Impact of climate change on workers and community health

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Greenhouse gases
- Carbon dioxide
- Methane
- Nitrous oxide
- Ozone O₃
- Black Carbon
- Fluorinated gases
  - Chlorofluorocarbons (CFCs)
  - hydrochlorofluorocarbons (HCFCs)
  - hydrofluorocarbons (HFCs)
  - perfluorocarbons (PFCs)
  - sulfur hexafluoride (SF₆)

CLIMATE CHANGE AND HUMAN HEALTH

**CLIMATE DRIVERS**
- Increased T
- Extreme precipitation
- Extreme weather events
- Sea level rise

**EXPOSURE PATHWAYS**
- Extreme heat
- Poor air quality
- Reduced food/water quality
- Changes in infections agents

**HEALTH OUTCOMES**
- Heat-related stress
- Cardiopulmonary illness
- Food, water, vector borne disease
- Pollen and allergies
- Mental Health & stress
- Chronic Kidney disease

From: U.S. Global Change Research Program
In the second week of August 2019, public safety concern declared for 13 States due to heat wave

Cooling center with water distribution provided for outdoor workers

WORKERS MORE AT RISK

- Outdoor workers: agriculture, construction, transportation, oil production, landscaping, firefighting, emergency response
- Indoor work environments: steel mills, dry cleaners, manufacturing facilities, commercial kitchens, warehouses
- Workers in natural environment, including soil, water, animals and infrastructure, animal agriculture and forestry workers, veterinarians, and in meat-handling industries.
- In extreme rain, workers who maintain septic or sewage systems, work on plumbing and water systems

Schulte PA, Chun H. Climate change and occupational safety and health: establishing a preliminary framework. J Occup Environ Hyg. 2009 Sep;6(9):542-54

Cardiovascular Heat stress:
↑ blood viscosity
↑ thrombogenicity
↑ cardiac demand
↑ heart strain
Factors Affecting Risk of Heat-related Illness

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Clinical Climate Change Temperature Recommendations

• Monitoring/adjusting doses/temporarily suspending drugs during predicted heat waves (AHA)
  – diuretics, beta-blockers, renin-angiotensin inhibitors, some antidepressants and anticholinergics.

• Advise about heat/cold exposure, hydration, value of even a few hours of AC, provide sources of emergency heat information

• Advise about alcohol:
  – Cold—vasodilates sending blood to skin where it can increase risk of hypothermia
  – Heat—diuretic leading to water loss reducing ability to lose heat through sweating

• Educate all patients with risk factors/CVD about air pollution
  – Most patients are unaware of the connection between air quality and CARDIAC conditions.

• Provide patients with sources of information about current air quality and what steps to take to protect themselves

Vector borne infections
• *Aedes aegypti* is a highly efficient vector for:
  - Dengue Fever
  - Yellow Fever
  - Chikungunya
  - Zika Virus

• *Aedes albopictus* is a less efficient but *still capable* vector for all of the above.
Climate Change and Range Expansion of the Asian Tiger Mosquito (*Aedes albopictus*) in Northeastern USA: Implications for Public Health Practitioners

- Correctly modeled and predicted current known *Aedes albopictus* range based on past → present climate data
  - Also predicted future range expansion based on future climate predictions

https://doi.org/10.1371/journal.pone.0060874
- Not just moving geographically, but also temporally.
- Lyme season is classically April/May-October
  - The ticks hibernate during cold weather and emerge in spring.
- In past 5 years on Long Island, local Lyme incident cases have expanded into November, December, and January.
- Hurricanes and flash floods may cause increases in infectious disease outbreaks through multiple ways:
  - Bring salt water organisms into water and food supply
  - Bring fresh water or soil organisms in as above
  - Sewage contamination due to overloaded sewers and storm drains, loss of power/pumps
  - Displaced animal vectors (rats)

- Salt water organisms
  - Vibrio—diarrheal illness, infected wounds
  - Aeromonas—bacteremia, infected wounds
  - Mycobacterium marinum—infected wounds

- Fresh water and soil organisms
  - Botulism—paralysis, death
  - Aeromonas
  - Pseudomonas
  - Amebiasis—diarrhea, anemia
  - Giardia—diarrhea
  - Legionella—pneumonia, death
- No access to clean water/sewage contamination
  - All of the above, especially Giardia, Amebiasis, Vibrio
  - Cryptosporidium
  - E coli (all forms including EHEC, HUS)—dysentery, shock
  - Shigella/Salmonella—dysentery, bacteremia
  - Typhoid—fever, bacteremia, death
  - Cholera (not unheard of)
  - Hepatitis A/E—liver disease
  - Norovirus—diarrhea

- Displaced animals—rats & other rodents in particular:
  - Plague
  - Hantavirus
  - Typhus
  - Salmonella
  - Rabies

Infectious Disease Issues Associated with Hurricane Katrina (HK)

Joe Posid
Centers for Disease Control and Prevention

- 6 cases of cholera
- 17 cases of other Vibrio (5 deaths)
- Norovirus
- E coli
- Salmonella
- Flu & pneumonia (overcrowding of evacuees)
Pollen, pollution, asthma and allergies

**Allergic Sensitization**

Carbon dioxide (CO₂) levels in the air promote growth of plants that release airborne allergens:
- ▲ temperature,
- ▲ Carbon dioxide
- ▲ Ozone

Pollen season length, production, and amount of major ragweed allergens have increased in response to elevated ambient levels of carbon dioxide.
Climate change and mental health

• shifting from monthly temperatures of 25-30 °C to >30 °C increases the probability of mental health difficulties by 0.5% points.
• 1°C of 5-year warming associates with a 2% point increase in the prevalence of mental health issues.
Trauma Related Disorders

- Rates of PTSD following disaster usually ~ 30%
- Flooding, expected to increase in the Northeast, is associated with PTSD, anxiety, and depression
- Evacuation from disasters associated with MH impact: 62% of evacuees from Katrina met criteria for acute stress disorder (Mills et al, 2007)

Heat and Suicide

Robust literature documenting association-

- 2 available reviews (Gao 2019, Thompson 2018)
- +1 C in average monthly temperature increased suicide rate by 0.68% in US (Burke et al 2018)
- By 2050 Climate Change expected to cause 14,020 excess suicides in US due to heat (RCP 8.5)

Heat and Violence

- Well documented association
- Climate change is associated with collective violence, generally in combination with other causal factors, e.g. scarcities of cropland and other resources (Levy, et al, 2016; Zhang et al, 2007, 2007, 2011)
- Heat is associated with interpersonal violence, (reviews: Anderson, 2001; Burke, 2015)
- Heat wave associated with 13% increase in assault injuries in Adelaide (Nitschke et al, 2007)
Vulnerabilities of Psychiatric Patients

• Increased mortality of psychiatric patients during heat waves
• Schizophrenic patients can have impaired thermoregulation
• Psychiatric medications, particularly antipsychotics, anticholinergics and benzodiazepines (Matin-Latry 2007) increase heat sensitivity

“EcoAnxiety”

• Most Americans are worried about climate change and 21% are very worried. (Yale Climate Study, 2018)
• Research from Australia
  – Australian study of OCD patients, 28% of participants had OCD concerns directly related to climate change (Jones et al, 2012)
  – Quantitative study of Australians, half of whom lived in urban areas, documented significant distress over climate change, particularly among women and adults aged 35 and younger. (Searle K. & Gow, K., 2010)

Chronic Kidney Disease: the first Emergent Epidemic due to global warming
Kidney anatomy and functions

Renal toxicity and biomarkers

Climate Change and the Emergent Epidemic of CKD from Heat Stress in Rural Communities: The Case for Heat Stress Nephropathy

La Isla Foundation, Chicago, IL, USA; University of Colorado, CO, USA; National Oceanic and Atmospheric Administration (NOAA), Boulder CO, USA; Baylor College of Medicine, Houston, TX, USA; Centro de Hemodiálisis, San Salvador, El Salvador; Instituto Nacional de Cardiología Ignacio Chávez, Mexico; Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico; University of São Paulo Medical School, São Paulo, Brazil; University of Kelaniya, Sri Lanka; Nizams Institute of Medical Sciences Hyderabad, India; Madras Medical Mission & Pondicherry Institute of Medical Science, Puducherry, India; Khon Kaen University, Thailand; Karolinska University Hospital, Stockholm, Sweden; Koc University School of Medicine, Istanbul, Turkey

1. Recurrent heat exposure with physical exertion and inadequate hydration can lead to CKD distinct from diabetes, hypertension, or GN.

2. Epidemics of CKD consistent with heat stress nephropathy are now occurring across the world.

3. Heat stress nephropathy may represent one of the first epidemics due to global warming.

4. Government, industry, health policy makers should place greater emphasis on occupational and community interventions.

Global Climate Risk Index 1996–2015
Source: GermanWatch and Munich RE NatCatSERVICE (Kreft S et al. 2017)
Confirmed site (Andhra Pradesh) and suspected sites of CKD epidemics of unknown etiology in India.

SRI LANKAN NEPHROPATHY

TEMPERATURE TRENDS IN CENTRAL AMERICA
Young men with asymptomatic rise in serum creatinine with low-grade or no proteinuria
Mild anemia, hypokalemia, hyperuricemia are common
Renal biopsies: interstitial fibrosis, low grade inflammation, tubular atrophy, extensive glomerulosclerosis
Estimated 20,000-30,000 sugarcane workers dead in El Salvador/Nicaragua

Emmando Jesus age 39 from El Salvador suffers from heat stress nephropathy and continues to cut sugarcane earning $2.26/ton cut. Both father and brother died from the disease (Tom Laffay/AlJazeera)

Emmanuel Jarquin and Sandra Perraza take the accelerometre readings of Raul, a young sugarcane worker. Researchers with the WE Programme used accelerometers to measure the difference in workload between two machetes used by the cane cutters to see how hard their bodies are being worked. (Tom Laffay/AlJazeera)
Juan Wright, owner of the El Angel sugar mill in Apopa, volunteered for his mill to be part of the WE Programme, which is aimed at preventing the onset and development of CKDu.

Workers from Los Almendros hydrate in different ways while cutting sugarcane. The WE Programme’s intervention of shade tents provides a cooler place for workers to rest and refill bottles or hydration backpacks. (Tom Laffay/Aljazeera)

Demonstration of sugarcane cutting in practice. Photo credit: Amanda Walker.

(Left) Sugarcane cutter using a machete to cut sugarcane. (Right) Cut sugarcane being collected and stacked.
Kidney function worsened during the six-month harvest for one-third of the workers.

Dehydration not the only contributor:
- Nephrotoxic agrochemicals
- Heavy metals
- Nonsteroidal anti-inflammatory drug (NSAID)
- Dietary fructose consumption
- Infectious agents
cumulative incidence of AKI after a single day of summer agricultural work is alarming due to an increased risk of long-term kidney damage and mortality

A strikingly high prevalence of dehydration and AKI exists in Florida agricultural workers

Air Pollution and the Risk of Incident CKD

CONCLUSION: Our findings demonstrate a significant association between exposure to ambient PM$_{2.5}$ and risk of incident CKD, AGFR decline, and ESRD.
CONCLUSIONS

HEALTH IMPACTS CANNOT BE UNDERESTIMATED:
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- Cardiopulmonary illness
- Food, water, vector borne disease
- Pollen and allergies
- Mental Health & stress
- Chronic Kidney disease