



National Institute of
Environmental Health Sciences

NIEHS-WHO Collaborating Centre for Environmental Health Sciences



Summary Report 2013–2017



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Introduction to the Collaborating Centre

The National Institute of Environmental Health Sciences (NIEHS) - World Health Organization (WHO) Collaborating Centre for Environmental Health Sciences (the Collaborating Centre) was designated on Sept. 14, 2013, building on several decades of productive partnership between the two institutions. The NIEHS vision, presented in the 2012-2017 Strategic Plan, is to provide “global leadership for innovative research that improves public health by preventing disease and disability.” NIEHS identifies global environmental health (GEH) as one of its strategic themes, recognizing that because environmental health problems cross national boundaries, conducting studies around the world benefits not just those in the areas being studied, but all people who suffer from the same or related environmental health problems. The inclusion of GEH continues a tradition of NIEHS global leadership and collaboration on solving the most pressing environmental health problems and improving the lives of the most vulnerable populations, both in the U.S. and around the world. While the focus of this report is on Collaborating Centre activities, NIEHS is proud to organize

a number of initiatives that may be relevant to global audiences and inform health professionals around the world.

Directed by NIEHS Senior Advisor for Public Health John Balbus, M.D., the Collaborating Centre provides a focal point and resource for NIEHS to fulfill its strategic goals related to GEH. This partnership with WHO provides NIEHS opportunities for translating research findings into effective public health interventions to improve health around the world.

Under its designation for 2013-2017, the Collaborating Centre's Terms of Reference are:

1. To assist WHO by promoting international cooperation among environmental health research institutes around the world.
2. To assist WHO in promoting global awareness of emerging issues in environmental health.
3. To assist WHO in the preparation of training materials and to support education and training efforts in environmental and occupational health sciences.

Acknowledgements

An initiative like the NIEHS-WHO Collaborating Centre for Environmental Health Sciences cannot be created and launched without the wisdom, leadership, and contributions of many talented people.

NIEHS Director Linda Birnbaum, Ph.D., provided leadership, vision, and critical support to the creation of the Collaborating Centre, combining her ideals of global leadership for NIEHS with her vision of “One NIEHS.”

We are extremely grateful to Maria Neira, M.D., director of Public Health and Environment at WHO, our technical liaison Marie Noël Bruné-Drisse, Ph.D., Luis Galvao, M.D., and Agnes Soares da Silva, M.D., of PAHO, and Kathy Prout, WHO liaison to NIEHS at the time of the initial development of the Collaborating Centre, as well as other WHO and PAHO staff for their ideas, guidance, and inspiration in the creation of this new phase in our partnership.

The NIEHS Global Environmental Health Steering Committee, identified on the following page, has provided valuable guidance and support, always serving to improve and enhance the value of GEH activities conducted by the Collaborating Centre and the GEH Program.

The NIEHS Global Environmental Health Working Group, too numerous to name individually here, played a critical role in developing the initial strategic plan for the GEH Program and the activities that form the basis of the Collaborating Centre.

Last but not least, the Collaborating Centre Focus Area Leads and GEH Program Staff, identified on the following pages, have done the heavy lifting to accomplish all of the results highlighted in this report.

Many thanks to all who have contributed.

Collaborating Centre Launch

In February 2014, NIEHS and WHO celebrated the formal beginning of a new phase of cooperation, with the launch of the Collaborating Centre.



NIEHS staff involved with the Collaborating Centre met with staff from WHO and the Pan American Health Organization (PAHO). Seated, left to right, are Agnes Soares da Silva, M.D. (PAHO); Marie-Noël Bruné Drisse, Ph.D. (WHO); John Balbus, M.D.; Linda Birnbaum, Ph.D., Maria Neira, M.D. (WHO); and Luiz Augusto Cassanha Galvao, M.D. (PAHO). Standing, left to right, are Kimberly Gray, Ph.D.; William Suk, Ph.D.; Kathy Prout (WHO); Claudia Thompson, Ph.D.; Michelle Heacock, Ph.D.; Bono Sen, Ph.D.; Jerry Heindel, Ph.D.; Stephanie London, M.D., Dr.P.H.; and Kimberly Thigpen Tart, J.D. (Photo courtesy of Steve McCaw)

NIEHS Leadership for the WHO Collaborating Centre

Focus area leaders come from different branches of NIEHS and provide guidance to each area.



*John Balbus, M.D., M.P.H.
Collaborating Centre director and
lead for climate change*



*Kimberly Gray, Ph.D.
Co-lead for children's
environmental health and
indoor air pollution*



*Michelle Heacock, Ph.D.
Co-lead for children's
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electronic waste*



*Jerrold Heindel, Ph.D.
Co-lead for developmental
origins of health and
disease (2013-2017)*



*Thaddeus Schug, Ph.D.
Co-lead for developmental
origins of health and disease*



*Banalata Sen, Ph.D.
lead for Training and Capacity
Building (2013-2016)*



*William Suk, Ph.D., M.P.H.
Co-lead for children's
environmental health and
electronic waste*



*Claudia Thompson, Ph.D.
Co-lead for developmental
origins of health and disease and
indoor air pollution*



*Christopher Weis, Ph.D.
Representative to the WHO
Chemical Risk Assessment Network*

NIEHS Leadership for Global Environmental Health

Steering Committee



*Gwen Collman, Ph.D.
Division of Extramural
Research and Training*



*Stephanie London, M.D., Dr.PH
Division of Intramural Research*



*Kimberly Thigpen Tart, J.D., M.P.H.
Office of the Director*



*Mary Wolfe, Ph.D.
National Toxicology Program*

GEH Program Staff



From left to right: John Balbus, M.D., Ty Lawson, and Trisha Castranio (Photo courtesy of Steve McCaw)



Collaborating Centre Activities: 2013-2017

This section describes the implementation of the first NIEHS Collaborating Centre work plan, from September 2013 to September 2017.

Focus Area 1: Children’s Environmental Health

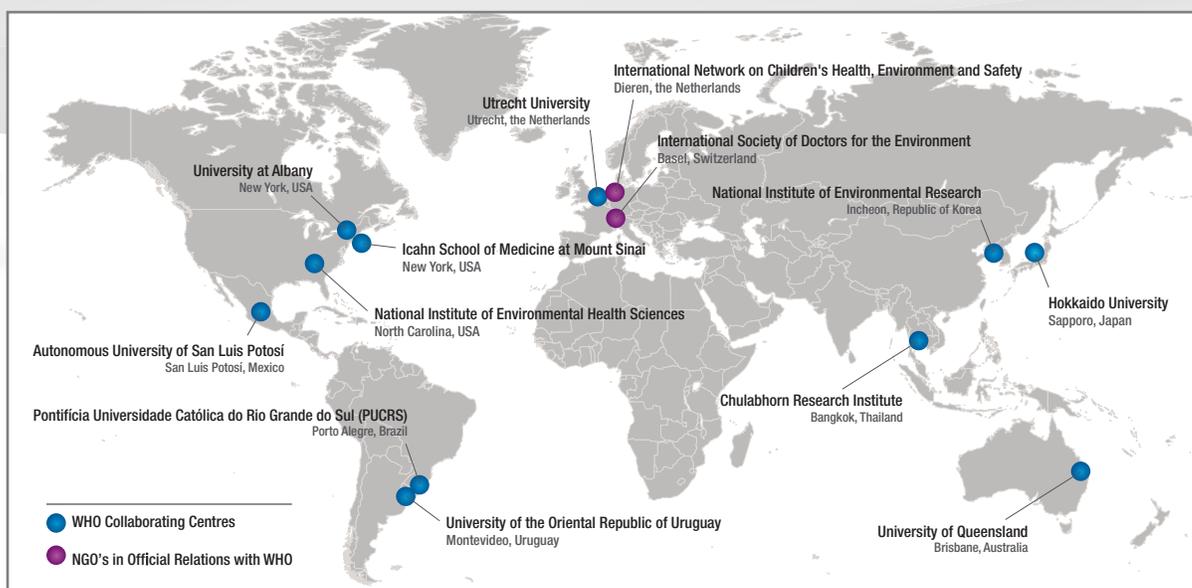
Creation of Network of Children’s Environmental Health Collaborating Centres and Partners

In September 2013, the NIEHS Centre began coordinating a children’s environmental health network, composed of the (then) eight existing WHO Collaborating Centres specifically working in children’s environmental health. Coordination of the network began with a meeting of the Pacific Basin Consortium in Hawaii in September 2013. Representatives of Collaborating Centres discussed and drafted a roadmap to facilitate communication, harmonize initiatives, and identify research and training needs. The roadmap also included developing targeted publications highlighting children’s environmental health. The first of these publications, ***Networking to advance progress in children’s environmental health***, was published in *The Lancet Global Health* and publicly marked

the formation of the children’s environmental health network.

Following a successful initial meeting and launch of the Network, participation grew from the original

As part of efforts to raise awareness about this collaborative endeavour, the NIEHS Global Environmental Health program developed and promoted a **podcast series** about the Network. The podcasts, featuring interviews with William Suk, Ph.D., and Amalia Laborde, M.D., of the University of the Republic in Uruguay, described the history of the Network and the research priorities of its participants.



eight Centres to include two new Centres in South Asia in 2014. NIEHS provided resources and logistical support to ensure continued collaboration and information sharing. To promote each Centre in the Network, a set of webpages, including a landing page outlining Network goals and individual pages featuring each Centre, were developed.

In 2015-2016, three additional Centres and non-governmental organizations (NGOs) in official relations with WHO joined the network. NIEHS worked with all Centres to expand existing webpages and to add new pages for new Centres. The site now provides easy access to basic Centre information, including a description of the Centre and its research or training activities, chemical(s) and health effects being examined, training areas being developed or conducted, relevant publications, collaborations and collaborators, and collaborative network publications. A major effort of 2016 was to expand the webpages to include information on cohort studies being undertaken by Network Centres, including study descriptions, locations, contact information for principal investigators, health effects studied,

sample types collected, questionnaires, and any published key findings.

The Centres and NGOs in official relations with WHO¹ participating in the Network have expanded from the original eight to the following 13:

- The Center for Applied Research in Environment and Health at the Autonomous University of San Luis Potosí in San Luis Potosí, Mexico
- Centre for Environmental and Health Sciences at Hokkaido University in Sapporo, Japan
- Center for Environmental Hazards to Children's Health (CEHCH) at Pontificia Universidade Católica do Rio Grande do Sul in Porto Alegre, Brazil
- Children's Health and Environment Program at the University of Queensland in Brisbane, Australia
- Chulabhorn Research Institute in Bangkok, Thailand
- Department of Toxicology, Faculty of Medicine at the University of the Oriental Republic of Uruguay in Montevideo, Uruguay
- Icahn School of Medicine at Mount Sinai in New York, New York, USA

¹ NGO's in "Official relations" is a privilege that the WHO Executive Board may grant to nongovernmental organizations, international business associations and philanthropic foundations that have had and continue to have a sustained and systematic engagement in the interest of the Organization.



Participants at the CEH Network meeting pose for a photo (Photo courtesy William Suk)

- Institute for Health and the Environment at the University at Albany in Albany, New York, USA
- Institute for Risk Assessment Sciences at Utrecht University in Utrecht, the Netherlands
- International Network on Children's Health, Environment and Safety (INCHES) in Dieren, the Netherlands*
- International Society of Doctors for the Environment (ISDE) in Basel, Switzerland*
- National Institute of Environmental Health Sciences in Durham, North Carolina, USA
- National Institute of Environmental Research in Incheon, Republic of Korea

Convening Internationally

Many CEH Network participants attended the **Fourth International Summit of Prenatal Programming and Toxicity (PPTOX IV)** in October 2014. At the event, participants convened to help determine the Network plan for 2014-2015.

Additionally, many Network members attended the **16th International Conference of the Pacific Basin Consortium for Environment and Health (PBC)**, August 10 - 13, 2015 in Indonesia. A training

workshop was held in advance of the conference that covered the principles underlying the special vulnerability of children and highlighted risks in specific environments. Network members presented on such topics as the health effects of gold mining, electronic waste, and hydraulic fracturing; environmental exposures; and emerging pollutants.

In November 2016, Network participants again met in person at the Workshop on Southeast Asian Children's Environmental Health, following the **8th Princess Chulabhorn International Science Congress (PC VIII)** in Bangkok, Thailand. Discussions focused on identifying needs for CEH research in Southeast Asia. Participants in the meeting included Network Centres as well as researchers from Bhutan, India, Myanmar, Nepal, and Vietnam. A draft document of meeting discussions was created for publication in the *Bhutan Journal of Health*.

Writing Collaborative Publications

Since 2014, NIEHS staff joined Network participants in the publication of multiple peer-reviewed articles, including:

- ***Children's health in Latin America: the influence of environmental exposures***
- ***Early-life exposure to widespread environmental toxicants and health risk: a focus on the immune and respiratory systems***
- ***Environmental pollution: an under-recognized threat to children's health, especially in low- and middle-income countries***
- ***Ensuring a bright future for children's environmental health***
- ***Health consequences of environmental exposures: causal thinking in global environmental epidemiology***
- ***Health consequences of environmental exposures in early life: coping with a changing world in the post-MDG era***
- ***Mechanisms underlying latent disease risk associated with early-life arsenic exposure: current research trends and scientific gaps***

Other CEH Activities

In August 2014, Claudia Thompson, Ph.D., Kimberly Gray, Ph.D., and Gwen Collman, Ph.D., of NIEHS attended the International Society of Children's Health and the Environment (ISCHE) retreat in Whidbey Island, Washington. This was the first time ISCHE convened a group of researchers and health professionals to discuss the future of children's health. Nine countries were present, and the retreat was planned by ISCHE members and facilitated by the Collaborative on Health and the Environment. The meeting included five-minute "ignite talks" on various trends, challenges, and opportunities in the field of children's environmental health. Attendees highlighted the need for more integration by ISCHE with the WHO Collaborating Centres focused on children's health. Attendees also discussed approaches to sharing science and outreach materials and ways to collaborate with WHO to enable a larger global presence.



Focus Area 2: Electronic Waste

Investigating ways to reduce exposure

The importance of electrical equipment and electronic waste (e-waste) as a research topic and health risk has acquired increased visibility through NIEHS in a number of ways. In June 2013, NIEHS supported the meeting of health and policy experts at the International Workshop on E-waste and Children at WHO headquarters, which examined the current state of research and provided recommendations to WHO. The workshop resulted in the 2013 Geneva Declaration on E-waste and Children's Health.

NIEHS supported a plenary session on e-waste at the 2013 International Conference of the Pacific Basin Consortium, as well as a post-event follow-up meeting. Following the Pacific Basin Consortium meeting, NIEHS, in conjunction with WHO and other Collaborating Centres, drafted an e-waste training program to inform healthcare providers and researchers.

As part of NIEHS efforts to bring the work of the WHOCC to an international audience, Michelle

Heacock, Ph.D., presented "Prevention/Intervention Strategies to Minimize Exposure to E-waste" at the May 2014 Central and Eastern European Conference on Health and the Environment in Cluj-Napoca, Romania.

Network members attended the **16th International Conference of the Pacific Basin Consortium**, held August 10 - 13, 2015, wherein Heacock co-chaired a symposium titled "Prevention and Intervention Strategies to Reduce Exposure to E-waste." Presenters discussed the United Nations Environment Programme initiative titled "Solving the E-waste Problem (StEP)," as well as projects in China, Ghana, India, and Sri Lanka.

Following the PBC meeting, the Collaborating Centre held a separate workshop to explore prevention and intervention strategies to reduce exposure to e-waste. The workshop and its activities were planned with representatives from the StEP Initiative, the Fogarty International Center, e-waste experts, engineers, and environmental scientists. Presenters discussed case studies from China, Ghana, the Philippines, and

Uruguay, highlighting successes and lessons learned in reducing and studying e-waste. Building on the case studies, breakout groups addressed reducing exposures, monitoring the effectiveness of prevention efforts, effective interventions, and communication strategies. This successful workshop resulted in the development of recommendations for future activities, which were shared in the journal **Reviews on Environmental Health**.

Pure Earth, an international non-profit based in the U.S., sponsored a documentary video featuring William Suk, Ph.D., in which he explained the hazard and health effects of e-waste. The video was used to set the stage for workshop discussions and activities.

NIEHS has held several events on the NIEHS Research Triangle Park (RTP) campus to raise awareness of e-waste, including presentations focused on e-waste at the two most recent NIEHS Global Environmental Health (GEH) Day

events. In 2016, e-waste was a featured topic in a panel session at GEH Day exploring issues in sustainable development. In 2017, GEH Day again featured a discussion and video of e-waste issues around the world.

Writing Collaborative Publications

Building on successful collaborations and past publications, NIEHS staff and CEH Network participants published the following:

- ***A quarter century of the Pacific Basin Consortium: looking back to move forward***
- ***Changing exposures in a changing world: models for reducing the burden of disease***
- ***E-waste and harm to vulnerable populations: a growing global problem***
- ***E-waste: the growing global problem and next steps***
- ***Health effects of exposure to e-waste***



E-waste meeting attendees pose for a photo before departing Indonesia. (Photo courtesy of Michelle Heacock)



Focus Area 3: Developmental Origins of Health and Disease and Prevention of Early-Life Exposures

Leading Efforts to Understand Early Exposures

As a WHOCC, NIEHS has worked with WHO to develop a three-pronged approach for the developmental origins of health and disease (DOHaD): 1) raising awareness and communication of DOHaD and non-communicable diseases; 2) identifying and engaging researchers currently working in this area, as well as bringing new researchers into the field; and 3) identifying and communicating public health interventions for reducing avoidable exposures. This approach was then presented at sessions of the Fourth International Summit of Prenatal Programming and Toxicity (PPTOX IV) that were jointly organized by WHO and NIEHS to set future directions for DOHaD.

Fourth International Summit of Prenatal Programming and Toxicology (PPTOX IV)

The Collaborating Centre co-sponsored PPTOX IV, “Environmental Stressors in Disease and Implications for Human Health,” held in Boston,

October 27 - 29, 2014. This international conference provided a forum for interdisciplinary discussions on the current landscape, future directions, and ongoing global implications of environmental hazards during early life.

During PPTOX IV, NIEHS staff served on conference planning and scientific committees and developed conference sessions. The first session, “Developing a Global Definition of Developmental Origins of Health and Disease (DOHaD)” was co-chaired by John Balbus, M.D., and featured Linda Birnbaum, Ph.D., NIEHS director, and Jerry Heindel, Ph.D. The second session, “Developing a Global DOHaD Network,” was co-chaired by Claudia Thompson, Ph.D., and included a panel discussion with staff from WHO, NIEHS, and non-profit organizations.

Following the 2014 conference, NIEHS coordinated a special meeting for representatives of the International Society for Developmental Origins of Health and Disease, the Endocrine Society, WHO, and interested scientists. They explored how to

better coordinate efforts to further understanding of early-life exposures. Their goal was to guide the progress of this rapidly growing field.

Fifth Conference on Prenatal Programming and Toxicity (PPTOX V)

NIEHS was highly involved in the *Fifth Conference on Prenatal Programming and Toxicity* (PPTOX V), held in Kitakyushu, Japan in November 2016. The conference included presentations from international experts representing cohort studies and basic science covering prenatal and developmental toxicity. Topics included new and emerging fields, such as epigenetics, preconception exposures, complex exposures, metabolic disturbances, and lessons learned from birth cohort studies. NIEHS focus area leaders Heindel and Thaddeus Schug, Ph.D., were members of the international organizing committee. NIEHS provided scholarships to 13 scientists to cover travel costs. Presentations and sessions chaired by NIEHS staff included: “Expanding the DOHaD Perspective in Setting Research Priorities,” “The DOHaD Paradigm in Environmental Health Research and Public Health,” “Regional and Global DOHaD Research and Collaborative Potential,” “Preconception Exposures,” and “Understanding Variability: A Key to Interpreting Data and Understanding Health Risks of Early-Life Exposures.”

NIEHS organized a side event at PPTOX V that brought together representatives of institutions from Asia, the U.S., Europe, and Canada to explore potential collaborations across the DOHaD Society affiliates, focusing initially on developing an Asian DOHaD Society and network. Investigators from birth cohorts in the region and more than 50

scientists joined the event to stimulate collaboration, coordination, sharing of knowledge/technologies, and education and outreach across the globe.

Advancing Understanding of Exposures

NIEHS performed a comprehensive literature review to describe the human evidence for the association of developmental exposures to environmental chemicals and later-life disease and dysfunction. Health endpoints included in the review were neurodevelopmental, behavioral, and neurodegenerative outcomes; cancer and respiratory diseases; reproductive disorders; immune dysfunction; and obesity and metabolic syndrome. The analysis contributed to WHO’s international initiative on DOHaD by providing scientific summaries of the evidence for early-life effects, and results were published in 2017, in the journal *Reproductive Toxicology*.

In 2015, NIEHS continued to raise awareness of the role of early-life exposures in adult non-communicable disease, particularly those influenced by the environment. The Institute’s primary focus for the year included support for and participation in the WHO Meeting on Avoidable Early Environmental Exposure, held June 13 - 14 in Geneva, Switzerland. The meeting aimed to synthesize WHO information on avoidable exposures; discuss possible interventions to reduce the risks to children; discuss effective education and advocacy strategies for health care professionals, policymakers, the general public, nongovernmental organizations, and civil society; and identify the key elements of a roadmap for action by the global community, including priority areas for action, advocacy, capacity building, research, and other



Participants of the 2015 Early Avoidable Environmental Exposure meeting pose for a group photo. (Photo Courtesy of Emiko Todaka, WHO)

elements. NIEHS focus area leaders Kimberly Gray, Ph.D., and Heindel attended and helped plan the meeting, along with Thompson. NIEHS provided additional support to the meeting by coordinating and supporting travel for an on-site scientific writer and meeting assistant.

NIEHS celebrated the history of research on endocrine-disrupting chemicals at the **25 Years of Endocrine Disruption Research: Past Lessons and Future Directions** workshop hosted in September 2016 at the NIH campus in Bethesda, Maryland.

NIEHS worked with U.S. scientists to develop a U.S. DOHaD Society affiliate chapter. The chapter works to stimulate DOHaD research, communication, and collaborations among researchers working in nutrition, environmental chemicals, stress, and the microbiome. This DOHaD Society affiliate chapter provides a means to interact with other Society affiliates in Africa, Australia / New Zealand, Canada, France, Japan, and South America to form a global network focusing on DOHaD and its importance to disease across the globe.

In 2015, NIEHS hosted a satellite symposium in conjunction with **the DOHaD Society Conference**, held November 8 - 11 in Cape Town, South Africa that focused on sexually dimorphic disease outcomes from developmental exposures to environmental chemicals. In addition, NIEHS organized the First African Conference on Health Effects of Endocrine Disruptors, which focused on the DOHaD paradigm and brought together researchers from across Africa, as well as the U.S. and Europe. This conference set the stage for further DOHaD activities in Africa. As a follow-up, NIEHS and meeting attendees published **Endocrine disruptors and health effects in Africa: a call for action** in 2017.

NIEHS staff also attended the 8th Princess Chulabhorn International Science Congress (PC VIII) in November 2016, hosted by the Chulabhorn Research Institute in Bangkok, Thailand. Among the many topics at the Congress, NIEHS staff spoke at or chaired the following sessions: "The Complex Pathway to Noncommunicable Disease: Opportunities for Prevention," "The Role of Nutrition/ Diet to Reduce Disease Risks Associated with

Environmental Exposures,” “Susceptibility to Infectious Diseases: Does Exposure to Environmental Chemicals Play a Role,” and “In Utero and Early Childhood Exposure and Cancer in Children.”

Writing Collaborative Publications

Over the course of the years, NIEHS staff were involved in publishing a number of DOHaD-focused peer-reviewed articles, including:

- *A proposed framework for the systematic review and integrated assessment (SYRINA) of endocrine disrupting chemicals*
- *A special issue on the environment and developmental origins of health and diseases*
- *Burden of disease and costs of exposure to endocrine disrupting chemicals in the European Union: an updated analysis*
- *Developmental origins of health and disease: a paradigm for understanding disease cause and prevention*
- *Developmental origins of health and disease: integrating environmental influences*
- *Elucidating the links between endocrine disruptors and neurodevelopment*
- *Endocrine disruptors and obesity*
- *Estimating burden and disease costs of exposure to endocrine-disrupting chemicals in the European Union*
- *Evolution of DOHaD: the impact of environmental health sciences*
- *Life-long implications of developmental exposure to environmental stressors: new perspectives*
- *Male reproductive disorders, diseases, and costs of exposure to endocrine-disrupting chemicals in the European Union*
- *Manufacturing doubt about endocrine disrupter science - a rebuttal of Industry-sponsored critical comments on the UNEP/WHO Report “State of the Science of Endocrine Disrupting Chemicals 2012”*
- *Mechanisms underlying latent disease risk associated with early-life arsenic exposure: current research trends and scientific gaps*
- *Metabolism disrupting chemicals and metabolic disorders*
- *Minireview: endocrine disruptors: past lessons and future directions*
- *NIEHS/FDA CLARITY-BPA research program update*
- *Obesity, diabetes, and associated costs of exposure to endocrine-disrupting chemicals in the European Union*
- *Parma consensus statement on metabolic disruptors*
- *Review of developmental origins of health and disease publications in environmental epidemiology*
- *Uppsala consensus statement on environmental contaminants and the global obesity epidemic*



Focus Area 4: Health Implications of Climate Change and Sustainable Development

Informational Activities in International Science and Policy Settings and Support for Meetings and Convening of Experts

As part of a set of activities coordinated with WHO and related to the **United Nations Framework Convention on Climate Change's 19th Conference of the Parties** (COP 19) that took place in Warsaw, Poland in November 2013, NIEHS organized an event at the U.S. Centre regarding "Health Adaptation in the United States and Around the World." This event was the subject of a December 2013 article in the **Environmental Factor**, NIEHS's newsletter. In addition, the U.S. Department of State created a **video of the event**.

NIEHS was part of the Technical Advisory Group for the first WHO Climate and Health Summit, held August 27 - 29, 2014. John Balbus, M.D., spoke as a panel member for the session titled "Strengthening Health Resilience to Climate Change" and participated as part of the U.S. delegation.



U.S. delegation members in Paris included (left to right) John Balbus, M.D., (NIEHS), Juli Trtanj, M.E.Sc. (NOAA), Kimberly Thigpen Tart, J.D., (NIEHS), Mark Shimamoto, M.P.H. (U.S. Global Change Research Program), and Joshua Glasser, M.S. (U.S. Department of State). Third from right is Maria Neira, M.D., WHO Director, Department of Public Health and Environmental and Social Determinants of Health (PHE). (Photo courtesy of NIEHS)

Balbus and Kimberly Thigpen Tart, J.D., were members of the U.S. delegation to the Second Global Conference on Health and Climate in Paris in July 2016. Balbus also served on the planning committee and spoke on a panel on enhancing the resilience of health systems.



Health and environment professionals from across Southeast Asia attended the health and climate workshop in Singapore. (Photo Courtesy of John Balbus)

NIEHS co-sponsored and was on the organizing and scientific committees for the WHO/PAHO Collaborating Centres workshop, titled ***Climate-Smart and Sustainable Societies: Addressing Public Health Vulnerabilities and Promoting Sustainable Adaptation Now***, in Montreal, September 9 - 11, 2015. Balbus provided opening comments and later presented about “Sustainable and Climate Resilient Health Care Facilities.” NIEHS also helped plan a pre-meeting workshop, “Climate Resilient Health Systems,” that brought together experts from around the Americas. They discussed successes and challenges in making health sector facilities and systems more resilient. Balbus also presented the ***U.S. Department of Health and Human Services’ Sustainable and Climate Resilient Health Care Facilities Toolkit***, which he helped develop in 2014-2015. As a follow up to the workshop, the article ***Enhancing the sustainability and climate resiliency of health care facilities: a comparison of initiatives and toolkits*** was published in September 2016 in the Pan American Journal of Public Health’s special issue on climate change.

Building on NIEHS-Indian collaborations described below, Balbus travelled to India in March 2016 to

deliver an opening address at the Indian Institute of Tropical Meteorology’s Monsoon Forecast Conference and represented NIEHS at an Indo-U.S. bilateral meeting with the Indian Council on Medical Research to explore areas of collaboration in environmental health. He also met with the principal health secretary of the State of Maharashtra, Sujata Saunik, and her staff to discuss that state’s efforts to enhance health resilience to climate change impacts.

NIEHS participated in Health and Climate: Realizing the Promise of Co-Benefits, a training workshop held September 14 - 18, 2015, and hosted by the Singapore Environment Institute. Health and environment ministry professionals from all members of the Association of Southeast Asian Nations (ASEAN) took part. It focused on tools for assessing the health benefits of climate mitigation strategies associated with reductions in conventional air pollutants.

Participation in and Support for Critical Scientific Assessments and Reports

NIEHS played a leading role in the development of the U.S. Global Change Research Program (USGCRP) report, ***The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment***. The publication includes an updated assessment of the climate change and health literature from around the globe, along with national-scale modeling of selected health impacts in the United States. Climate change focus leader Balbus was a convening lead author on two chapters and, along with Thigpen Tart, was a member of the steering committee that provided guidance and oversight to the entire report. Balbus was also a lead author of the ***Human Health Chapter of***

the Third National Climate Assessment and is the co-convening lead author of the Human Health Chapter in the upcoming Fourth National Climate Assessment, Volume II: Climate Change Impacts, Risks, and Adaptation.

Balbus also served as a review editor for the **Urban Areas Chapter** of Volume II of the Intergovernmental Panel on Climate Change (IPCC) Fifth Annual Report, providing health expertise in the final shaping of that document.

Activities Supporting Training and Capacity Building

Since 2015, NIEHS has worked to build capacity in India and South Asia for understanding climate change impacts. In September 2015, NIEHS sponsored the training workshop **Understanding Climate and Health Associations in India (UCHAI)** in New Delhi, a kick-off to building a community of practice (CoP) on climate and health in India. The workshop, sponsored by NIEHS and organized

by TARU Leading Edge, Ltd., focused on three core frameworks in dealing with climate and health issues: vulnerability, adaptation, and co-benefits. It also covered policy research, skill building, and networking. UCHAI endeavours to bring researchers, practitioners, and students from diverse fields, including climate science, environment, public health, public policy, social development, and urban planning, together through a resource network and community of practice.

Leading representatives of India's government and academic institutions participated in the event, as well as representatives from the U.S. Embassy in New Delhi, the National Oceanographic and Atmospheric Administration (NOAA), the Indian Council of Medical Research, and the WHO South-East Asia Regional Office (SEARO). Training materials developed by SEARO were demonstrated during the workshop. Bono Sen, Ph.D., gave a presentation on community-based participatory research, and Balbus provided the opening keynote



NIEHS and NOAA staff pose with local hosts at the kick-off of UCHAI in 2015. (Photo Courtesy of Nitish Dogra)

address and a lecture on the use of epidemiology and risk assessment to understand health effects from climate change.

With support from the NIEHS Collaborating Centre, UCHAI also hosted a **National Level Workshop on Building Climate Resilience for Ensuring Transformational Health Outcomes** in March 2017. Attendees included researchers, policymakers from the Ministry of Health and Family Welfare, the Indian National Centre for Disease Control, U.S. Embassy staff, and representatives of WHO (New Delhi). Participants discussed national, state, and local actions to plan for climate sensitive diseases, address preparedness issues, and build capacity.

UCHAI also has hosted a series of webinars to explore different health outcomes and exposures related to climate change. Two webinars were developed by NIEHS, The Energy Research Institute (TERI), and TARU Leading Edge, including “Sustainable Development Goals: Hopes and Challenges” and “Building the Bridge Between Climate and Public Health.” Recent additional webinars have featured local, state, and national experts discussing “Preparedness for Vector Borne Diseases in India,” “Heat Adaptation and Disaster Plans,” and “What Medical Students and Health Professionals Need to Know about Climate Change and Health.” In early 2016, a **new UCHAI website** was developed to help further the goals of the CoP. UCHAI, through the secretariat at TERI, supported a film festival in September 2017 at the Annual College Cultural Festival (PULSE) at the All India Institute of Medical Sciences. The festival organized events on the importance of global climate change and its impact on health and featured a video competition to raise awareness.

Writing Collaborative Publications

Building on the collaboration between NIEHS and WHO in conducting an **Expert Consultation on Measuring Health Gains from Sustainable Development** (May 17 - 18, 2012), Balbus co-authored, with WHO staff Maria Neira, M.D., Carlos Dora, M.D., Ph.D., Elaine Fletcher, and Heather Adair-Rohani, M.P.H., a Lancet article, titled **Indicators linking health and sustainability in the post-2015 development agenda.**

NIEHS staff have published additional articles throughout the past four years, including:

- ***A wedge-based approach to estimating health co-benefits of climate change mitigation activities in the United States***
- ***Changing the climate of respiratory clinical practice. insights from the 2016 Climate and Health Assessment of the U.S. Global Change Research Program***
- ***Estimating the health effects of greenhouse gas mitigation strategies: addressing parametric, model, and valuation challenges***
- ***Marking a new understanding of climate and health***
- ***Protecting our children from climate change***



Focus Area 5: Cookstoves, Indoor Air Pollution, and Child Health in the Americas

In August 2014, NIEHS hosted a workshop focusing on ***Assessing Exposures and Health Effects Related to Indoor Biomass Fuel Burning***. Speakers explored the burden of disease resulting from biomass exposures and the latest science on cookstove interventions. Presenters included NIEHS scientists from the Collaborating Centre, as well as speakers from the United Nations Foundation and members of the CEH Collaborating Centre Network.

In an effort to share the latest science and explore future research needs related to indoor air pollution, John Balbus, M.D., co-authored ***Household air pollution in low- and middle-income countries: health risks and research priorities***, which was published in PLOS Medicine.

Supporting International Research Translation and Cooperation

In June 2015, NIEHS worked with PAHO to organize

a workshop on cookstoves. This event, hosted in Honduras, brought together policymakers from Latin American and Caribbean countries to explore the potential for changes related to stoves and cleaner fuel. NIEHS organized and secured speakers for a scientific session that focused on the health effects of indoor air pollution and evidence-based solutions.

Also in 2015, NIEHS partnered with the Fogarty International Center, other U.S. government agencies, and the Global Alliance for Clean Cookstoves to develop an ***implementation science network***. This network comprises extramural and federal scientists, NGOs, and others with experience in improving adoption and uptake of interventions – including, but not limited to, improved cookstoves – in high-burden countries. Products from this network include a series of papers on regional case studies and a summary of best practices for both researchers and implementers. This project



will help WHO implement its new Indoor Air Quality Guidelines.

The NIEHS GEH program developed and promoted a **podcast series** about cookstove research. Two episodes, released in March 2015 and featuring the NIEHS's Claudia Thompson, Ph.D., and Kalpana Balakrishnan, Ph.D., of Sri Ramachandra University in Chennai, India, described current efforts to research the health effects of cookstoves. A Global Environmental Health Newsletter article also highlighted NIEHS grantee research on cookstoves.

Centre Theme: Promotion of Global Environmental Health Professional Training and Capacity Building

Crosscutting all Focus Area activities of the NIEHS WHO Collaborating Centre are Centre Themes. These themes are included in each area and aim to expand the impacts of Centre activities. Training and Capacity Building is one such theme.

Following the Pacific Basin Consortium meeting in 2014, a new training on the effects of e-waste on children's health was created by an international team, including NIEHS scientists. The training explores the health impacts of e-waste on children, including possible exposure routes, and specifically focuses on educating health care providers on their role. NIEHS is helping promote the use of this training through extramural grantees working in Africa and Canada.

In March 2014, Bono Sen, Ph.D., NIEHS training and capacity building focus area lead, traveled to India and, through a partnership with the Public Health Foundation of India, conducted a training **on research, writing, and publication**. This three-day workshop was developed to help researchers from low- and middle-income countries (LMICs) strengthen their writing and publishing abilities.

To better educate students on the health impacts of climate change, NIEHS revised and updated high school curricular materials related to climate and health to align with IPCC and USGCRP assessments. In addition, NIEHS contracted to convene a working group of educators, scientists, and advocates who share an interest in bringing

climate change and health education to classrooms around the world. This initiative aims to distribute newly created climate and health education materials, share ideas and teaching strategies with teachers, and better understand existing tools for reaching students with important climate and health information. Materials, slides, and flashcards are available on the NIEHS website. NIEHS also has worked to share the training materials via national and international training networks, such as the CLEAN Network and GLOBE. NIEHS, with the assistance of a medical fellow from the University of Colorado, has begun adapting the materials so they can be used with graduate students in public health and in medical and clinical education programs.

In December 2016, NIEHS released the ***NIEHS Climate Change and Human Health Literature Portal***, building on a bibliographic database of climate change and health literature that had been provided to the authors of the USGCRP Climate Health Assessment. NIEHS is working to update the portal with the latest scientific literature and, in 2017, also added new search fields.

Centre Theme: Improving Global Awareness through Multimedia

The Collaborating Centre shares scientific updates and information on global environmental health through a number of NIEHS communication channels.

The **NIEHS GEH Newsletter** is the Collaborating Centre's primary communication platform. This free, online, bi-monthly publication has a specific focus on NIEHS Collaborating Centre activities. It includes scientific updates and a feature exploring a recent international event or research project. These stories are intended to inform a global audience and to promote best practices in global, community-engaged environmental health research. In the past year NIEHS re-designed the newsletter to be mobile-friendly and created a specific section to highlight Collaborating Centre activities.

Additional media products include the NIEHS monthly newsletter, **Environmental Factor**, which highlights presentations by NIEHS staff at international meetings and attendance at WHO or PAHO events. The January 2016 issue featured a **story** on Collaborating Centre climate change outreach efforts at COP 21. In 2017, the WHO/ UNEP Healthy Environments for Children Alliance monthly newsletter included a number of stories highlighting NIEHS and WHO efforts to bring awareness to CEH issues.

The **Global Environmental Health Chat podcast series** provides interviews with leading international

NIEHS had a unique opportunity in 2017 to provide travel support and training for Adesuwa Aigbokhaode, M.P.H., a researcher at the Federal Medical Centre in Nigeria. Aigbokhaode is leading a study on household air pollution exposure from biomass burning in Nigeria. Through a mentoring event at the American Thoracic Society (ATS) Annual Meeting, NIEHS became aware of Aigbokhaode's work and the many research challenges she faces. In the spring of 2017, NIEHS supported Aigbokhaode's travel to the ATS annual meeting to facilitate further discussion and training to advance her cookstove research. NIEHS also organized her travel to NIEHS to receive training on the use of microPEM sensors that she will use to measure exposures in her study. Aigbokhaode presented at a seminar for NIEHS fellows and staff, where she described her work and helped trainees understand the challenges of conducting research on a limited budget outside the U.S.



Stephanie London, M.D., Dr.P.H., poses with Aigbokhaode at the 2017 ATS meeting (Photo courtesy of Stephanie London)

researchers about recent studies, opportunities, and policies. Podcasts are free to download and available worldwide through the NIEHS website and iTunes. The NIH and NIEHS Facebook and Twitter accounts promote news, events, and publications associated with the Collaborating Centre.

The NIEHS flagship journal, *Environmental*

Health Perspectives (EHP), publishes peer-reviewed research and news that highlights the interrelationships between the environment and public health. Collaborating Centre focus area leadership and many members of the CEH Network have published in EHP. To reach additional researchers, EHP also provides a Chinese-language version of each issue.

NIEHS and GEH Multimedia

- *NIEHS WHO Collaborating Centre for Environmental Health Sciences Website*
- *NIEHS GEH Newsletter*
- *NIEHS Environmental Factor Newsletter*
- *NIEHS GEH Podcasts*
- *NIEHS on Twitter: @NIEHS*
- *NIEHS on Facebook*

Centre Theme: WHO Chemical Risk Assessment Network Support

NIEHS supports training and capacity building in LMICs through its participation in and support for the WHO Chemical Risk Assessment Network. The Network is organized by the WHO International Programme on Chemical Safety (IPCS) and was founded in 2014. Christopher Weis, Ph.D., serves as the NIEHS liaison to the Network. A major Network goal is to train researchers in risk assessment and to build capacity for researchers in LMICs to understand and perform risk assessments.

NIEHS has provided support to the Network Secretariat through participation in steering committee calls and document reviews and by providing contract support to WHO. With the assistance of a support contract with MDB, Inc., NIEHS provides meeting support and assists WHO with the development of quarterly network newsletters, website content, and other communications products.

In October 2014, NIEHS supported the first in-person meeting of the Network in Paris, which was attended by 55 chemical risk assessment institutions from 29 countries. Weis served as a meeting co-chair. The keynote speaker was Kenneth Olden, Ph.D., former NIEHS director and current director of the U.S. Environmental Protection Agency's National Center for Environmental Assessment. Working groups developed collaborative plans to address biomonitoring, identify high-priority needs in research and methods development, increase and coordinate training efforts for risk assessors, and establish communication among participants.

To expand participation in the Network, Weis has presented Network activities and materials at major international conferences, including the Society of Toxicology Annual Meeting and EuroTox. NIEHS supported a series of Network webinars



Attendees at the 2017 WHO Chemical Risk Assessment Network in-person meeting pose for a photo at the host institution. (Photo Courtesy of the European Food Safety Authority)

aimed at increasing awareness and understanding of systematic review (SR) for chemical risk assessment. Speakers in the two-part series, held between December 2015 and May 2016, explained the basics of SR, shared case studies of SR in risk assessment, and addressed SR's benefits and challenges. NIEHS is now supporting the Network working group that is developing the first WHO Guidelines for SR in Chemical Risk Assessment and coordinating efforts with other international SR initiatives. NIEHS staff members, including representatives of the National Toxicology Program, are working to co-author multiple chapters of the guidelines.

NIEHS support for the Network in 2017 included in-kind support and participation at the 2017 WHO Chemical Risk Assessment Network in-person meeting. The meeting was hosted by the European Food Safety Authority (EFSA) in Parma, Italy in June. Weis served as a meeting co-chair and joined the Systematic Review Working Group in delivering a training for attendees. NIEHS also provided support for a meeting planner and notetaker to attend the event and contribute to the final report.

Looking to the Future: NIEHS WHOCC Redesignation Plans for 2017-2021

In September 2017, NIEHS was redesignated as a WHOCC for the years 2017-2021. NIEHS will continue assisting WHO in promoting international cooperation among environmental health research institutes, promoting global awareness of emerging issues in environmental health, and preparing training materials and events in the environmental and occupational health sciences.

NIEHS will support WHO in the following focus areas:

- Chemical Risk Assessment Network
- Children's Environmental Health
- Environmental Factors and Non-Communicable Diseases
- Health Consequences of Weather and Climate Extremes

Under these areas, NIEHS will continue work on existing projects focused on e-waste, indoor air pollution, and the developmental origins of health and disease (DOHaD). The Institute also plans to expand work into new and emerging areas, such as chronic kidney disease of unknown origin (CKDu). Training and capacity building remains an important cross-cutting theme, and NIEHS efforts will continue in this vein. New NIEHS staff members will join these efforts, and the Institute looks forward to the coming years of continued collaboration.





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