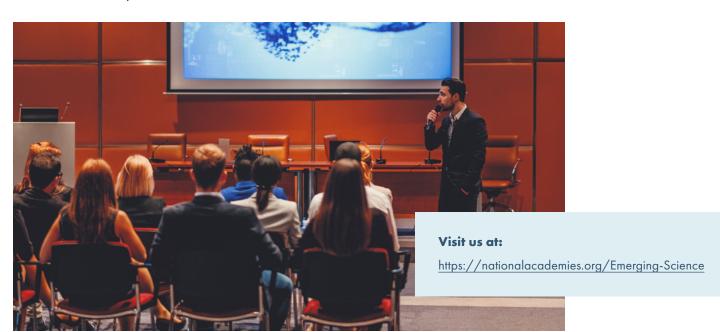




About Us

What are the latest advances in science and technology? How can they be leveraged to gain new understanding about the relationship between the environment and human health? How will these scientific advances influence our decisions about environmental exposures at home, in our communities, across the nation, and around the world?



Since 2008, the Standing Committee on the Use of Emerging Science for Environmental Health Decisions has convened workshops to explore new science, tools, and research methodologies that could deepen our understanding about the effects of the environment on human health and inform decision-making. These workshops bring together experts in science and public policy for transdisciplinary discussion about scientific advances and how they can be used to inform personal, public health, and regulatory environmental health decisions.

Using Emerging Science To Advance Environmental Health Research

Scientific and technological advances offer tremendous opportunities for innovation. The Standing Committee's convening activities help leaders in environmental health research and policy to leverage those opportunities and explore the potential for emerging areas of science to advance environmental health research.

For example, our workshop on genome editing—a suite of biological tools for making precise additions, deletions, and alterations to the DNA and RNA of living cells-identified ways the tools could revolutionize

understanding of the biological mechanisms resulting from chemical exposures. Researchers and policy makers discussed how gene editing could lead to faster ways to determine which gene variants predispose a person to different responses to the environment, and could lead to better regulatory decisions as scientists better understand how exposures lead to observed effects in the body.

The human microbiome—the bacteria, viruses, and fungi that live in or on human bodies—may serve as an intermediary between people and the environment. The Standing Committee convened workshops on the mirobiome in 2011 and 2016, bringing together experts who discussed how environmental factors can change the human microbiome, and the human health problems that could result from those changes—a crucial step in understanding the effects of environmental exposures.

"The broad expertise gathered at this workshop is crucial to understanding the complexity of the microbiome and the role it plays in how people respond to the environment."

- Linda Birnbaum at the 2016 workshop on the microbiome1

EMERGING SCIENCE ON THE EXPOSOME

The exposome—all of the environmental compounds an individual is exposed to from conception to death—was first described in 2005 by Christopher Wild.² In the years that followed Wild's seminal publication, there was little progress in exposome research, with no manuscripts even mentioning the word "exposome." That changed in 2010, when the Standing Committee convened the first workshop to focus on the exposome. The workshop brought together experts to discuss the importance of exposure assessment in identifying the environmental causes of chronic diseases such as cancer, and helped to lay the foundation for this emerging field of study.

2005	2010				2010	
The exposome is first described by Christopher Wild	first work "The Exp Evaluation	The Standing Committee convenes the first workshop to focus on the exposon "The Exposome: A Powerful Approach Evaluation Environmental Exposures a Their Influence on Human Diseases"			me Commission issues a call h for for exposome research	
2012			2012			
The 2012-2017 NIEHS Strategic Plan prioritizes exposome research		The National Academies publishes the report, Exposure Science in the 21st Century		The Standing Committee convenes the workshop "Emerging Technologies for Measuring Individual Exposomes"		
2013		2015		2016		
NIEHS funds the Health and Exposome Research Center: Understanding Lifetime Exposures (HERCULES) at Emory University		NIEHS launches the Children's Health Exposure Analysis Resource (CHEAR)		The Standing Committee convenes the workshop "Personal Environmental Exposure Measurements: Making Sense and Making Use of Emerging Capabilities"		
		2020		2019	2018	
The European Commission funds the creation of a European Human Exposome Network		NIEHS launches the Human Health Exposure Analysis Resource (HHEAR)		The 2018-2023 NIEHS Strategic Plan prioritizes exposome research		
2020			2021	202	21	
The Standing Committee convenes the workshop "Predicting Human Health Effects From Environmental Exposures: Applying Translatable and Accessible Biomarkers of Effect"			Oxford University Press launches the scientific journal, Exposome	con "Int Env	Standing Committee Evenes the workshop Everplay Between Everplay Evenes and Eventual Exposures and Eventual Health Outcomes"	

Leveraging Multidisciplinary Science to Guide Federal Agencies and Programs

At its core, the Standing Committee focuses on the premise that environmental health decisions should be based on the best available science—and that science is constantly advancing. The Standing Committee is leading innovative approaches to address the challenges of translating emerging scientific information to policy decisions that improve public health.

For example, a 2021 workshop highlighted the need to support research collaboration across federal agencies, including the many institutes of the National Institutes of Health, to explore the mechanistic relationship between environment and mental health. Workshop speakers discussed funding opportunities for interdisciplinary collaboration and noted the need to incorporate environmental health considerations into decision making to support mental health, for example on local zoning codes, public housing architecture and green space.

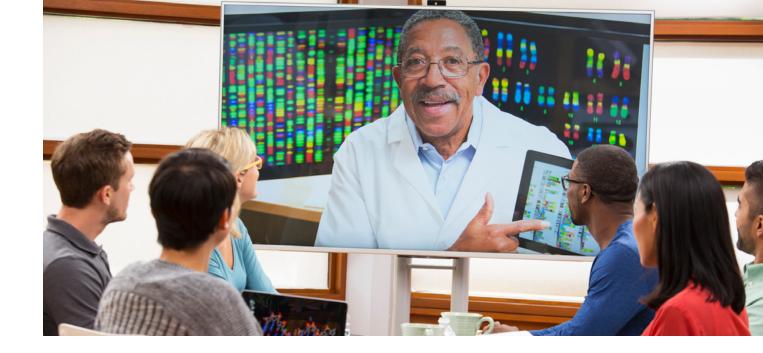
A 2015 workshop explored how individual reactions to environmental stressors could influence the regulation of environmental pollutants. Understanding intrinsic variability in reactions to exposures across the human population has long been a key consideration for those tasked with risk-based decisions. The workshop highlighted state-of-the-art tools for studying variations, including in vitro toxicology methods using highly diverse human cell lines, in vivo methods using highly diverse animal populations, and epidemiologic analytical approaches.

"Working together has the potential to improve our ability to study, treat, and most importantly, prevent the onset of human disease and to promote highquality human health."

-Rick Woychik at the 2021 environment and mental health workshop⁴

"In the arena of Tox 21, for example, we are talking about reinventing risk assessment. Fundamental shifts in the science underlie those decisions, but those decisions will always come back to the regulatory context."

-Michael DeVito at the 2015 workshop on interindividual variability and environmental health⁵



A PARADIGM SHIFT IN TOXICITY TESTING AND **DECISION MAKING**

New tools and tests of chemical toxicity—from high throughput, cellbased, in vitro studies to tissue chips to environment-wide association studies—are faster, less expensive, and increasingly more relevant to human exposures than legacy animal toxicity testing approaches.

These advantages have lead industry and government agencies to consider using emerging toxicity testing approaches in risk assessment and analysis contexts. This shift has been further encouraged by the passage of the Frank R. Lautenberg Chemical Safety for the 21st Century Act (Lautenberg Act), which amended the Toxic Substances Control Act (TSCA).

Our workshop on toxicity testing and decision making brought together experts to explore key factors that influence whether and how scientists, policy makers, risk assessors, and regulators incorporate new science into their decisions. Speakers and panels considered whether regulatory reform was sufficient to encourage the environmental health community to adopt emerging toxicity testing approaches and what other steps may be necessary to support a paradigm shift away from legacy animal testing and toward the use of the novel testing approaches.

Anticipating Next Directions in Environmental Health Research

Much of the Standing Committee's work helps guide the environmental health science enterprise itself. Working with expert committees and the scientific community, our workshops anticipate new research pathways and set strategic directions for future work.

For example, a 2019 workshop explored the potential of artificial intelligence (AI) and machine learning for advancing environmental health research. These technological innovations provide the ability to analyze large volumes of complex data to find patterns and make predictions. Workshop participants discussed potential applications for AI in environmental health research, including characterizing sources of pollution, predicting chemical toxicity, and estimating human exposures to contaminants.



[This workshop is] "intended to be an anchor from which new ideas are generated, influencing your work and influencing new investigations and collaborations."

 Melissa Perry at the 2019 artificial intelligence workshop⁶

Several workshops have touched on a growing awareness of environmental justice in all areas of environmental health. For example, our 2021 workshop highlighted how geospatial data reveals the profound effect of where a person lives on environmental health outcomes—from access to quality education to clean air and water, from employment opportunities to health care access, and from prenatal health to life expectancy. Similar themes were discussed at our workshop on environment and mental health, which explored ways that the environment in which one lives may present mental health risks or promote resilience.

"We really cannot talk about the environment without talking about structural racism."

-Eugenia South at the 2021 mental health and environment workshop.⁷



TOWARD A FUTURE OF ENVIRONMENTAL HEALTH SCIENCES

To inform a research agenda for environmental health science, the Standing Committee posed a challenging question:

How do we reach a future research enterprise that integrates environmental health science, biomedical science, prevention research, and disease-specific research across the continuum from fundamental discovery research through the application of this research to population health?

With this question in mind, participants at a 2022 workshop explored a ten-year horizon for the field of environmental health science, and the near-term research activities that can contribute to that future. The workshop examined particular considerations for advancing knowledge and decision making in three areas:

- precision medicine,
- environmental justice and the exposome,
- climate change and health.

Panelists took a scenario-based approach to envision an integrated research enterprise, explore possible routes to reach this research future, and examine key scientific, technical, and policy gaps.

OUR RECENT WORK

Standing Committee Activities in 2021–2022

FUTURECASTING FOR ENVIRONMENTAL HEALTH

What could the future of environmental health sciences hold, and what steps might be taken now to guide the field's trajectory?

To begin to answer these questions, over the past year the Standing Committee has worked with stakeholders in academia, government, and industry to set strategic directions for the future of environmental health sciences.

Starting with the vision of a future research enterprise that integrates environmental health science, biomedical science, prevention research, and disease-specific research across the continuum from fundamental discovery research through to population health, the Standing Committee has gathered input to inform public policy and research to reach this future.

This project has included a scoping process (initial research, information gathering, and subject matter expert discussions); three scenario-based, futurecasting exercises; and a public workshop to explore further the scientific, technical, and policy gaps, enablers, and needs identified during the scoping process. The work is captured in a commissioned white paper that sets out strategic goals for the future work of the Standing Committee.



WORKSHOPS

The Standing Committee convened four workshops in 2021 and 2022. These workshops continued the Standing Committee's exploration of the most pressing issues in environmental health science research and policy, including strategic thinking about future directions for environmental health research.

Toward a Future of Environmental **Health Sciences**

In April 2022, the Standing Committee convened a workshop to explore the ten-year horizon for environmental health sciences, focusing on advancing knowledge and decision making in three areas: precision medicine, environmental justice and the exposome, and climate change and health. Panelists took a scenario-based approach to envision an integrated research enterprise, explore possible routes to reach this research future, and examine key scientific, technical, and policy gaps.

In her presentation, Kristen Malecki of the University of Wisconsin-Madison noted that systems thinking, cumulative risk, translational research, and equity provide opportunities to enhance future directions for environmental health sciences.



The workshops were webcast live; videos, slide presentations, and other resources for these events are archived at: https://www.nationalacademies.org/our-work/ standing-committee-on-the-use-of-emerging-science-forenvironmental-health-decisions

Pivotal Interfaces of Environmental Health and Infectious Disease Research to Inform Responses to Outbreaks, **Epidemics, and Pandemics**

Pathogens are the cause of infectious diseases, but the environment can play an important role in influencing the conditions under which pathogens spread and cause harm. Understanding the complex interplay between people, pathogens, and the environment-broadly encompassing our chemical, biological, physical, and social surroundings—can lead to a more complete picture of where and how infectious diseases emerge and how they spread. This knowledge can improve tools for monitoring, containing, and preventing outbreaks, epidemics, and pandemics.

The workshop featured opening remarks by speakers from the National Institute of Environmental Health Sciences and from the National Institute of Allergy and Infectious Diseases, who discussed the potential for synergies and collaborations between their agencies to help advance work at the intersection of environmental health and infectious disease research.

In this presentation, Erin Mordecai of Stanford University discusses global change, the ecology of vector-borne disease, and using data driven models to observe the effects of environmental change on infectious disease.



Leveraging Advances in Remote Geospatial Technologies to Inform **Precision Environmental Health Decisions**

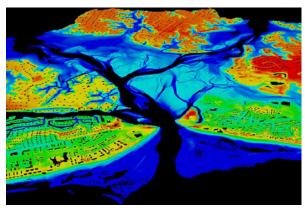


Image credit: NOAA. What is lidar? National Ocean Service website, https://oceanservice.noaa.gov/facts/lidar.html

As understanding of the links between environmental exposures and human health grows, and as environmental justice assumes a central role in efforts to address the harms that environmental exposures can inflict on communities, new tools can provide insights on the spread of pollution and disease. Geospatial technologies—remote sensing and geospatial tools used to map and analyze the environment and aspects of human society—can help identify at-risk populations and monitor environmental health trends.

This April 2021 workshop explored how advances in geospatial technologies can inform "precision environmental health," the targeted public health interventions that reach the right populations at the right time.

In this presentation, Cecilia Martinez, White House Council on Environmental Quality discussed screening tools, including EPA's EJSCREEN, Cal EnviroScreen, and the development of the Climate and Economic Justice Screening Tool (CEJST).



The Interplay between Environmental **Exposures and Mental Health Outcomes**



Janiere Fernandez/Pexels

Mounting evidence shows that the environment can play an important role in mental health, yet comparatively few studies have focused on the mental or behavioral health outcomes of environmental stressors. This workshop provided mental health and environmental health research experts from government, academia, and the private sector with the opportunity to explore emerging research on the relationships between environmental exposures and mental health.

In his presentation, Joshua Gordon, Director of the National Institute of Mental Health (NIMH), discussed research to uncover the various inputs that alter mental health and to explore the mechanistic relationship between environmental exposures and mental health, both in terms of risk and resilience. Developing that mechanistic relationship, said Gordon, require collaborative studies across the many institutes of the National Institutes of Health.

In this presentation, Sandro Galea of Boston University discussed an intersectional perspective on the breadth of environmental considerations in mental health research and public health practice.



Proceedings of a Workshop

Four publications resulting from the Standing Committee's work were released in 2021-2022:

- Toward a Future of Environmental Health Sciences: Proceedings of a Workshop in Brief
- Pivotal Interfaces of Environmental Health and Infectious Disease Research to Inform Responses to Outbreaks, Epidemics, and Pandemics: Proceedings of a Workshop in Brief
- Leveraging Advances in Remote Geospatial Technologies to Inform Precision Environmental Health Decisions: Proceedings of a Workshop-in Brief
- The Interplay Between Environmental Exposures and Mental Health Outcomes: Proceedings of a Workshop—in Brief

OTHER PUBLICATIONS

The Interplay of Environmental Exposures and Mental Health: Setting an Agenda.

Aaron Reuben; Erika M. Manczak; Laura Y. Cabrera; Margarita Alegria; Meghan Bucher; Emily C. Freeman; Gary W. Miller; Gina M. Solomon and Melissa J.

Perry; Environmental Health Perspectives; February 16

2022. https://doi.org/10.1289/EHP9889

Adopting a "Compound" Exposome Approach in Environmental Aging Biomarker Research: A Call to Action for Advancing Racial Health Equity.

Jamaji C. Nwanaji-Enwerem, Chandra L. Jackson, Mary Ann Ottinger, Andres Cardenas, Katherine A. James, Kristen M.C. Malecki, Jiu-Chiuan Chen, Andrew M. Geller, and Uchechi A. Mitchell; Environmental Health Perspectives, April 6, 2021. https://doi. org/10.1289/EHP8392

Past Workshops

2022

 Towards A Future Of Environmental Health Sciences: A Workshop

2021

- · Pivotal Interfaces Of Environmental Health And Infectious Disease Research To Inform Responses To Outbreaks, Epidemics, And Pandemics: A Workshop
- Leveraging Advances In Remote Geospatial Technologies To Inform Precision Environmental Health Decisions: A Workshop
- The Interplay Between Environmental Exposures And Mental Health Outcomes: A Workshop

2020

- Predicting Human Health Effects From Environmental Exposures: Applying Translatable And Accessible Biomarkers Of Effect: Workshop
- Integrating The Science Of Aging And Environmental Health Research: A Workshop
- Emerging Technologies To Advance Research And Decisions On The Environmental Health Effects Of Microplastics: A Workshop

2019

- Emerging Advances In Artificial Intelligence For Environmental Health Research And Decisions: A Workshop
- The Promise Of Single Cell And Single Molecule Analysis Tools To Advance Environmental Health Research: A Workshop
- Understanding The Interplay Of Environmental Stressors, Infectious Disease, And Human Health: A Workshop

2018

- Informing Environmental Health Decisions Through Data Integration Workshop
- The Promise Of Genome Editing Tools To Advance Environmental Health Research Workshop

2017

- Understanding Pathways To Paradigm Shift In Toxicity Testing And Decision Making: A Workshop
- Advances In Causal Understanding For Human Health Risk-Based Decision Making: A Workshop

2016

- Personal Environmental Exposure Measurements: Making Sense And Making Use Of Emerging Capabilities Workshop
- Interindividual Variability: New Ways to Study and Implications for Decision-Making

2015

- · Environment and Health: What's the Human Microbiome Have to Do with It?
- Metabolomics as a Tool for Characterizing the Exposome

2014

- · Modeling the Health Risks of Climate Change
- The Potential of the Tissue Chip for **Environmental Health Studies**

2013

- Integrating Environmental Health Data to Advance Discovery
- Exploring Human Genomic Plasticity and Environmental Stressors: Emerging Evidence on Telomeres, Copy Number Variation, and Transposons

2012

- Systems Biology-Informed Risk Assessment
- Biological Factors That Underlie Individual Susceptibility to Environmental Stressors and Their Implications for Decision-Making

2011

- Emerging Technologies for Measuring Individual Exposomes
- Applying 21 st Century Toxicology to Green Chemical and Material Design

- Mixtures and Cumulative Risk Assessment: New Approaches Using the Latest Science and Thinking about Pathways
- Interplay of the Microbiome, Environmental Stressors, and Human Health

2010

- Use of In Utero and Post-Natal Indicators to Predict Health Outcomes Later in Life
- Stem Cell Models for Environmental Health
- The Exposome: A Powerful Approach for Evaluating Environmental Exposures and Their Influences on Human Disease

2009

- Computational Toxicology: From Data to Analyses to Applications
- · Use of Emerging Science and Technologies to Explore Epigenetic Mechanisms Underlying the Developmental Basis for Disease

ENDNOTES

- https://factor.niehs.nih.gov/2016/2/sciencehighlights/microbiome/index.htm
- Wild, CP. Complementing the Genome with an "Exposome": The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology, Cancer Epidemiology, Biomarkers & Prevention, August 2005,14;1847.
- Miller, GW. Exposome: a new field, a new journal, Exposome, Volume 1, Issue 1, 2021, https://doi.org/10.1093/exposome/osab001
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