohort \(Massachusetts, USA\).](#)

Harris MH, Gold DR, Rifas-Shiman SL, Melly SJ, Zanobetti A, Coull BA, Schwartz JD, Gryparis A, Kloog I, Koutrakis P, Bellinger DC, White RF, Sagiv SK, Oken E. *Environ Health Perspect.* 2015 Oct;123(10):1072-8. doi: 10.1289/ehp.1408803. Epub 2015 Apr 3. Erratum in: *Environ Health Perspect.* 2019 Jun;127(6):69001. PMID: 25839914; PMCID: PMC4590752.

[Prenatal and early life exposure to air pollution induced hippocampal vascular leakage and impaired neurogenesis in association with behavioral deficits.](#)

Woodward NC, Haghani A, Johnson RG, Hsu TM, Saffari A, Sioutas C, Kanoski SE, Finch CE, Morgan TE. *Transl Psychiatry.* 2018 Nov 29;8(1):261. doi: 10.1038/s41398-018-0317-1. PMID: 30498214; PMCID: PMC6265287.

[Prenatal exposure to urban air nanoparticles in mice causes altered neuronal differentiation and depression-like responses.](#)

Davis DA, Bortolato M, Godar SC, Sander TK, Iwata N, Pakbin P, Shih JC, Berhane K, McConnell R, Sioutas C, Finch CE, Morgan TE. PLoS One. 2013 May 29;8(5):e64128. doi: 10.1371/journal.pone.0064128. PMID: 23734187; PMCID: PMC3667185.

[PM<sub>2.5</sub> associated with gray matter atrophy reflecting increased Alzheimers risk in older women.](#)

Younan D, Wang X, Casanova R, Barnard R, Gaussoin SA, Saldana S, Petkus AJ, Beavers DP, Resnick SM, Manson JE, Serre ML, Vizuete W, Henderson VW, Sachs BC, Salinas JA, Gatz M, Espeland MA, Chui HC, Shumaker SA, Rapp SR, Chen JC; Women's Health Initiative. Neurology. 2020 Nov 18;10.1212/WNL.0000000000011149. doi: 10.1212/WNL.0000000000011149. Epub ahead of print. PMID: 33208540.

[Quadruple abnormal protein aggregates in brainstem pathology and exogenous metal-rich magnetic nanoparticles \(and engineered Ti-rich nanorods\). The substantia nigrae is a very early target in young urbanites and the gastrointestinal tract a key brainstem](#)

Calderón-Garcidueñas L, González-Maciél A, Reynoso-Robles R, Hammond J, Kulesza R, Lachmann I, Torres-Jardón R, Mukherjee PS, Maher BA. Environ Res. 2020 Dec;191:110139. doi: 10.1016/j.envres.2020.110139. Epub 2020 Sep 2. PMID: 32888951.

[Selective memory and behavioral alterations after ambient ultrafine particulate matter exposure in aged 3xTgAD Alzheimer's disease mice.](#)

Jew K, Herr D, Wong C, Kennell A, Morris-Schaffer K, Oberdörster G, O'Banion MK, Cory-Slechta DA, Elder A. Part Fibre Toxicol. 2019 Nov 26;16(1):45. doi: 10.1186/s12989-019-0323-3. PMID: 31771615; PMCID: PMC6878709.

[Stroke Damage Is Exacerbated by Nano-Size Particulate Matter in a Mouse Model.](#)

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