How Climate Change Impacts Women and Their Health

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Advisory Committee on Research on Women's Health

National Institutes of Health • U.S. Department of Health and Human Services
The mission of the National Institute of Environmental Health Sciences is to discover how the environment affects people in order to promote healthier lives.

The vision of the National Institute of Environmental Health Sciences is to provide global leadership for innovative research that improves public health by preventing disease and disability.
NIEHS Strategic Plan
What’s in our environment that can impact our health?

- Microbiome
- Infectious Agents
- Air, Water and Soil
- Agricultural Chemicals, Pesticides
- Synthetic Materials
- Disasters and Wildfires
- Diet
- Lifestyle
- Exercise
- Stress
- Personal Care Products
- Green spaces
What’s in our environment that can impact our health?

Inter-individual genomic and biological heterogeneity
What’s in our environment that can impact our health?

- Microbiome
- Infectious Agents
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The Exposome Concept

**ECOSYSTEMS**
- Food & alcohol outlets
- Built environment, urban land uses
- Population density
- Walkability
- Green/Blue space

**LIFESTYLE**
- Physical activity
- Sleep behavior
- Diet
- Drug use
- Smoking
- Alcohol use

**SOCIAL**
- Household income
- Inequality
- Social capital
- Social networks
- Cultural norms
- Cultural capital
- Psychological & mental stress

**PHYSICAL - CHEMICAL**
- Temperature/humidity
- Electromagnetic fields
- Ambient light
- Odor & noise
- Point, line sources
- Air pollution
- Agricultural activities, livestock
- Pollen/mold/fungus
- Pesticides
- Fragrance products
- Flame retardants
- POPs
- Plastics & plasticizers
- Food contaminants
- Soil contamination
- Drinking water contamination
- Groundwater contamination
- Surface water contamination
- Occupational exposures

Vermeulen et al., Science, 2020
Women's health is an essential part of the NIEHS research agenda.

In our intramural and extramural divisions, NIEHS is focused on studying the environmental, lifestyle, and behavioral factors to prevent or reduce the chance of women developing health problems over the life course.

Strong and basic mechanistic research on women’s health and reproductive biology.

Integrate the genetic and non-genetic factors that contribute to promoting women’s health.

Using the Exposomics framework NIEHS investigates how SES, structural racism, psychosocial stress can exacerbate chemical exposures that impact women’s health.
Windows of Susceptibility and Developmental Origins of Health and Disease
Environmental Impacts and Women’s Health Disparities
Women’s Health Awareness at NIEHS

• “Our mission is to inform and empower women to take responsibility for their health, understand their health options, and identify services, thereby increasing equal access to services, resources, and products that best help them prevent and reduce poor health.”

• Women’s Health Awareness Community Resiliency, Environmental Action, and Collaborations for Health (REACH) Equity—co-funding from OWHR
  – To identify predisposing factors and COVID-19 related factors that contribute to adverse health outcomes within the Women’s Health Awareness population

Joan Packenham, Ph.D.
Director
NIEHS Office of Human Research Compliance
Panel Presentations: Epidemiologic Contributions to Understanding the Environmental Impact on Women’s Health

- Dr. Kristen Upson: “Women’s Risk of Endometriosis (WREN) Study”
- Dr. Quaker Harmon: “Study of Environment, Lifestyle, & Fibroids (SELF)”
- Dr. Dale Sandler: “The NIEHS Sister Study”
"Code Red for Humanity"

UN Secretary General on IPCC 2021 report
Impacts of Climate Change on Human Health

**Changes in Climate**
- Increased global temperature
- Extreme weather and disasters
- Precipitation extremes
- Sea level rise
- Changes in land use and growing seasons

**Effects of Climate Change**
- Extreme heat
- Air and water pollution
- Reduced food and water quality
- Changes in infectious diseases and vector transmissions
- Increasing allergens

**Health Impacts**
- Heat related illness
- Cardiovascular disease, stroke, and other chronic conditions
- Injuries and death
- Mental and neurological disorders
- Zoonotic, vector- and water- borne diseases
- Respiratory diseases and asthma
Climate Change Affects Health Directly and Indirectly

**Direct Effects**
- Heat-related illness
- Respiratory disease
- Heart disease
- Food-, water-, and vector-borne diseases
- Injury
- Premature death
- Mental health impacts
- Poor maternal and birth outcomes

**Indirect Effects**
- Chemical releases into environment
- Changes in air, water, food quality and quantity
- Population displacement
- Interruptions to health care
- Infrastructure and supply chain disruption
- Economic impacts – more people living in poverty
Climate Change Affects Us Unequally

Under-served populations with health disparities
(Some communities of color; Low-income populations; Low-educational attainment groups; Immigrant groups; Indigenous populations)

Exposed workers
(e.g., farmers, construction workers)

Persons with disabilities

Vulnerability by life stage
(Fetal/pre-natal, infants, young children, pregnant women, elderly)

Vulnerability associated with chronic medical conditions
(e.g., diabetes, asthma, cardiorespiratory diseases, psychiatric diseases)

Populations in LMICs
(Higher rates of existing diseases, malnutrition, and extreme poverty)

USGCRP Climate Health Assessment, 2016
# Climate Change Affects Women Differently

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Physiologic and biologic vulnerabilities</th>
<th>Disparate health impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme heat</td>
<td>Women have higher working metabolic rate and reduced heat dissipation through sweating</td>
<td>Heat-related morbidity and mortality</td>
</tr>
<tr>
<td>Poor air quality</td>
<td>Women experience greater deposition of particles in the lungs</td>
<td>Respiratory and heart disease</td>
</tr>
<tr>
<td>Poor air quality</td>
<td>Air pollutants can cross placenta</td>
<td>Poor birth outcomes</td>
</tr>
<tr>
<td>Disasters</td>
<td>Women are more likely to have poor baseline nutritional status and physical health</td>
<td>Higher rate of mortality during disasters, birth complications, poor maternal and neonatal health</td>
</tr>
<tr>
<td>Food insecurity</td>
<td>Increased nutritional needs during menstruation, pregnancy, and nursing</td>
<td>Malnutrition, anemia, poor neonatal outcomes</td>
</tr>
<tr>
<td>Waterborne diseases</td>
<td>Dehydration and infection during pregnancy</td>
<td>Preterm birth, poor maternal and neonatal outcomes</td>
</tr>
<tr>
<td>Vector-borne diseases</td>
<td>Women produce higher CO2 which attracts mosquitos; Hormone changes during pregnancy reduce immune response</td>
<td>Poor reproductive, maternal, and neonatal outcomes</td>
</tr>
</tbody>
</table>

Adapted from Sorensen et al., PLoS Med, 2018
Air pollution Contributes to Infertility, Pregnancy Loss, Neonatal Respiratory Complications

- Chronic exposure in pregnancy to ozone and particulate matter were associated with pregnancy loss (miscarriage and stillbirth).

- In a preconception cohort study, residential exposures to certain types of particulate matter were associated with reduced fecundability.

- Neonatal respiratory complications were associated with prenatal exposure to common air pollutants.

Ha S et al, Fertil Steril 2018; NICHD intramural; PMID 29153729. Wesselink et al, Pediatric and Perinatal Epidemiology 2018, R01HD086742, PMID 34890081; Ha S et al, Environmental Research 2017; 159 622-628. NICHD intramural; PMID 28926807.
Ambient Temperature Changes Contribute to Maternal Cardiovascular Complications, Low Birth Weight

- Even small changes in temperature during the week prior to delivery were associated with cardiovascular risk for mothers during labor or delivery.
- Non-Hispanic Black women seemed to be more susceptible to temperature increases during the warm season.
- Exposure to atypically high or atypically low ambient temperatures was associated with low birth weight.

Fig. 2. Risk of cardiovascular events in the warm season associated with 1 °C higher in average temperature during the week prior to delivery. Asterisk indicates statistical significance at $p < 0.05$. 

Hotter Temperatures During Pregnancy Linked to Lower Fetal Growth

- Study included data from nearly 30 million births across the U.S. between 1989 and 2002
- High ambient temperatures across pregnancy were associated with higher risk of term small for gestational age (SGA) and lower birth weight
- Risks were more strongly associated with temperatures during the 2nd and 3rd trimesters, and in cold climates
- Study provides evidence that temperature may be novel risk factor for lower fetal growth

Sun et al., Enviorn Health Perspect, 2019
Higher Temperatures Linked to Lower Ovarian Reserve

- Assessed antral follicle count (AFC), a measure of ovarian reserve, in 631 women aged 18-45 years in Massachusetts.
- Estimated daily ambient temperature exposures 3 months, 1 month, and 2 weeks before AFC examination.
- A 1-degree C increase in average maximum temperature 3 months before ovarian reserve testing was associated with a 1.6% lower AFC.
- Results suggest that the steady increase in temperature due to climate change may result in accelerated reproductive aging in women.

Gaskins et al., Fertil Steril, 2021
Occupational Heat Exposure Linked to Breast Cancer

• Examined associations between female breast cancer risk and occupational heat in large case-control study (1,389 breast cancer patients and 1,434 controls)

• Women having ever been exposed to occupational heat had a higher risk of breast cancer

• Risk was higher among women with hormone receptor-positive breast cancer

• Jobs with the highest exposure included operators of furnaces, miners, cooks, and launderers and ironers

Hinchliffe et al., Cancer Epidemiol Biomarkers Prev, 2021
Climate Change Associated Natural Disasters Disproportionately Affect Women, Children, People with Disabilities

- Women, teens and young adults, and children more vulnerable to post-traumatic stress after Indian Ocean tsunami

- Children with chronic health conditions, and those who needed mental health care, experienced health care disruptions and unmet care needs after Hurricane Katrina

- At-risk children with higher exposure to natural disaster experienced more longer-term problems controlling aggression


Image: www.noaa.gov
Pregnancy Outcomes Before and After Hurricane Harvey

- Study included data from nearly 30,000 pregnant women – 3,842 of whom delivered within 40 weeks after Hurricane Harvey

- Women delivering after the hurricane were more likely to have adverse outcomes, as were their newborns, compared to women delivering before the storm:
  - 27% higher maternal morbidity
  - 50% higher neonatal morbidity

- Women of low socioeconomic status were most affected

Mendez-Figueroa et al., Obstet Gynecol, 2019
Breast cancer patients living through Hurricane Katrina had a 15% higher mortality rate compared to patients not exposed to the storm. The increase was likely caused by disaster-related disruptions in health care.

Associations among all cancer types trended toward higher mortality, but was only significant among breast cancer cases.

Even missing one week of chemotherapy has significant effects on long-term mortality. What does it mean if your access to health care is disrupted for an even longer period of time because of a disaster?

– Sue Ann Bell, Ph.D., study author

Bell et al., J Gen Intern Med, 2020
Climate Change Disrupts the Women’s Care Continuum

- Destroys or damages health care infrastructure
- Power outages, staff shortages, and transportation disruptions reduce access to care, including radiation therapy and preventive cancer screenings
- Overwhelms health system capacity
- Loss of medical records affects follow-up care
- Problems accessing or storing medications
- Disruptions to medical supply chains
- Threatens cancer research infrastructure and disrupts clinical trials
Proposed ALL of NIH Initiative on Climate Change and Health (CCH)

- **Executive Orders Bring Renewed Focus on Climate Change Across Agencies**
  - Executive Order 14008 *Tackling the Climate Crisis at Home and Abroad*

- **President’s Budget & Congressional Markup**
  - President’s Budget ($100M) to NIEHS for CCH Research in Fiscal Year 2023
  - House Markup ($10M) & Senate Proposed Level ($50M)

- **Seven Institute and Center Directors as NIH Leaders**
  - Drs. Bianchi (NICHD), Gibbons (NHLBI), Glass (FIC), Gordon (NIMH), Perez-Stable (NIMHD), Woychik (NIEHS), and Zenk (NINR)

- **Re-energized NIH Working Group co-chaired by NIEHS and FIC**
Framework Guides Future Climate Change and Health Research

- Outlines four core elements
  - Health Effects Research
  - Health Equity
  - Intervention Science
  - Training & Capacity Building

- Goal is to reduce health threats from climate change across the lifespan and build resilience

- New Funding Announcements posted: www.nih.gov/climateandhealth
Impacts of Climate Change on Human Health and Research Needs

- What are the new and emerging health risks from climate change?
- Who is most at risk?
- What health interventions are effective?
- Can we predict future health outcomes from climate models?
- What health benefits or costs come with climate actions?
- How can disaster warning systems best save lives?
- How can health care systems prepare for challenges to providing adequate care?
- How can communities best adapt to a changing climate?
First Projects with FY 2022 Funds from all 7 NIH Initiative Partners

- **Research Coordinating Center for the Climate Change and Health Community of Practice**
  - The Research Coordinating Center (RCC) will support the development of an inclusive Community of Practice (COP) of climate change and health researchers and trainees that fosters collaboration, capacity building, innovation and research.

- **Research Opportunity Announcement Alliance for Community Engagement- Climate and Health (ACE-CH)**
  - NIH is soliciting applications from teams to conduct community-engaged research focused on climate change impacts on health and, the co-benefits of identifying the mitigation of climate change risks, vulnerabilities and adaptation.

- **Notice of Special Interest: Climate Change and Health**
  - NOSI encourages applications that address the impact of climate change on health and well-being over the life course, including the health implications of climate change in the United States and globally.

- **Notices of Special Interest: Innovative Technologies for Research on Climate Change and Human Health (SBIR/STTR)**
  - NOSI to develop or adapt practical technologies for capturing the effects of climate change and extreme weather events on human health and to reduce the health threats posed by climate change across the lifespan.
2022-2023 NIH Climate and Health Scholars Program

- The program seeks to bring Climate and Health scientists from outside the U.S. federal government to work with NIH staff to share knowledge and help build our capacity in the scientific domains outlined in the NIH Climate Change and Health Initiative’s Strategic Framework.

- During their time at NIH, the scholars will be invited to collaborate with NIH staff on one or more of a diverse array of research, training, and policy activities that share their scientific knowledge with NIH laboratories, program offices, and the wider NIH community.

- Applications due September 15, 2022.
## Promoting Health Effects of Climate Change Research in the NIH Intramural Research Program

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<th>Supporting trans-NIH research</th>
<th>Implement a new competitive funding program, the Intramural Targeted Climate Change &amp; Health (ITCCH) program, that provides seed funding to stimulate research activities from NIH intramural investigators at multiple ICs.</th>
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<td>Building intellectual capacity</td>
<td>Establish a new intramural Laboratory/Branch/Center at NIH that focuses on biological mechanisms of health impact of climate change. This branch will serve as a central hub to facilitate research in this area across the entire NIH Intramural Research Program.</td>
</tr>
<tr>
<td>Building infrastructure</td>
<td>Build infrastructure within the NIH Intramural Research Program to begin to establish the tools necessary to conduct research into the health impact of climate change.</td>
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NIH Resources on Climate Change and Health

- **NIH Climate Change and Health Initiative**
  - *Information on the Initiative and Framework*
    - [www.nih.gov/climateandhealth](http://www.nih.gov/climateandhealth)

- **Funding Announcements**
  - *Updated live as announcements are released*
    - [www.nih.gov/climateandhealth](http://www.nih.gov/climateandhealth)

- **Public Seminar Series**
  - *Promoting transdisciplinary discussion and collaboration against this threat to health.*
    - [https://www.nih.gov/climateandhealth#seminar-series](https://www.nih.gov/climateandhealth#seminar-series)

- **Climate Change and Health Literature Portal**
  - *Searchable database to provide access to the most relevant scientific literature*
Thank You!