



COLUMBIA

THE COLLABORATIVE FOR
WOMEN'S ENVIRONMENTAL HEALTH

IN THE DEPARTMENT OF
OBSTETRICS AND GYNECOLOGY

Climate-related exposures and pregnancy health: *A focus on heat and diagnosing heat-related illness*

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Environmental Health at Columbia University

Disclosures



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I have no financial conflicts of interest.

ACKNOWLEDGMENT: Dr. Cecilia Sorenson, Department of Emergency Medicine, Columbia University, Global Consortium for Climate and Health Education

Learning Objectives

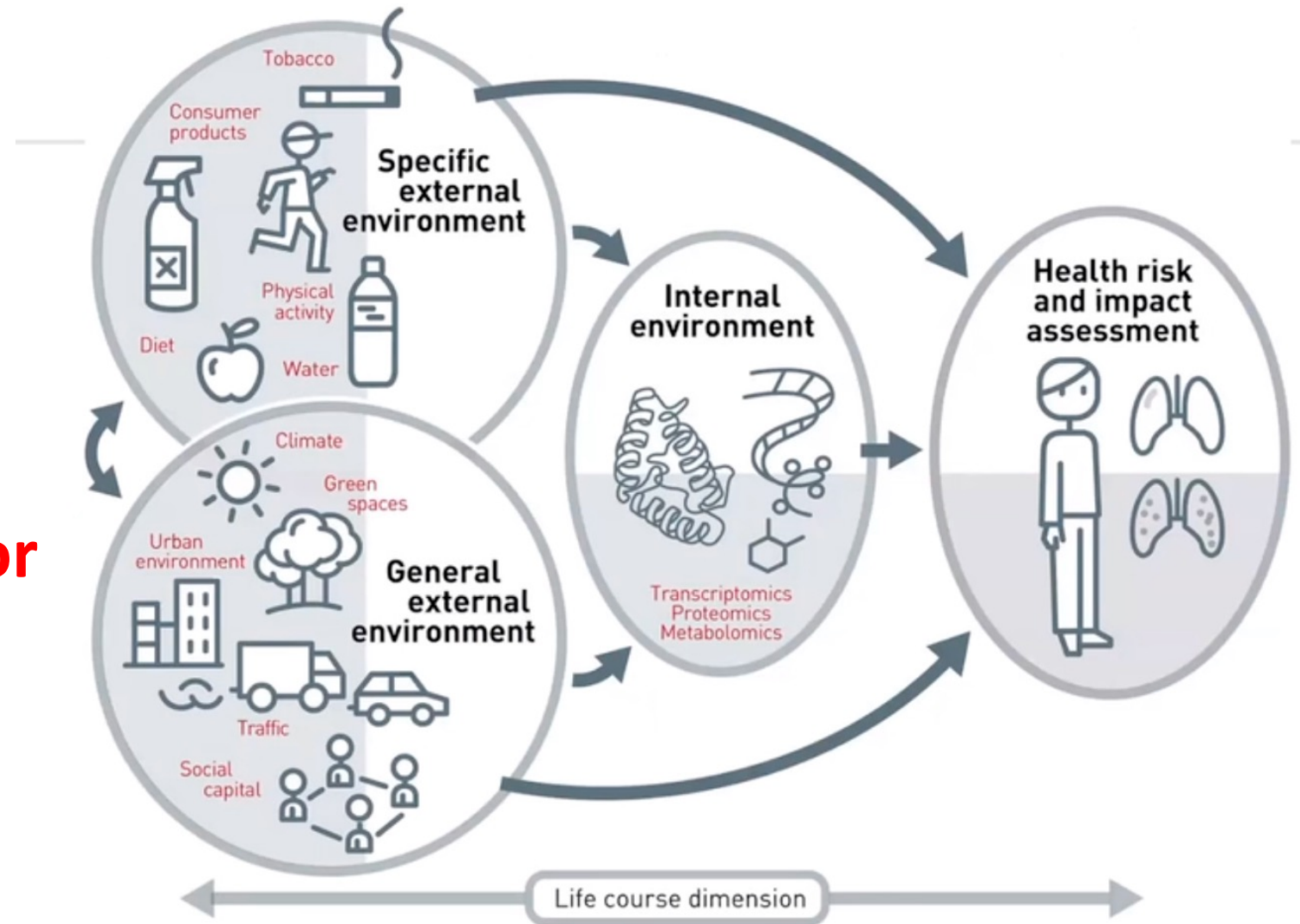


Upon completion of this webinar, the participant will be able to:

- (1) Understand the impact of climate change on the health of pregnant individuals and their pregnancies
- (2) Characterize the unequal burden of climate change among certain populations here in the US and internationally and how this contributes to widening perinatal inequities
- (3) Recognize the specific risks associated with acute heat exposure, how to diagnose heat-related illnesses, and how their presentation mimics routine pregnancy complications

Framework

Differences in the external environment estimated to account for 70-90% of disease risk



In order to improve health and **achieve health equity**, we must recognize and redress environmental contributions to disease.



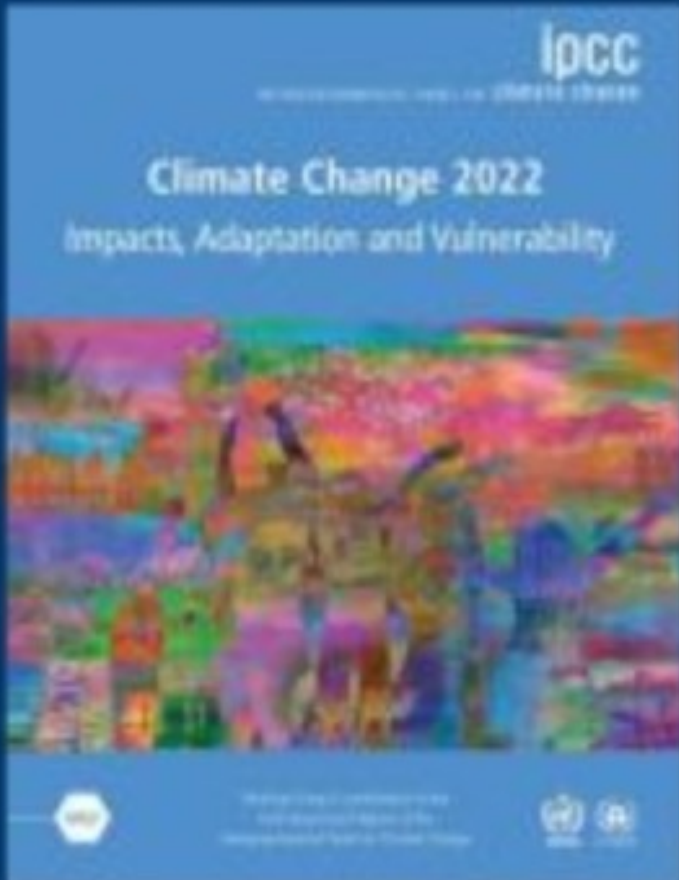
“Environmental Justice.” Art by Ricardo Levins Morales.

Managing the health effects of climate change



Climate change is the biggest global health threat of the 21st century.

[illegible]



“

Any further delay in concerted global action will miss a brief and rapidly closing window to secure a liveable future.

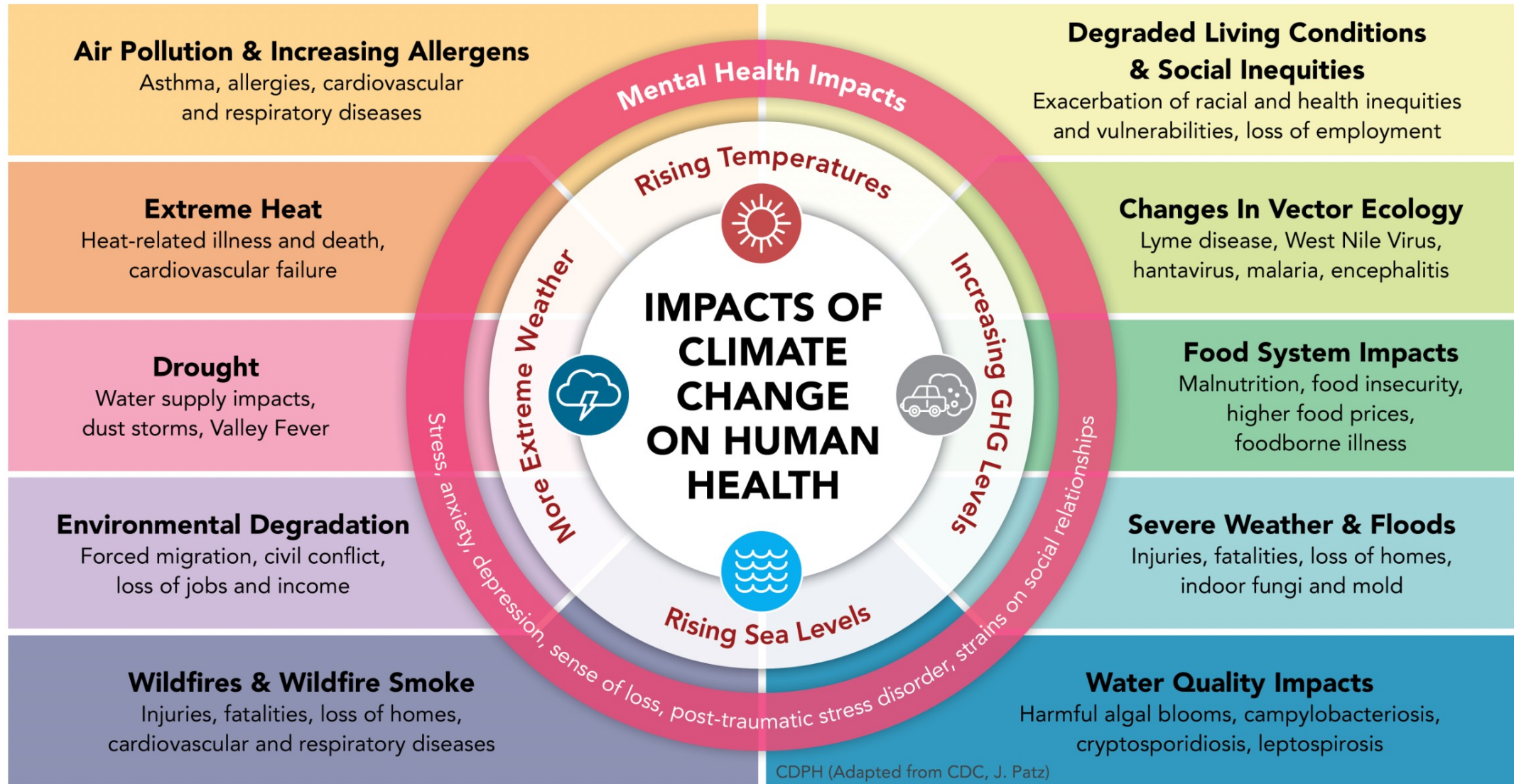
- Hans Otto-Portner, IPCC

Skating on Thin Ice: Climate Change Could See Polar Bears Extinct by 2100



For decades distressed polar bears on distant ice caps were an emblem for climate change – until experts began to doubt the effectiveness of these visuals.

Climate change





Introduction: Climate change and perinatal health: challenges and opportunities

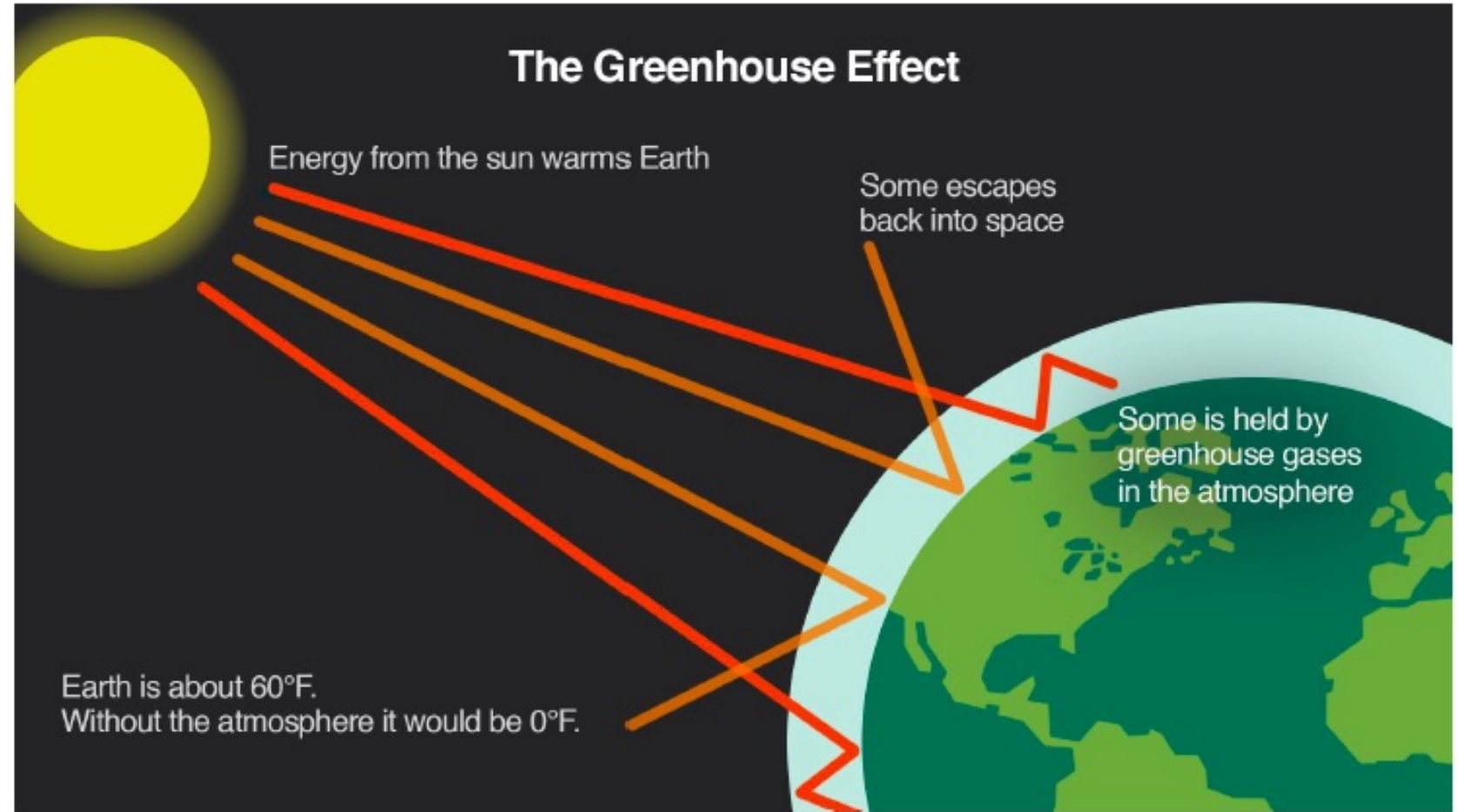
Blair J. Wyllie^a  , Cecilia Sorensen^{b c}

- **Heat**
- **Air Pollution**
- **Extreme weather- Wildfires**
- **Extreme weather- Hurricanes and flooding**
- **Vector-borne illness**
- **Food insecurity**
- **Climate change as threat multiplier to environmental injustice**
- **Health system decarbonization**
- **Forced migrations and disaster planning**

Heat

Heat Is Central to Climate Change

Fundamentally, climate change is driven by increased retention and re-radiation of heat by the Earth's atmosphere



The energy trapped by man-made global warming pollution is now “...equivalent to exploding

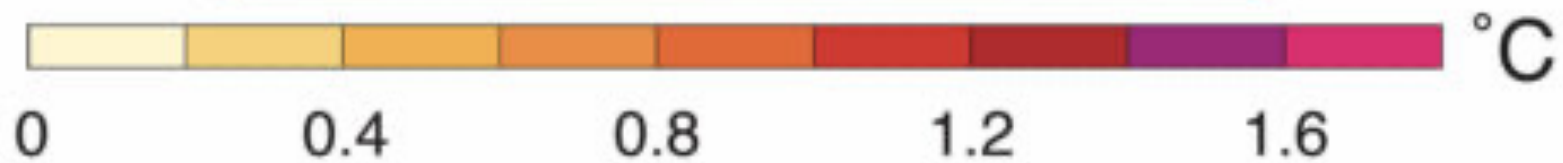
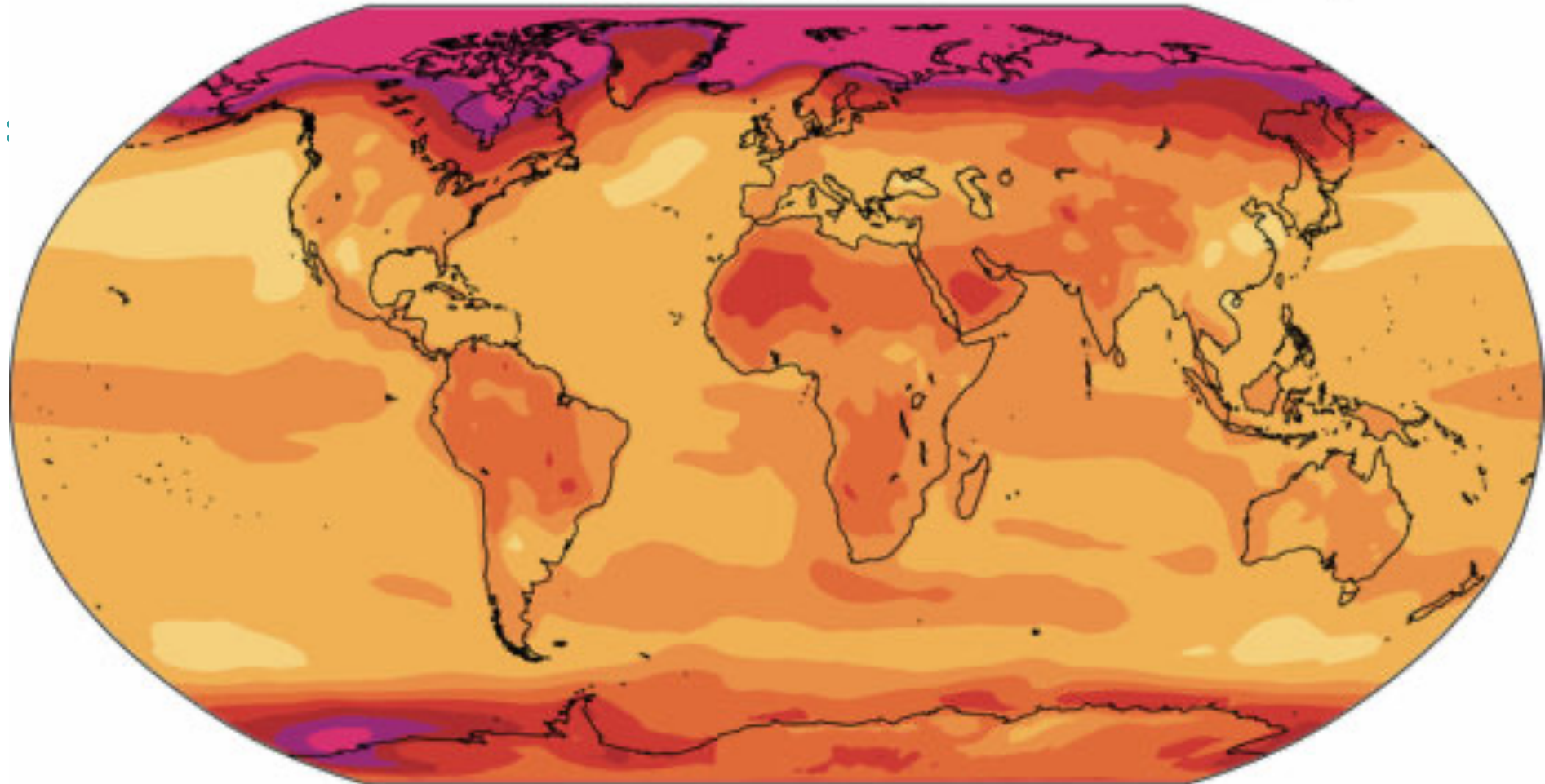
600,000

First-generation atomic bombs per day 365 days per year.”

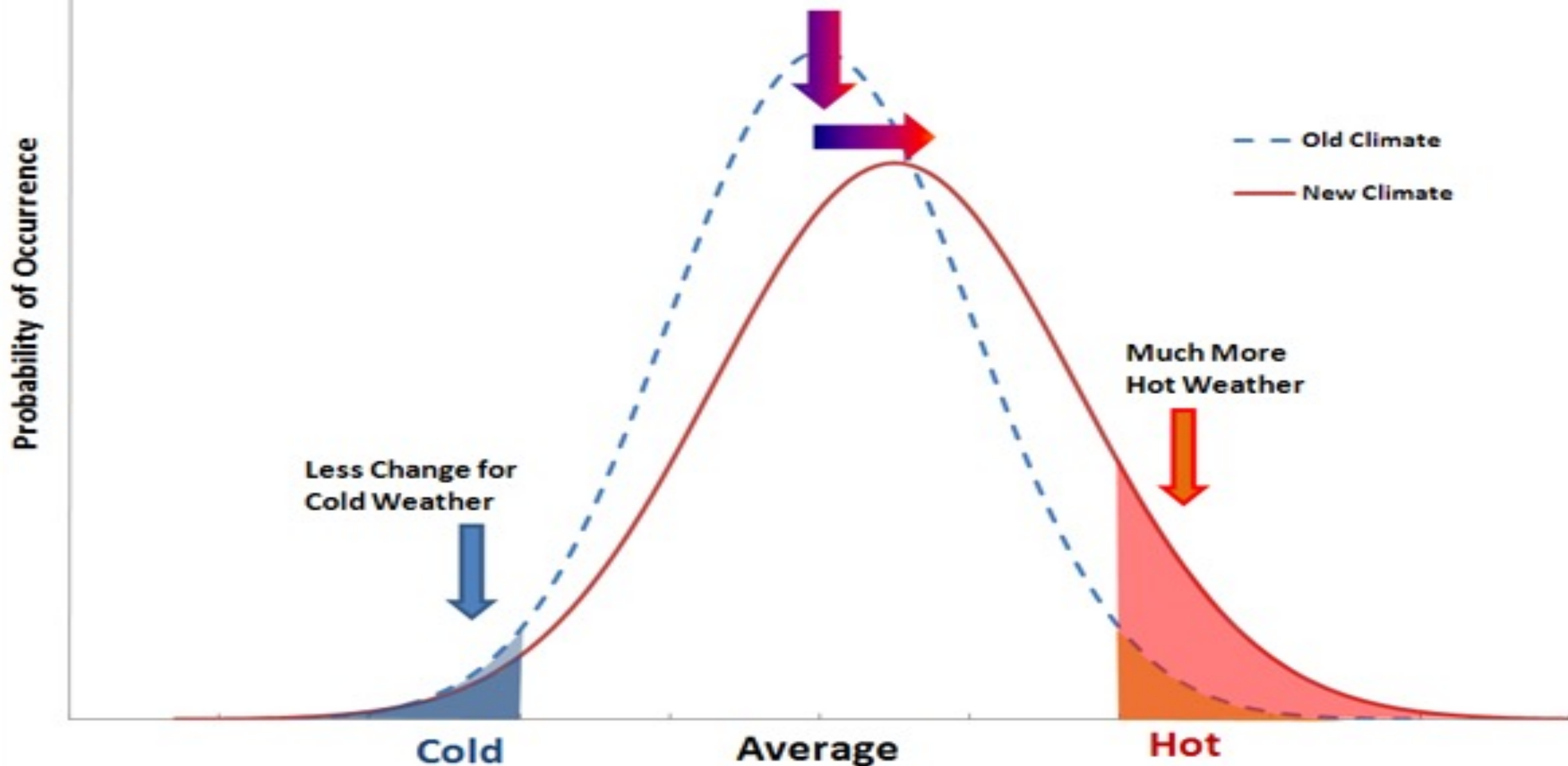
James Hansen
Former Director, NASA Goddard Institute for Space Studies

Change in Annual Temperature

from historical anthropogenic climate forcing



Increase in Mean Temperature and Variance



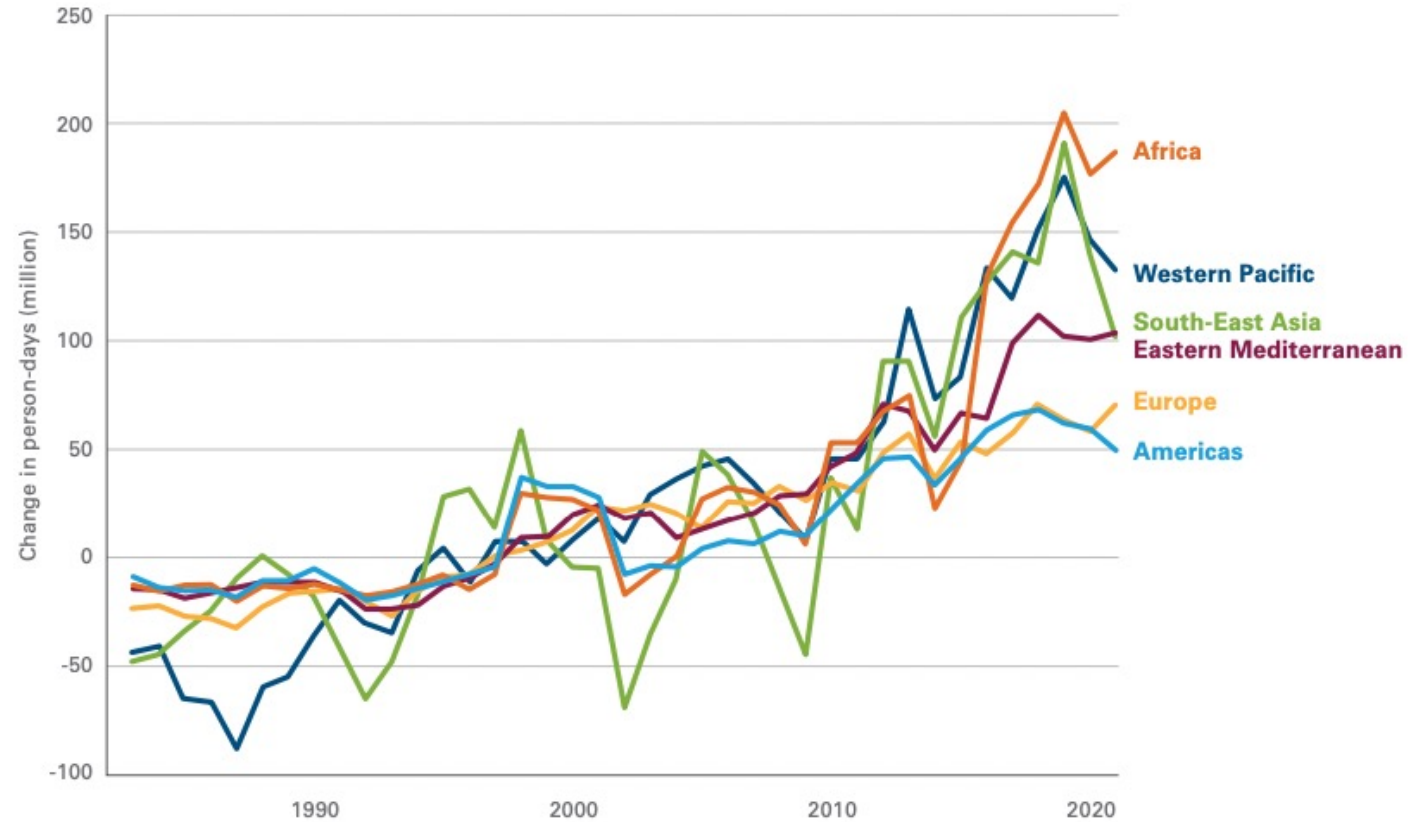
Exposure to heat increasingly the norm



As of 2020, 1 in 3 families with children < 1 year of age live in places with

> 80 days of temperatures exceeding 95 degrees F

Figure 2 Exposure of infants (under 1 year old) to heatwaves



Source: Romanello et al., '2022 Report of the *Lancet* Countdown'.

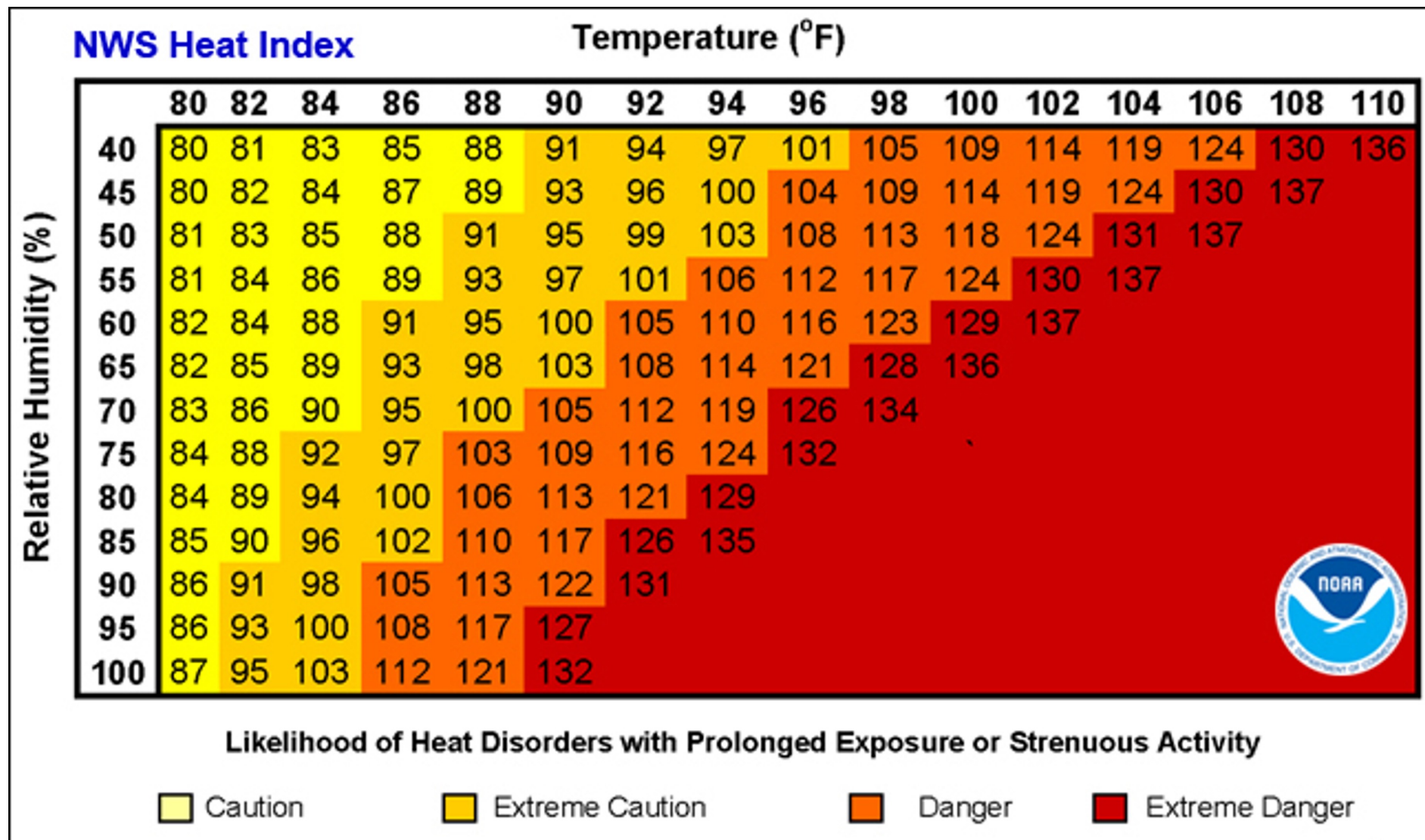
What is relevant measure of heat for human health?

Heat Index and Wet-bulb Globe Temperature (WBGT) aim to measure heat stress on the human body

	WBGT	HEAT INDEX
Measured in the sun	✓	✗
Measured in the shade	✗	✓
Uses temperature	✓	✓
Uses relative humidity	✓	✓
Uses wind	✓	✗
Uses cloud cover	✓	✗
Uses sun angle	✓	✗

HEAT RISK INDEX

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight



Acute Heat-related illnesses



Mild Acute Heat-related Illnesses

	Heat Rash	Heat Cramps	Heat Edema
Presentation	<ul style="list-style-type: none">• Small, inflamed raised red, blister-like bumps• Itching, prickling in area• Triggered by blocked sweat glands	<ul style="list-style-type: none">• Muscle spasms• Moist, cool skin• Normal core temperature	<ul style="list-style-type: none">• Extremity swelling• Occasional facial flushing
Treatment	<ul style="list-style-type: none">• Treat with evaporative cooling (don't cover)• Antibacterial creams as needed• Topical emollients to be avoided	<ul style="list-style-type: none">• Remove from heat• Fluid repletion• Rest• Oral electrolytes	<ul style="list-style-type: none">• Remove from heat• Elevate legs• Do NOT use diuretics

Moderate to Severe Acute Heat-related Illnesses

40°C = ~104°F

	Heat Syncope	Heat Exhaustion	Heat Stroke
Presentation	<ul style="list-style-type: none">Brief loss of consciousness from pooling of blood in extremities	<ul style="list-style-type: none">Profound fatigue, weakness, nausea, headache, dizzinessCore temp < 40°CNo altered mental status	<ul style="list-style-type: none">Core body temp > 40°CAltered mental statusMany overlapping symptoms of heat exhaustion
Treatment	<ul style="list-style-type: none">Remove from heatPassive coolingRest in supine positionOral or IV rehydration	<ul style="list-style-type: none">Remove from heatRest, supine positionEvaporative coolingIV, po rehydration	<ul style="list-style-type: none">Remove from heatManage ABCRapid active cooling (cold-water or ice immersion)ICU admission

Sorensen C, Hess J. NEJM 2022; 387(15).

- $< 104^{\circ}\text{F}$ ($< 40^{\circ}\text{C}$)
- No AMS

Heat Exhaustion

OR

Heat Stroke*

- $\geq 104^{\circ}\text{F}$ ($\geq 40^{\circ}\text{C}$)
- AMS

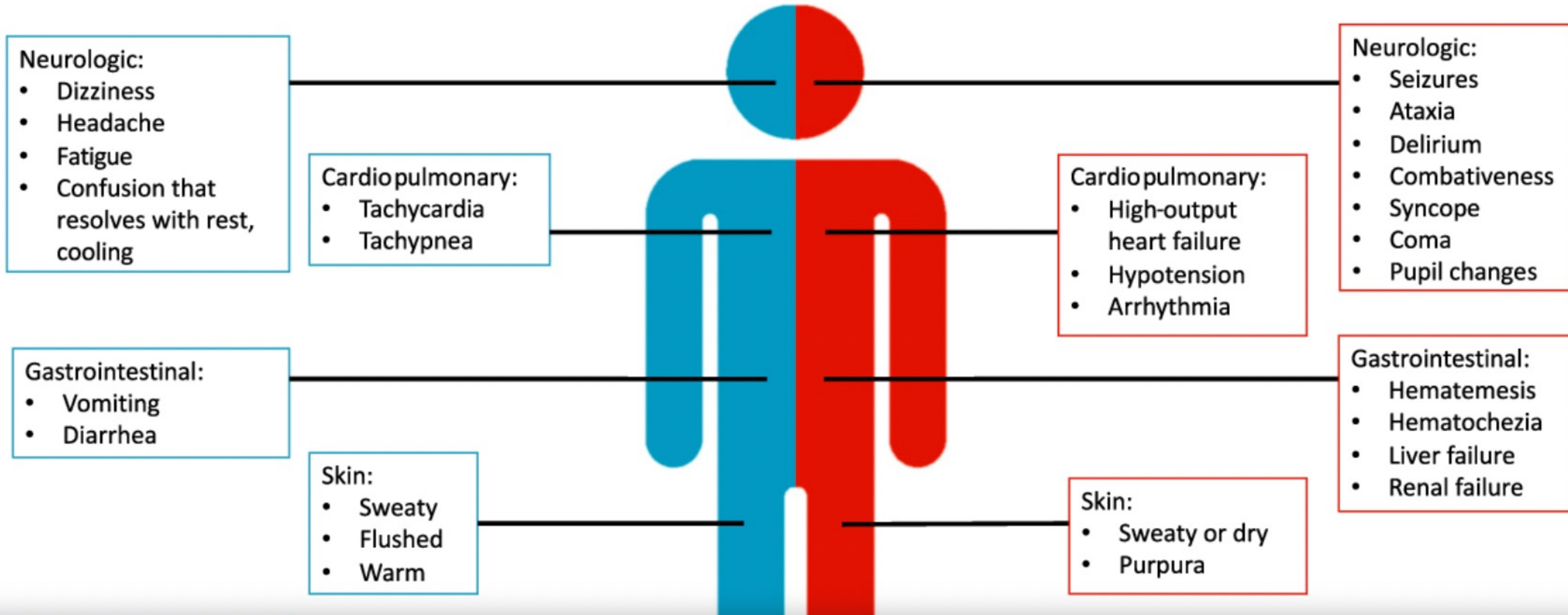


Figure 1. Clinical findings in heat exhaustion or heat stroke. AMS¼altered mental status.

Heat Stroke



- Subcategorized as exertional (healthy, exceed thermoregulatory boundaries with exercise) or classic (pre-existing conditions)
- Life threatening (**Mortality 33% with exertional, up to 80% with classic**)
- Cascade of physiologic abnormalities when unable to dissipate heat
 - Decreased central venous pressure
 - Cellular and organ dysfunction
 - CNS dysregulation
 - Endotoxemia from GI tract injury/leaking
 - Systemic inflammatory response





Heat Stroke



- 3 typical phases
 - Hyperthermia-neurologic acute phase
 - Elevated core temperature
 - Altered mental status
 - Hematologic-enzymatic phase
 - Inflammation
 - Coagulopathy/DIC
 - Late hepatic –renal phase
 - Organ failure
 - Typically > 96 hours after onset

Table 3 Signs and symptoms of heat-related illnesses in infants, children, adolescents and pregnant populations

High severity and urgency

Target Populations	Heat Stroke	Heat Exhaustion	Heat Syncope	Heat Cramps	Heat Edema	Heat Rashes	Dehydration**
All Populations 	<ul style="list-style-type: none"> Altered mental state (e.g., inappropriate behaviour, seizures, delirium, slurred speech, extreme lethargy, coma/loss of consciousness) Very high core body temperature (40°C/104°F) Associated symptoms include: <ul style="list-style-type: none"> Nausea Rapid heartbeat/breathing Hot and dry or damp skin Sweating may or may not be present 	<ul style="list-style-type: none"> No altered mental state High core body temperature (under 40°C/104°F) Increased thirst Heavy sweating Headache Cool and/or damp skin Weakness and tiredness Muscle cramps Nausea or vomiting 	<ul style="list-style-type: none"> Brief loss of consciousness, usually in person standing for a prolonged period or rapidly changing positions in a warm environment 	<ul style="list-style-type: none"> Painful and involuntary contractions of skeletal muscle Flushed and/or moist skin 	<ul style="list-style-type: none"> Swelling of hands, feet or other dependent areas 	<ul style="list-style-type: none"> Tiny bumps on skin, usually in chest or upper back Could result in tiny blisters 	<ul style="list-style-type: none"> Dry mouth and tongue Sticky lips/mouth Drowsy or sleepy Little urine Dark urin Dizziness Sunken eyes
Specific to Infants and Children under 4 years 	<ul style="list-style-type: none"> Very irritable (unable to express specific symptoms) May present symptoms of dehydration as well 	<ul style="list-style-type: none"> Very irritable (unable to express specific symptoms) 		<ul style="list-style-type: none"> Very irritable (unable to express specific symptoms) Mild/slightly high core body temperature may be present (less than 39.5°C/102.5°F) 		<ul style="list-style-type: none"> Can occur in diapered area or if baby is overclothed/ overdressed 	<ul style="list-style-type: none"> Sunken soft spot (fontanelle) on baby's head and cheeks No tears when crying Decreased urine output or dark urine Irritable (unable to express specific symptoms)
Specific to Older Children and Adolescents 	<ul style="list-style-type: none"> May be associated with exertion, e.g., sports 	<ul style="list-style-type: none"> Muscle cramps (may be verbally expressed) Nausea (may be verbally expressed) 					
Specific to Pregnant Women 	<ul style="list-style-type: none"> Very high core body temperature (above 39°C/102°F)* Symptoms of severe dehydration such as labour contractions (Braxton Hicks) may present 	<ul style="list-style-type: none"> Increase in core body temperature (under 39°C/102°F) 		<ul style="list-style-type: none"> Involuntary contractions may affect calves, arms and stomach area (most common) 	<ul style="list-style-type: none"> Swelling most often seen around lower legs and feet 	<ul style="list-style-type: none"> Tiny bumps on the skin, in particular in the crease between and beneath the breasts, crease where bulge of lower abdomen rubs against the top of pubic area, on back, inner thighs, armpits, and other creasing areas 	<ul style="list-style-type: none"> Inadequate breastmilk production False labour (Braxton-Hicks) contractions

Source: Adapted from various sources.⁷⁷

* While literature is still being generated to form consensus, the current convention is to presume that pregnant women are at higher risk at a lower core body temperature due to the potential effect that it has on the developing fetus. This also reflects guidance published by the Centers for Disease Control and Prevention (CDC).

** According to a publication in American Family Physician, if children present symptoms of dehydration, commercial electrolyte solutions or local/ home-based rehydration solutions should be administered using only clear liquids.⁷⁸ Infants 6 months and under should be exclusively breastfed.

Presentation of
heat-related
illnesses overlaps
with common
pregnancy
complications
(PTL, sepsis,
TTP-HUS)

Thermoregulation



CONVECTION: Heat transferred by wind (towards or away from body)

RADIATION: Heat emitted from hotter environment to cooler environment (towards or away from body)

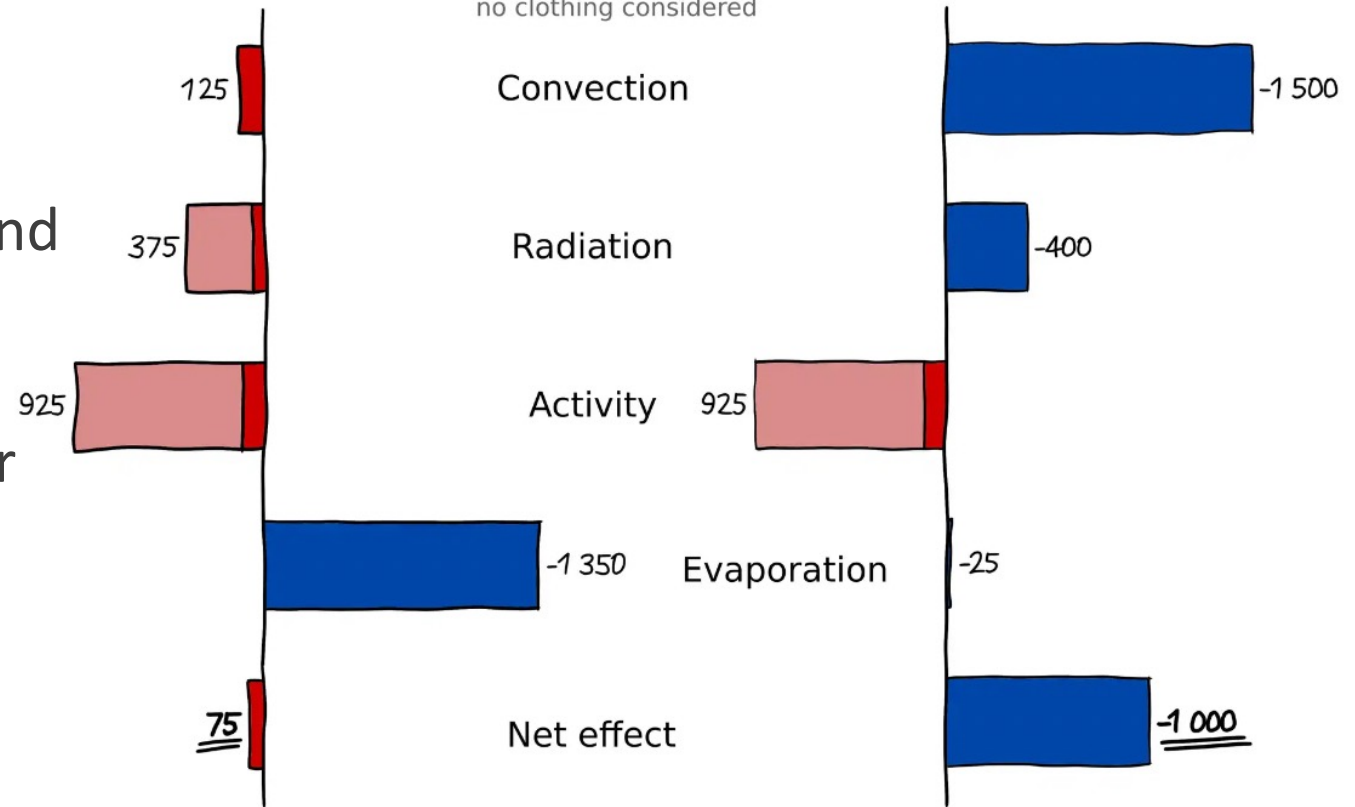
ACTIVITY: Internally generated heat

EVAPORATION: Heat dissipation from sweating

Summer 40°C

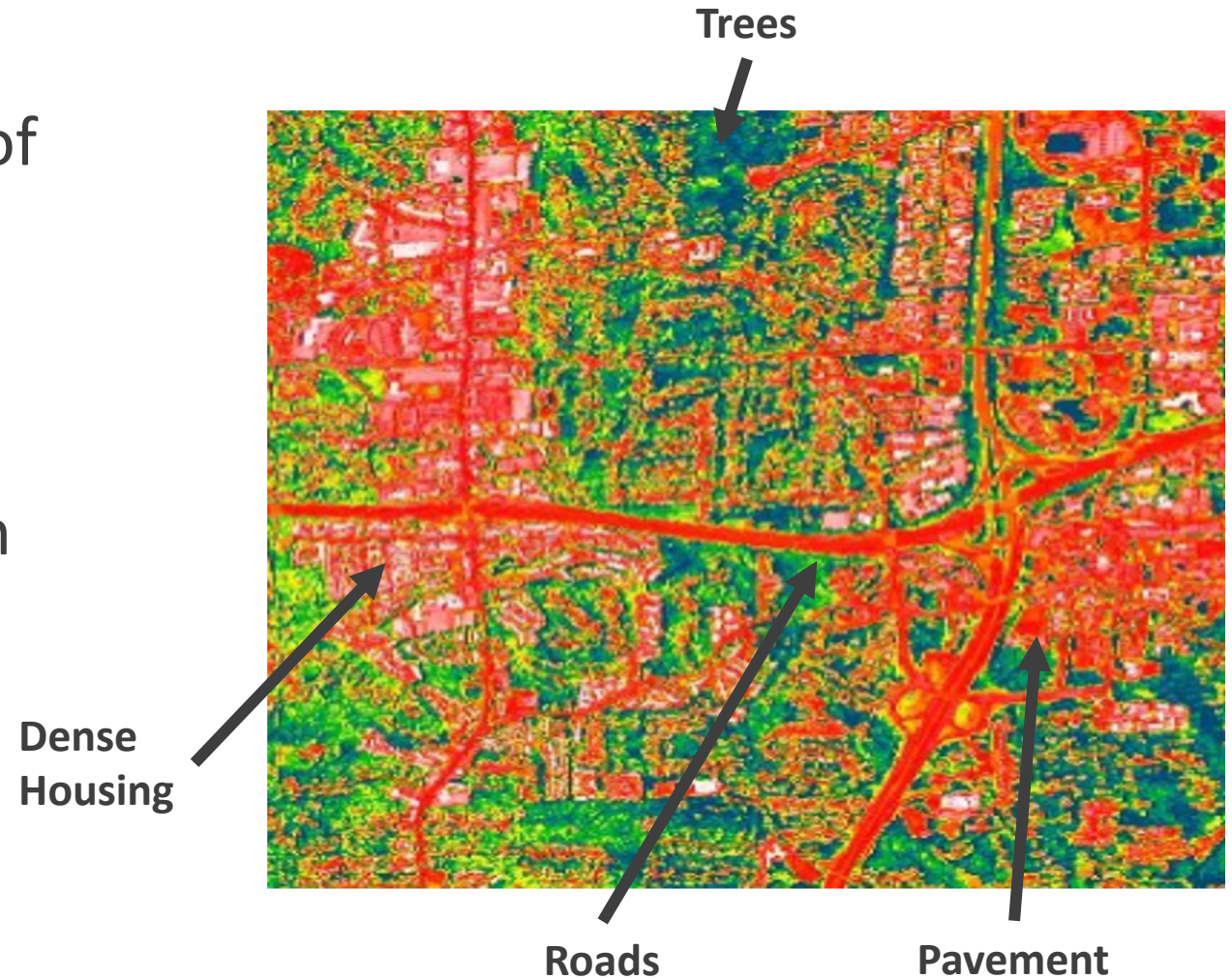
Winter 0°C

approximate, rounded values for major energy flows (in Watts) in/out of the human body
air velocity: 2 m/s (~10km/h)
no clothing considered



Urban Heat Islands

.....
Urban Heat Islands are areas of densely built infrastructure, which absorbs and then re-emits heat from the sun, resulting in “islands” of higher temperatures; temperatures in these areas can be 1° to 7°F (0.6° to 3.9°C) hotter



Does pregnancy increase vulnerability to heat-related illness?



Pregnant individuals able to maintain core temperature in narrow range

Increased heat

- Increased endogenous heat production (metabolic activity of fetus and placenta)
- Increased body mass
- Less body surface area to mass (less area for evaporation, convection)

Increased heat dissipation

- Increased plasma volume
- Increased blood flow to skin
- Allows for increased evaporative cooling and radiative heat loss (warmer skin to cooler environment)

Epidemiology of heat and adverse pregnancy outcomes

Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and meta-analysis

Matthew Francis Chersich,¹ Minh Duc Pham,^{2,3} Ashtyn Area,^{1,4} Marjan Mosalam Haghighi,⁵ Albert Manyuchi,⁶ Callum P Swift,⁷ Bianca Wernecke,^{8,9} Matthew Robinson,¹⁰ Robyn Hetem,¹¹ Melanie Boeckmann,¹² Shakoor Hajat,¹³ on behalf of the Climate Change and Heat-Health Study Group

Outcome	OR (95% CI)	Studies in meta-analysis	Total studies
Preterm birth	1.05 (1.03, 1.07) per +1* C 1.16 (1.10, 1.23) in heat waves	6 6	47
Stillbirth	1.05 (1.01, 1.08) per +1* C 1.46 (1.09, 1.96) in heat waves	3 1	8
Low birthweight*	N/A	0	28

Heat definition is highly variable across studies



Exposure across gestation or in specific window (trimester, weeks)

Average temps or maximal temps

Number of heatwave days (different definitions of heat wave)

Number of days above preset threshold (absolute threshold)

Number of days above preset threshold (relative to local situation)

Gradient of day vs nighttime temperatures

Lag models of high vs low temps (time-varying associations)

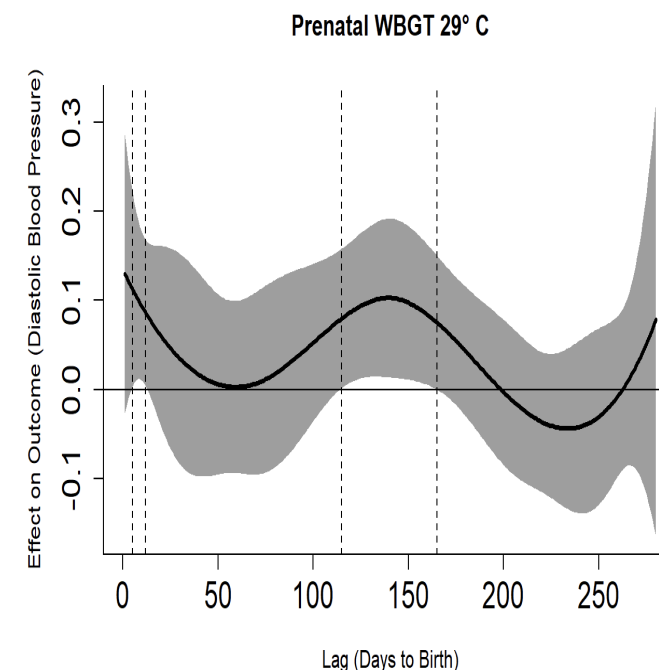
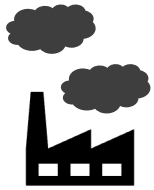


Figure 5. Time-varying associations between WBGT over pregnancy and maternal BP trajectories through 8 years postpartum. DLNMs find that higher WBGT in early and mid-gestation is associated with higher diastolic BP for 8 years postpartum.

Potential for confounders & effect modifiers



Potential confounders



Air pollution



Co-exposures
(occupation, pesticides)



Co-morbidities

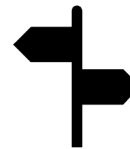
Potential Effect Modifiers



Urbanicity



Vegetation/Green
space



Personal (nutrition
status, stress)

Most data from high income country settings



Environment International 158 (2022) 106902



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journal homepage: www.elsevier.com/locate/envint



Extreme heat, preterm birth, and stillbirth: A global analysis across 14 lower-middle income countries

Sara McElroy^{a,b,c,*}, Sindana Ilango^{a,b,c,d}, Anna Dimitrova^{a,b,c}, Alexander Gershunov^{a,b,c},
Tarik Benmarhnia^{a,b,c}

^a University of California, San Diego-Herbert Wertheim School of Public Health, United States

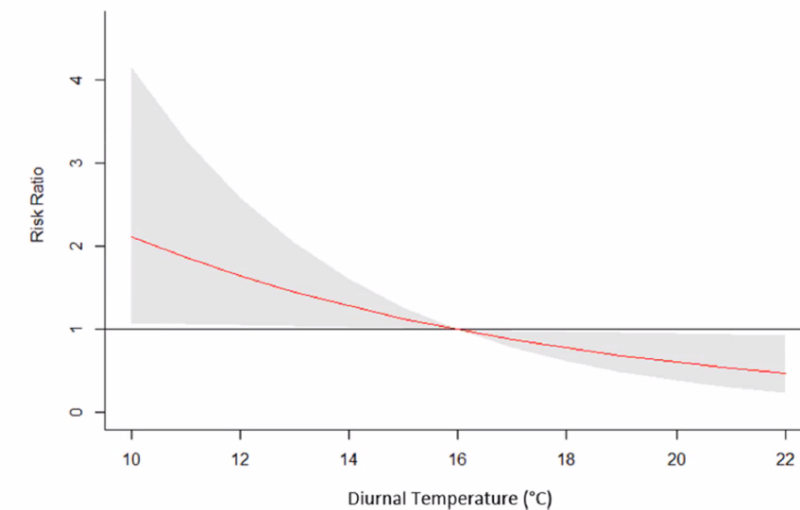
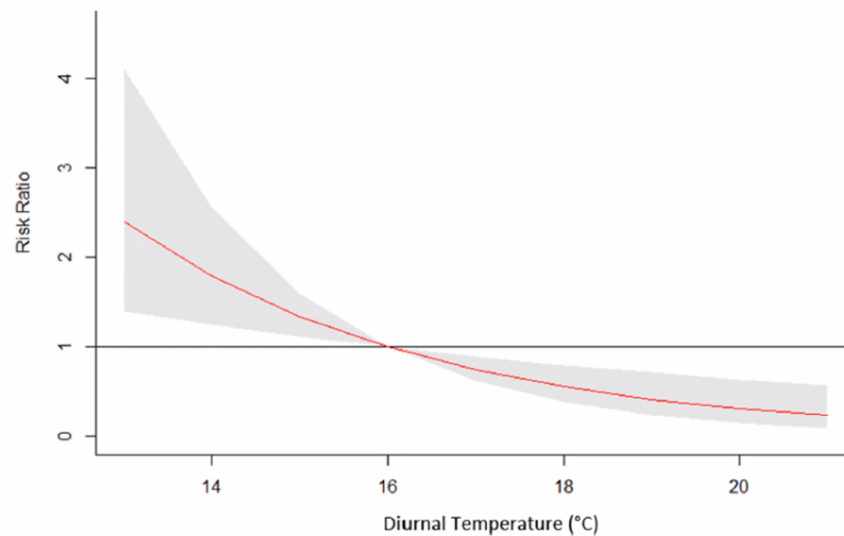
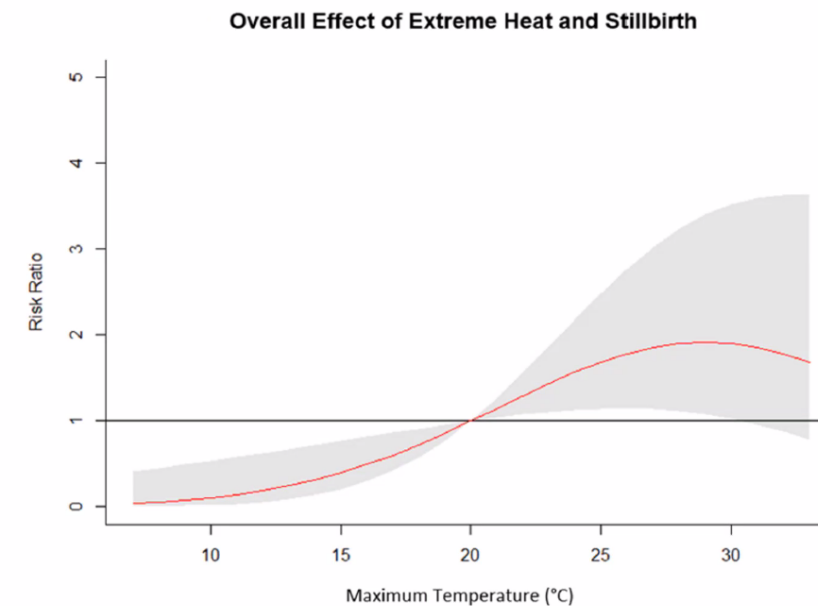
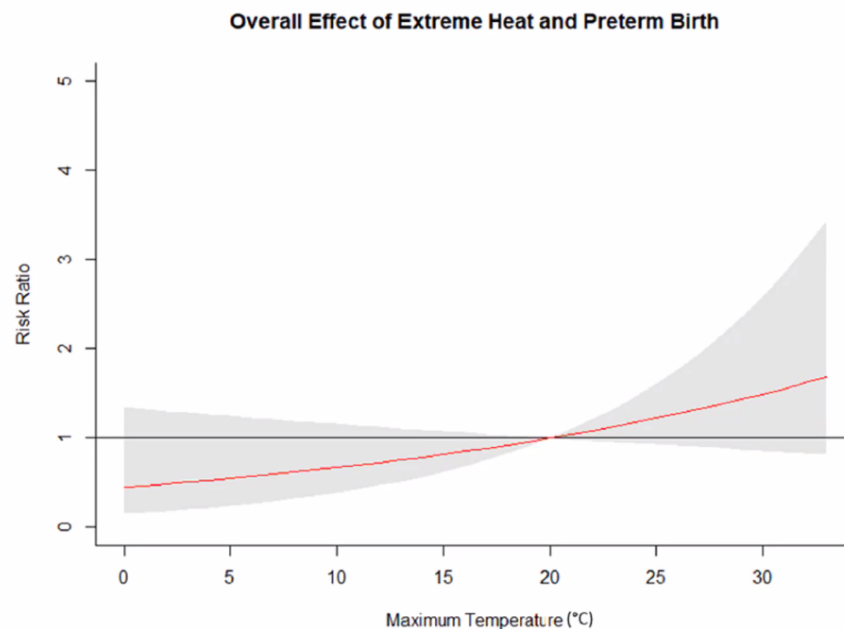
^b San Diego State University, United States

^c Scripps Institution of Oceanography, United States

^d University of Washington, United States



**Higher maximal
temperatures
& lower diurnal
temperatures
(Tmax – Tmin)
in week before delivery
increased risk of PTB and
stillbirth**



Associations between ambient temperature and pregnancy outcomes from three south Asian sites of the Global Network Maternal Newborn Health Registry: A retrospective cohort study

Kartik Shankar¹ | Kay Hwang² | Jamie L. Westcott¹ | Sarah Saleem³ | Sumera A. Ali³ | Saleem Jessani³ | Archana Patel^{4,5} | Avinash Kavi⁶ | Manjunath S. Somannavar⁶ | Shivaprasad S. Goudar⁶ | Patricia L. Hibberd⁷ | Richard J. Derman⁸ | Matthew Hoffman^{8,9} | Blair J. Wylie¹⁰ | Robert L. Goldenberg¹⁰ | Vanessa R. Thorsten² | Elizabeth M. McClure² | Nancy F. Krebs¹

Per 5 °C increase in trimester-specific Tmax average:

5% increase in PTB risk (2nd TM)
7% increase in PE risk (3rd TM)

n=126,273
2014-2020

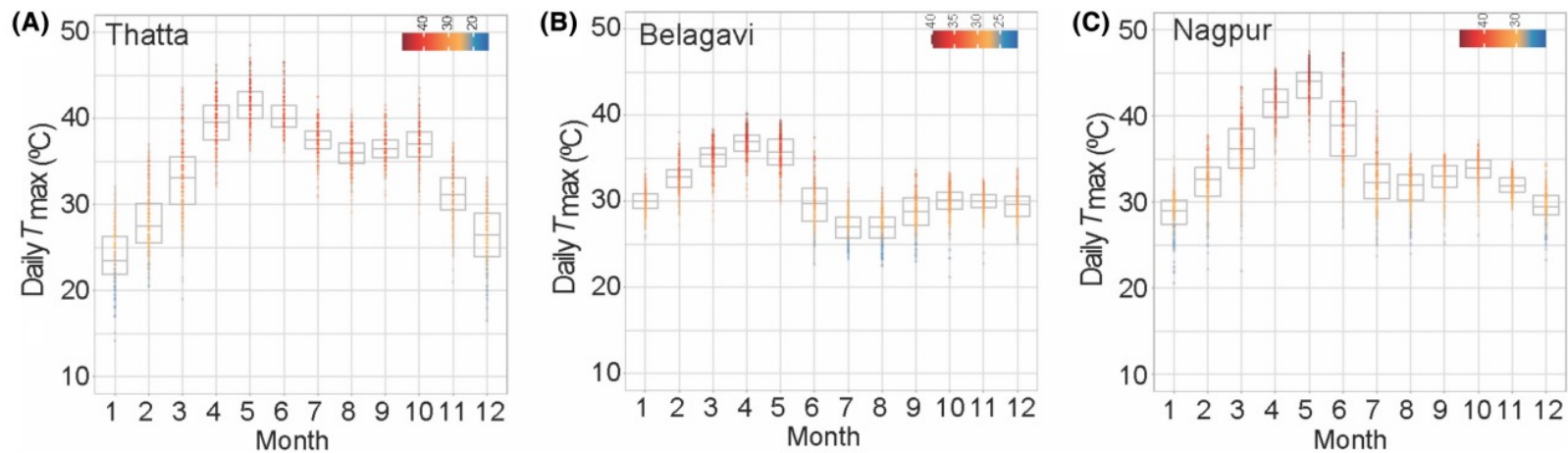


FIGURE 2 Average daily maximum temperatures summarised by month for the study duration for the three study sites.

Maternal nutritional status modifies heat-associated growth restriction in women with chronic malnutrition

Kartik Shankar^{a,*}, Sumera A. Ali^b, Meghan L. Ruebel^{a,c}, Saleem Jessani^b, Sarah J. Borengasser^a, Stephanie P. Gilley^a, Puujee Jambal^a, Deaunabah N. Yazza^a, Nicholas Weaver^d, Jennifer F. Kemp^a, Jamie L. Westcott^a, Audrey E. Hendricks^d, Sarah Saleem^b, Robert L. Goldenberg^e, K. Michael Hambidge^a and Nancy F. Krebs^{a,*}

Effects of heat stress on infant length for age (LGAZ) only observed in those whose mothers did NOT receive nutritional supplementation. . . suggesting **nutritional supplementation may mitigate heat stress**

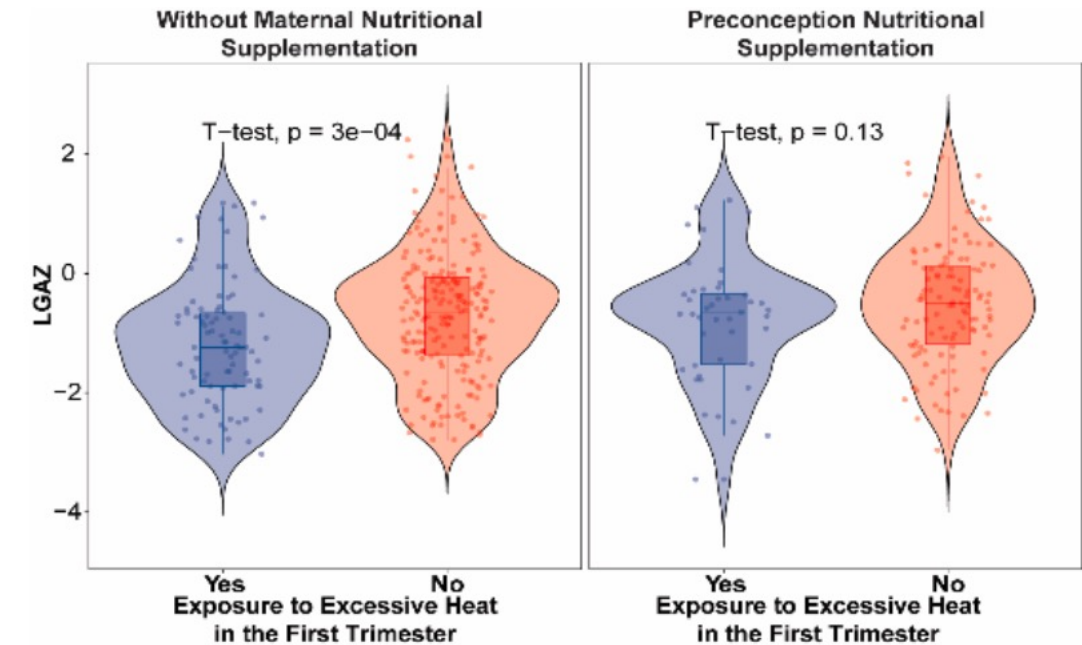
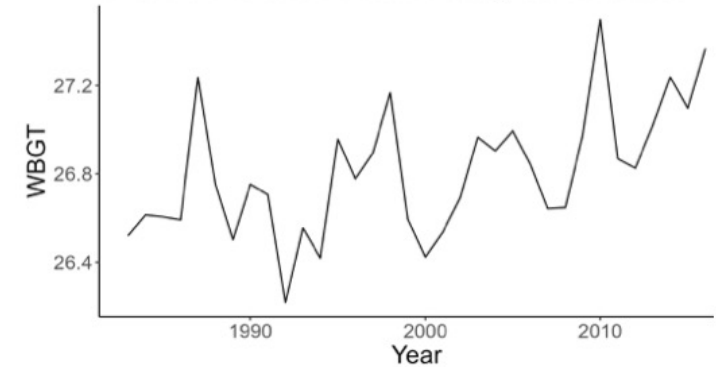


Figure 3: Influence of maternal nutritional supplementation on heat-associated effects on birth length (LGAZ) and head circumference (HCGAZ) z-scores. P-values derived from adjusted linear regression models⁵³.

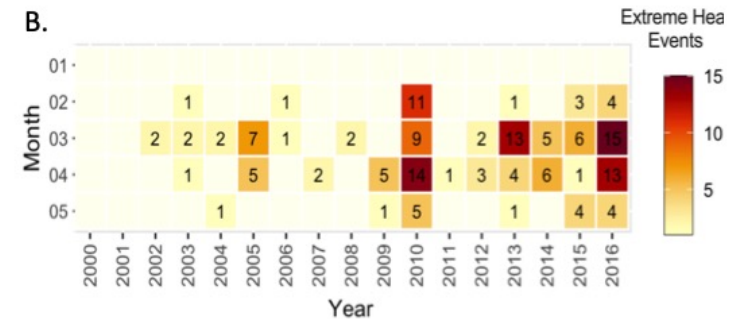
Rising temperatures over past decade in Ghana

(A) Average Annual Wet Bulb Globe Temp

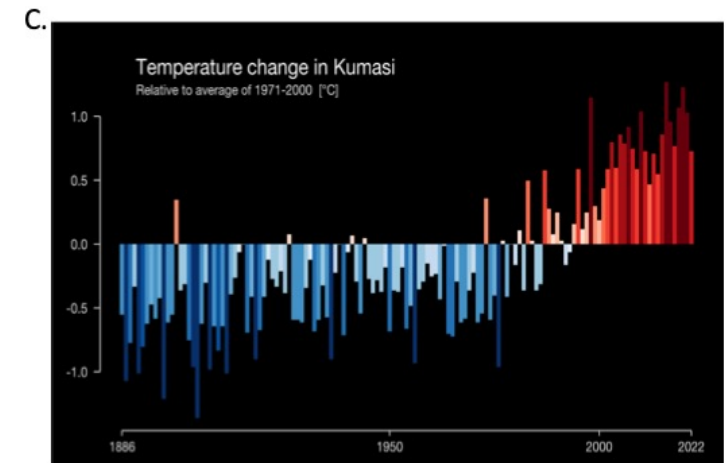
A. Trends in Annual Average WBGT (1983-2016) in GRAPHS and PRISMA study communities



(B) # of extreme weather events defined as a day with WBGT > 30°C

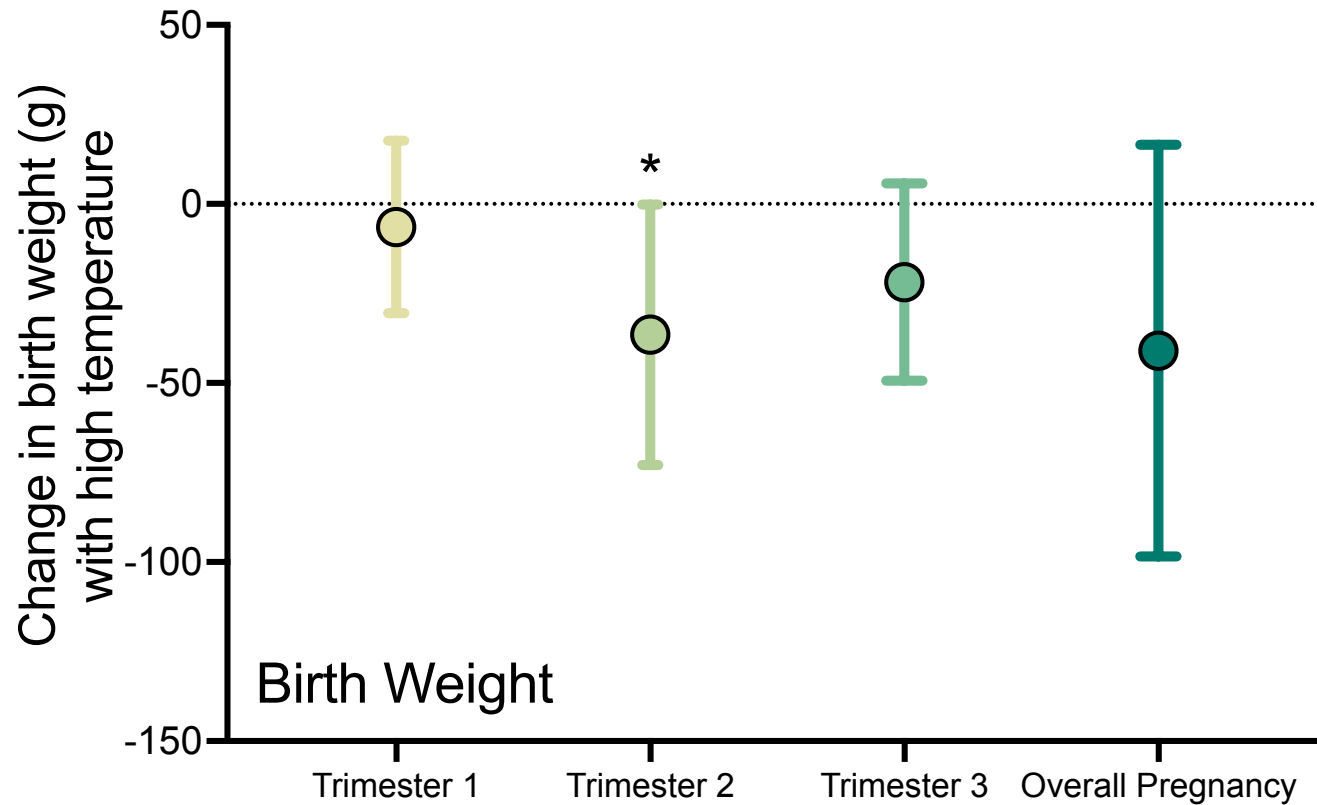


(C) Ambient temp trends relative to 1971-2000



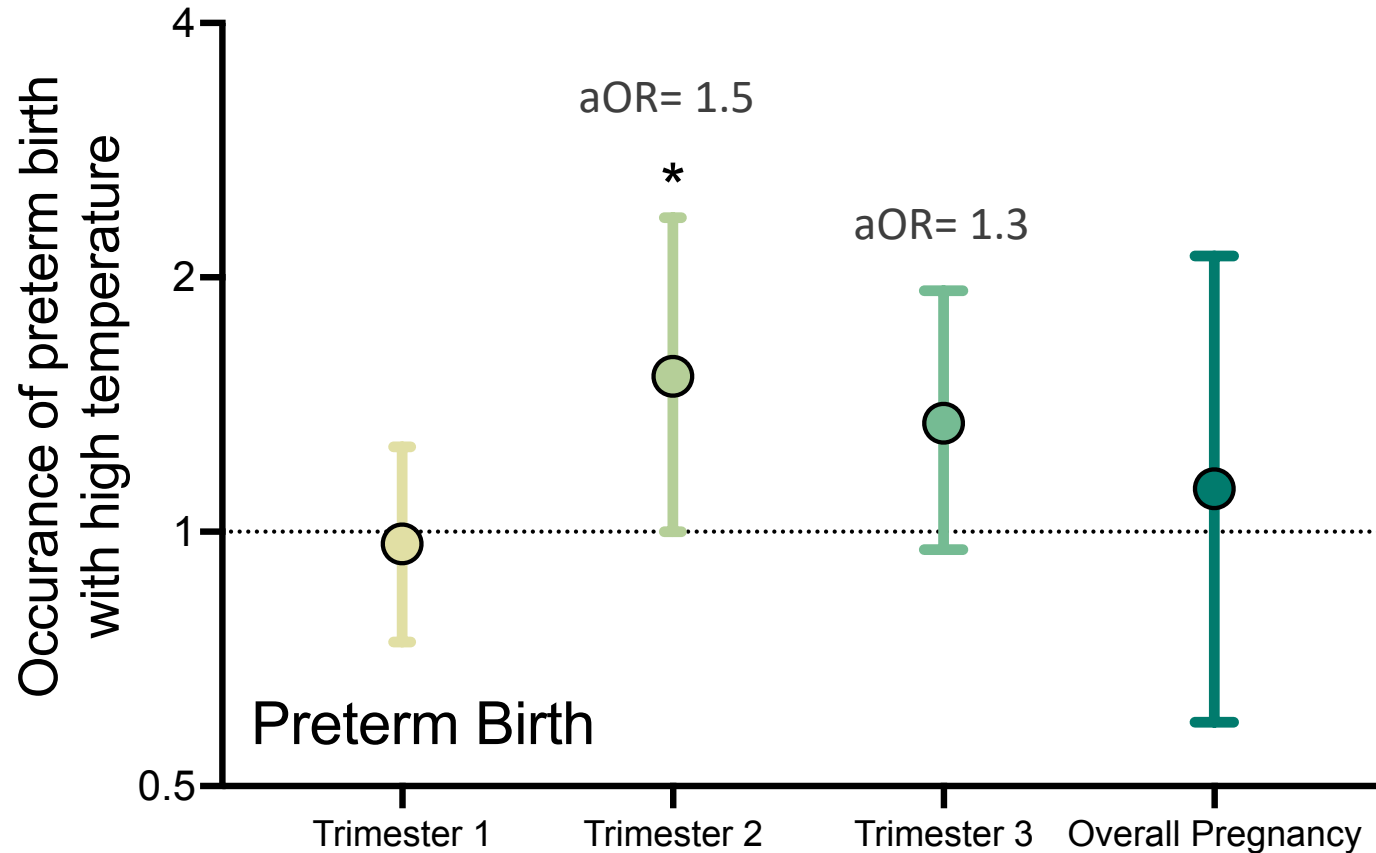
WBGT and newborn anthropometrics

Birth weight



1°C increase in average 2nd
TM WBGT
associated with
36.5 gram reduction
in birth weight
(95%CI -72.9, -0.2)

WBGT and preterm birth



1°C increase in 2nd TM
WBGT in pregnancy
associated with
1.5- fold increase
in odds of preterm birth
(95%CI 1.0, 2.4)

Summary of epidemiologic evidence



- Ambient heat exposure appears to increase risk of pregnancy complications
 - Preterm Birth
 - Stillbirth
 - Impaired fetal growth
 - Possibly hypertensive disorders of pregnancy
- Extent of effect unclear and may vary depending on baseline acclimatization to heat, nutritional status, timing in gestation, ability to shelter from heat
- Urgent need to quantify the burden associated with both acute and chronic heat exposure in pregnancy

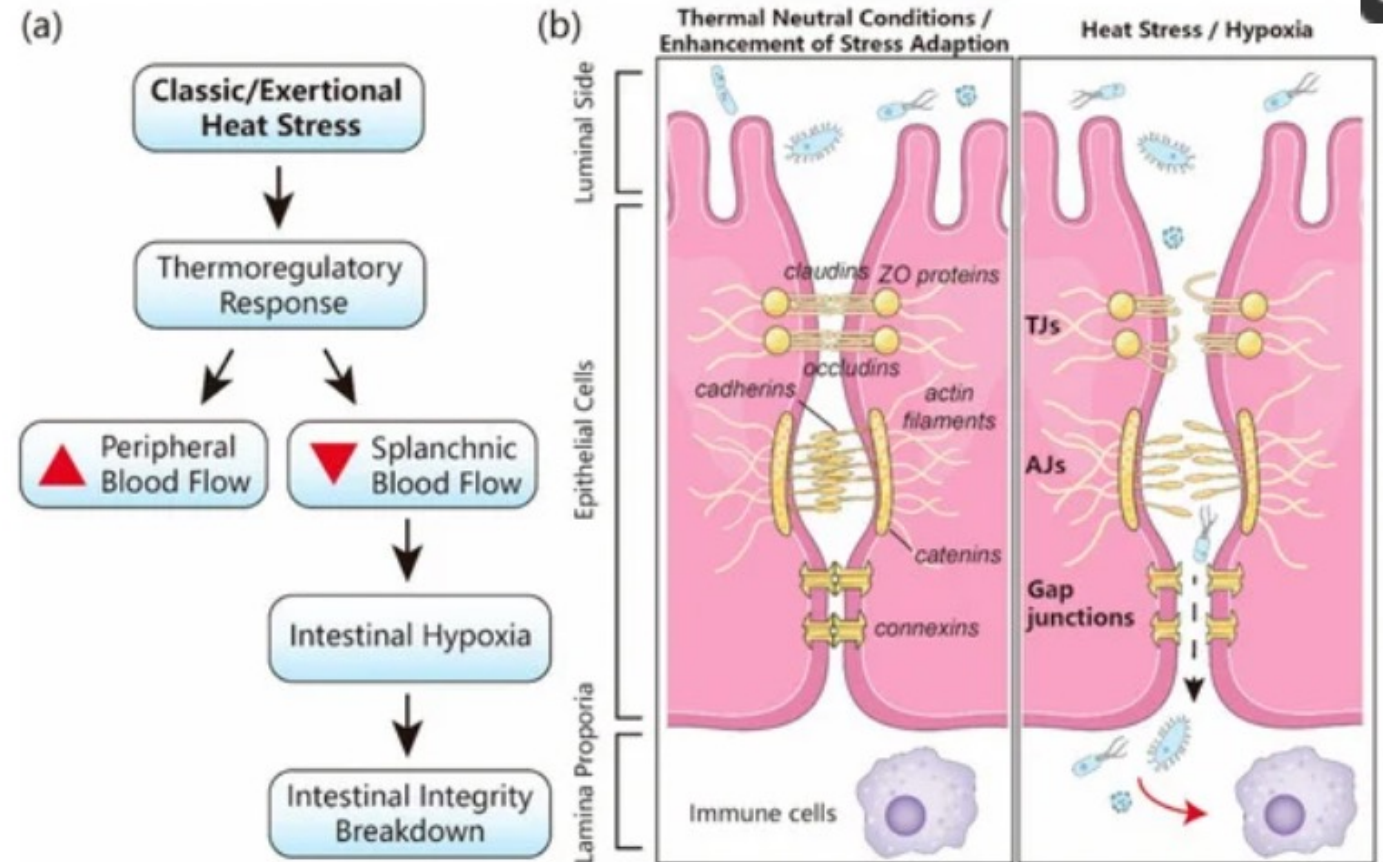
Mechanisms linking heat stress with adverse pregnancy outcomes incompletely understood



Leaky gut theory

Heat stress → reduced splanchnic and placental blood flow

Leaky gut → increased microbiota in blood → endotoxemia → triggers placental inflammatory response (animal data)



Many proposed mechanisms, mostly still theoretical or based on animal data only



- Leaky gut --> Endotoxemia → inflammation
- Heat → trigger oxytocin and PGF2-alpha release → contractions (animal data)
- Increased release of heat shock proteins (Hsp70 → associated with increased pro-inflammatory cytokines)
- Dehydration → decreased uterine perfusion → destabilized decidual lysosomes → triggering prostaglandin release
- Dehydration → trigger release of ADH (and release of oxytocin from posterior pituitary at same time)



CLIMATE CHANGE AND SOCIAL VULNERABILITY IN THE UNITED STATES

A Focus on Six Impacts

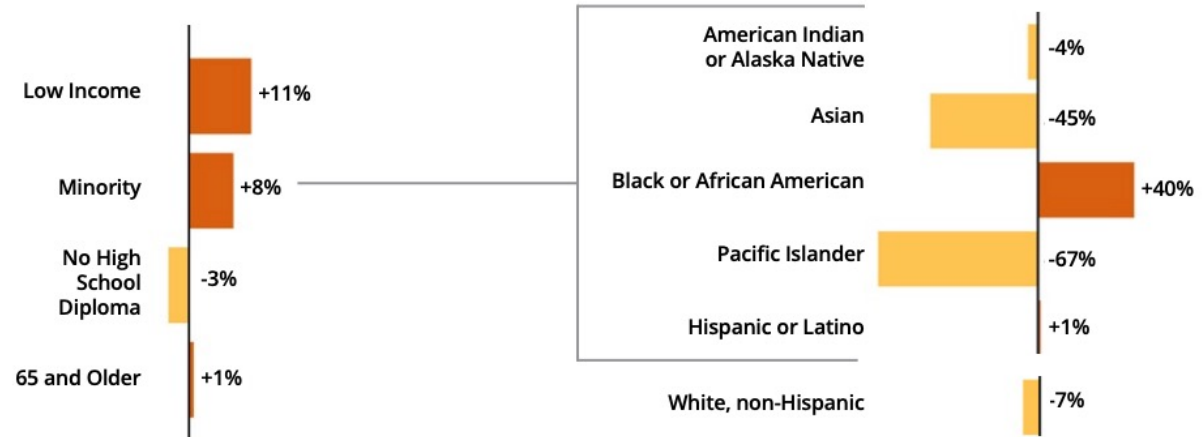
SEPTEMBER 2021

Vulnerability to Changes in Extreme Temps

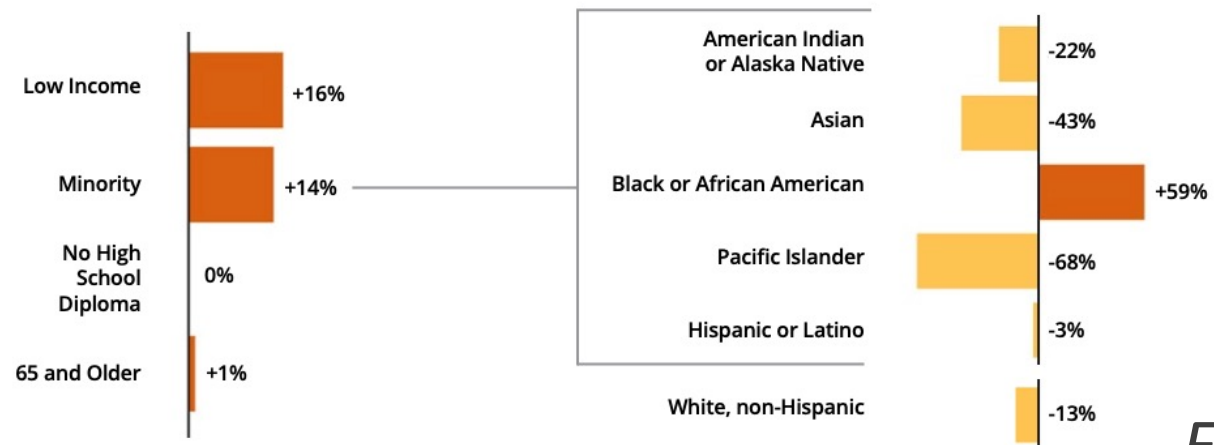


PREMATURE MORTALITY

2°C Global Warming



4°C Global Warming

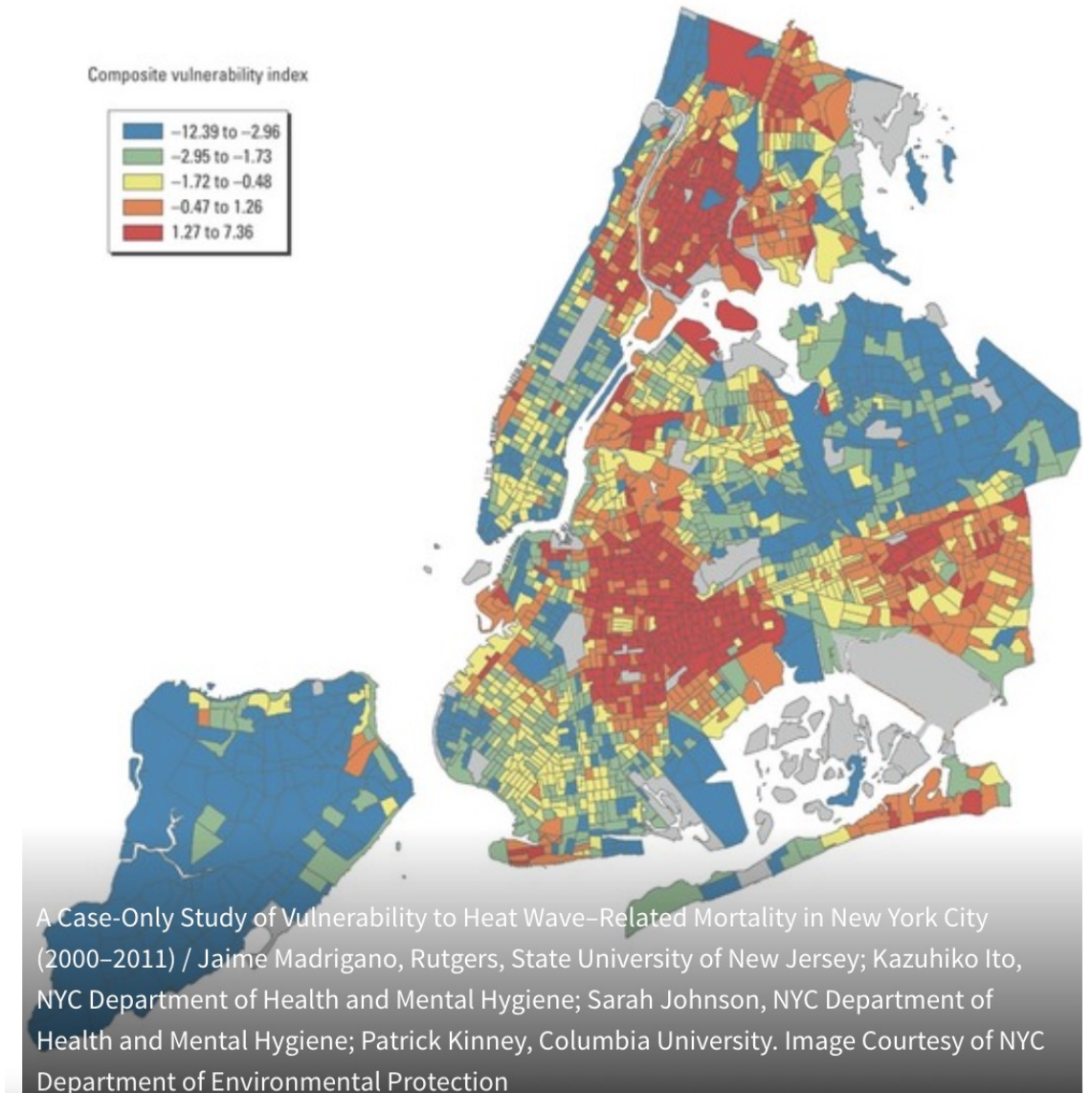


EPA, 2021.

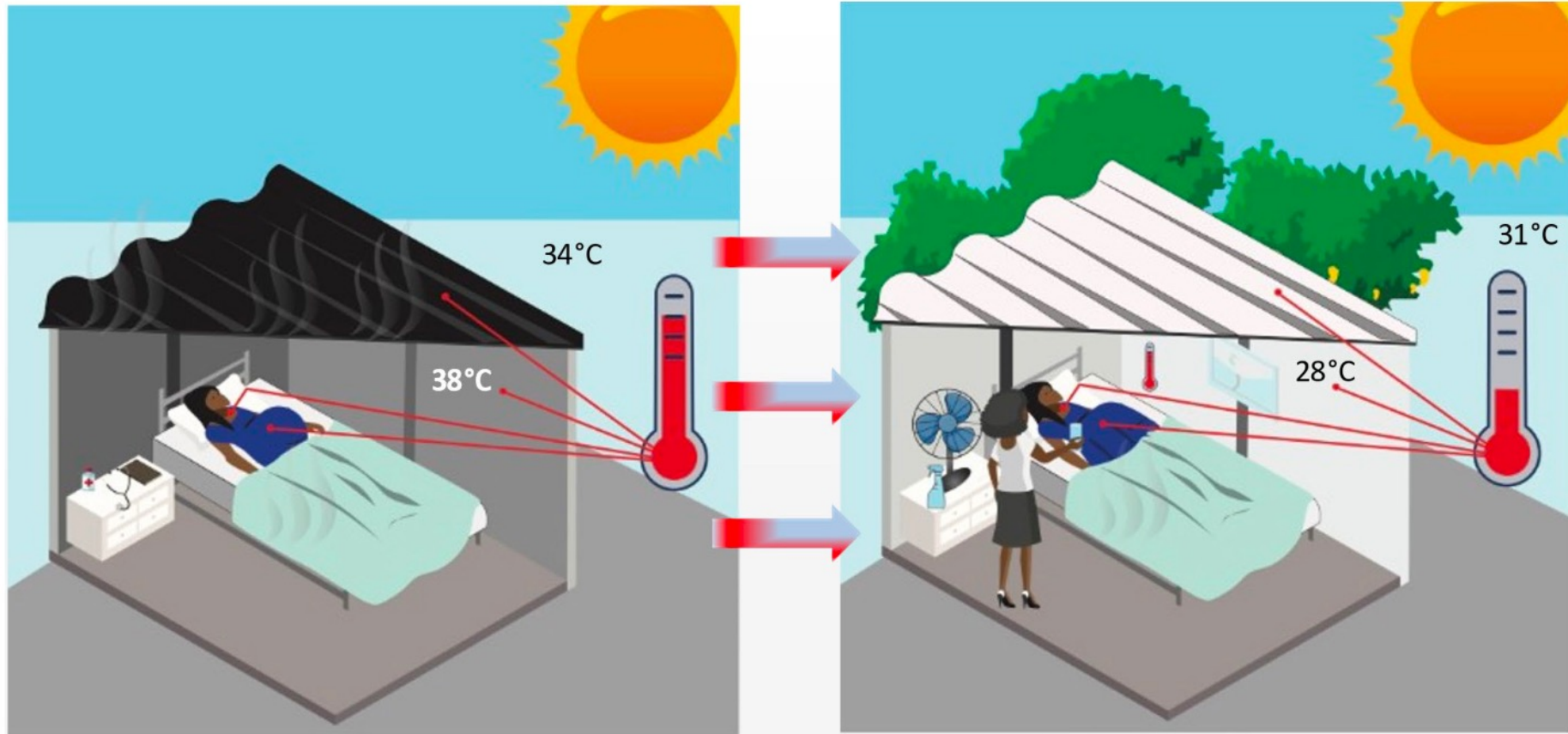
Unequal distribution of heat in NYC region



Geographic distribution of heat-related mortality



White rooftops



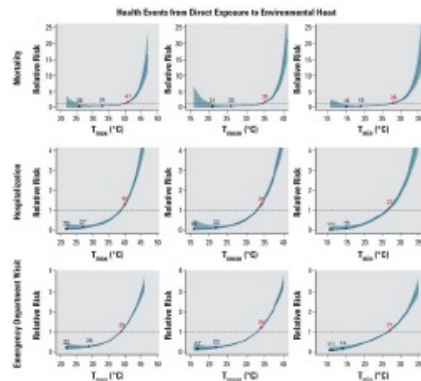
New York City has painted over 9.2 million square feet of rooftops white — and it could be a brilliant heat-fighting plan



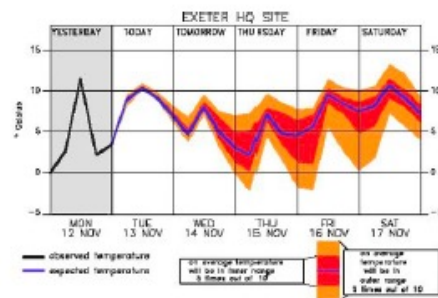
Population-level Interventions



Identify
temperature
thresholds
(harm)



Forecast
likelihood of
crossing
threshold(s)



Issue
warning
based on risk
assessment
(prognosis)



Interventions
(therapy)



Heat and Pregnancy



Summers are getting hotter. Extreme heat has been linked to problems in pregnancy, including preterm birth, stillbirth, gestational diabetes, and low birth weight. Keep reading to see how you can protect yourself and your child from the heat.

EXTREME HEAT DEFINITIONS

Heat Index	"Real feel" temperature. An estimate of how it feels when air temperature and humidity are combined. If it is humid, it will feel hotter!
Heat Wave	The National Weather Service defines a heat wave as at least three consecutive days with high temperatures of at least 90°F.
Heat Advisory	In New York City, a Heat Advisory is issued when the heat index is forecast to reach 95°F to 99°F for at least two consecutive days or 100°F to 104°F for any length of time.

SIGNS OF HEAT-RELATED ILLNESS

- Painful red and warm skin
- Red clusters of small blisters that look like pimples on the skin
- Heavy sweating while outside that leads to muscle pain or spasms
- Fast, weak pulse
- Cold, pale, and clammy skin
- Nausea or vomiting
- Tenderness or weakness, dizziness, headache, or fainting.
- High body temperature (103°F+)
- Losing consciousness
- Preterm contractions
- Decreased fetal movement

Call your doctor if you are experiencing any of these symptoms!

RECOMMENDATIONS FOR EXTREME HEAT

- 1 Drink non-alcoholic, non-caffeinated, non-sugared fluids to keep well-hydrated
- 2 Limit outdoor activities and exercise
- 3 Avoid using the stove/oven
- 4 Wear lightweight, loose-fitting clothing
- 5 Know the signs of preterm labor and contact your doctor if you are experiencing any of the symptoms
- 6 If you are overheating, cool down by applying wet cloths to your skin, and take a cool shower or bath.



TRYING TO STAY COOL WITHOUT AIR CONDITIONING?

- Open windows when it is cooler outside than inside your apartment and set up a fan for a cross-breeze
- Place cold water in front of your fan for extra cooling
- Seek out public air-conditioned spaces (libraries, etc.) or cooling centers



Seek Cooling Centers (Scan the QR code to find centers and other ways to stay cool in New York City)



Screening for energy insecurity – unclear best questions to ask



- From CMS, “In the past 12 months has the electric, gas, oil or water company threatened to shut off services in your home?” Yes, No, or Already Shut Off
- Is your home ever too hot?
- Is your home ever too cold?
- Do you have access to air conditioning?
- Do you ever have to reduce use of cooling/ air conditioning because of the cost?

Energy Insecurity Indicators Associated With Increased Odds Of Respiratory, Mental Health, And Cardiovascular Conditions

[Eva Laura Siegel](#), [Kathryn Lane](#), [Ariel Yuan](#), [Lauren A. Smalls-Mantey](#), [Jennifer Laird](#), [Carolyn Olson](#), and [Diana Hernández](#)

EXHIBIT 1

Weighted prevalence of energy insecurity indicators among New York City residents, 2022

Energy insecurity dimensions and associated indicators	Weighted prevalence ^a (%)	95% CI
Physical conditions		
Home too cold	29.5	26.1, 33.1
Home too hot	27.5	24.3, 30.9
Economic dynamics		
Difficulty paying bill	21.2	18.5, 24.2
Utility debt \$100 or higher	14.0	11.6, 16.7
Disconnection notice	8.2	6.4, 10.5
Service shut offs	3.2	2.0, 5.1
Coping responses		
No or reduced air conditioning during hot weather because of run cost	14.3	12.1, 16.9
No heat because of run cost	6.7	5.1, 8.6
Reduced energy use because of cost	38.7	35.3, 42.3
Stove or oven used for heat	21.3	18.3, 24.7

SOURCE New York City Household Energy and Health Survey, March 2022. **NOTE** Weighted estimates based on responses of N = 1,950 survey participants. ^aPercent of individuals.

Air Pollution

Links between climate change and air pollution



Hot sunny days increase ground level ozone

- Ozone a greenhouse gas-->traps heat→ further warming of climate

Increased particulate matter from droughts (more dust)

Increased particulate matter and other air pollutants from wildfires

Increased indoor air pollutants

- mold/bacteria following flooding & storm surges
- Increased outdoor air pollutants seeping inside

Increased allergens— longer pollen seasons, increased amount of pollens produced by plants

Air pollution & pregnancy outcomes

Many studies support link between ambient air pollution and adverse reproductive outcomes with modest effect sizes in systematic review.



Increased risk for:

Preterm birth

Impaired fetal growth

Stillbirth

Hypertensive disorders of pregnancy

Adverse neurodevelopment (e.g., autism spectrum disorder)

Systematic reviews

- *Zhang 2021 Environ Pollut*
- *Bearblock 2021 Placenta*
- *Bekkar 2020 JAMA Network Open*
- *Li 2017 Environ Pollut*
- *Malley 2017 Env Intl*
- *Flores-Pajot 2016 Environ Res*
- *Weisskopf 2015 Curr Env Health.*

Percent preterm births attributable to air pollution



**Estimated
15,808 PTBs
annual
attributable to
PM_{2.5} in US**

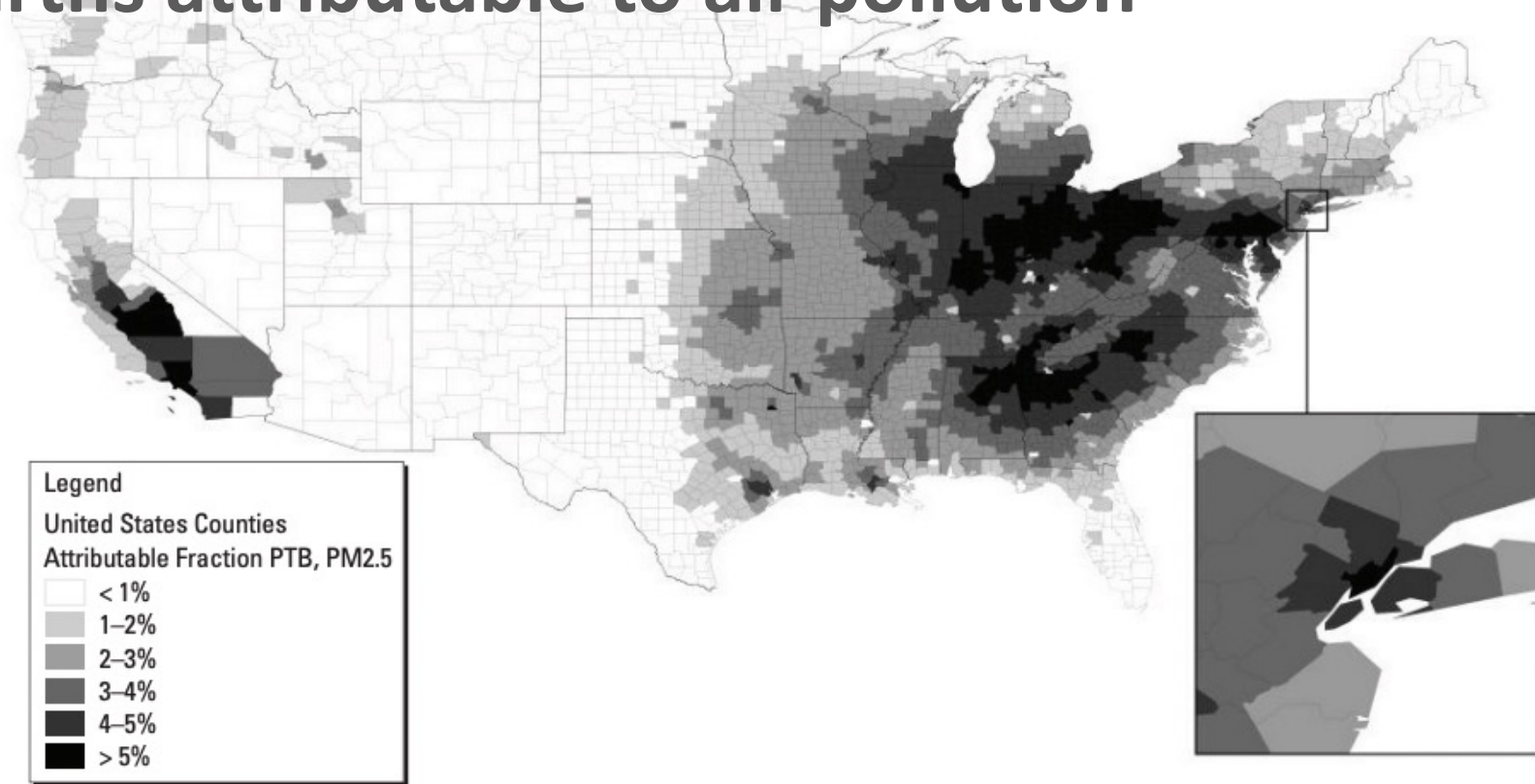
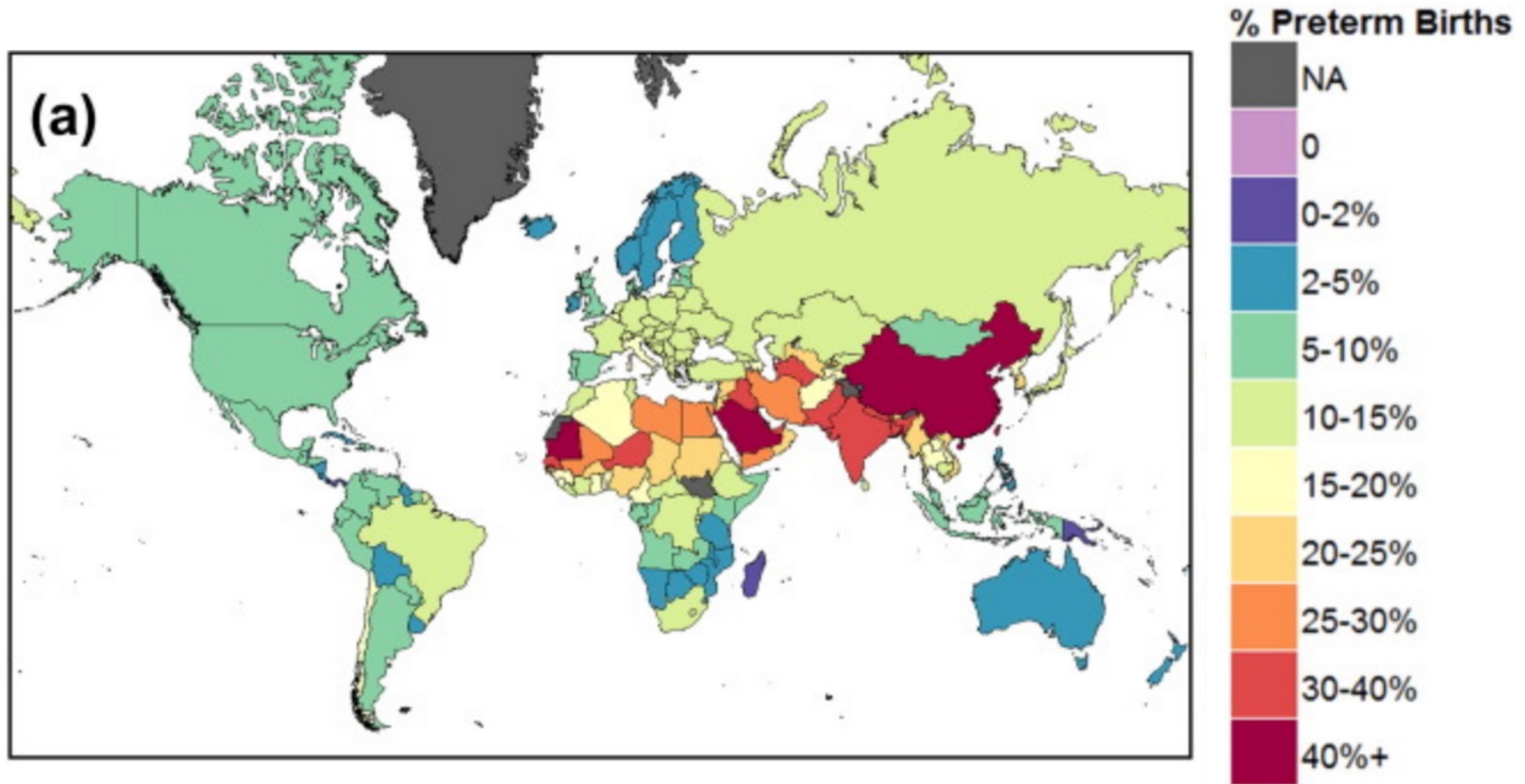


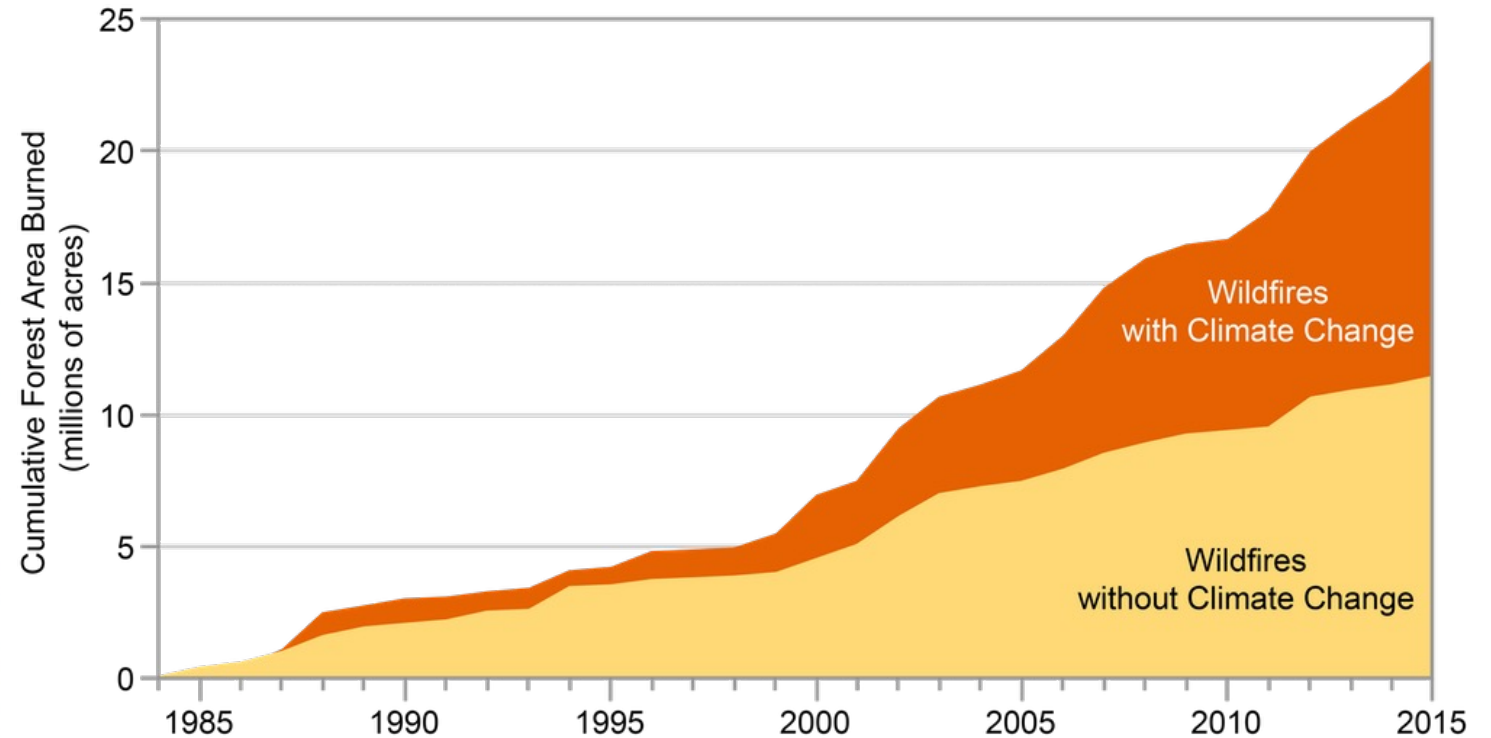
Figure 1. Fraction of preterm birth attributable to air pollution, county-level data.

Births in each county were obtained from the CDC WONDER database (CDC 2014a), as were county-level PTB rates, and multiplied together to calculate the number of preterm births in a county in 2010. For counties with population < 100,000, the overall rate (0.15) for those counties was applied. The number of preterm births in each county was multiplied by the AF for each county to estimate the number of PM_{2.5}-attributable premature births in 2010. Source for PM_{2.5} data: U.S. Environmental Protection Agency (U.S. EPA 2008).

Percent preterm births attributable to air pollution



Climate change driving increase in wildfires





Temperatures are rising

Average annual temperatures in the Western US have increased 1.9° since 1970.



Snow melts sooner

Winter snowpack melts up to 4 weeks earlier than in previous decades.



Forests are drier, longer

Conditions are primed for wildfires to ignite and spread.



Particulate matter exposure with wildfires

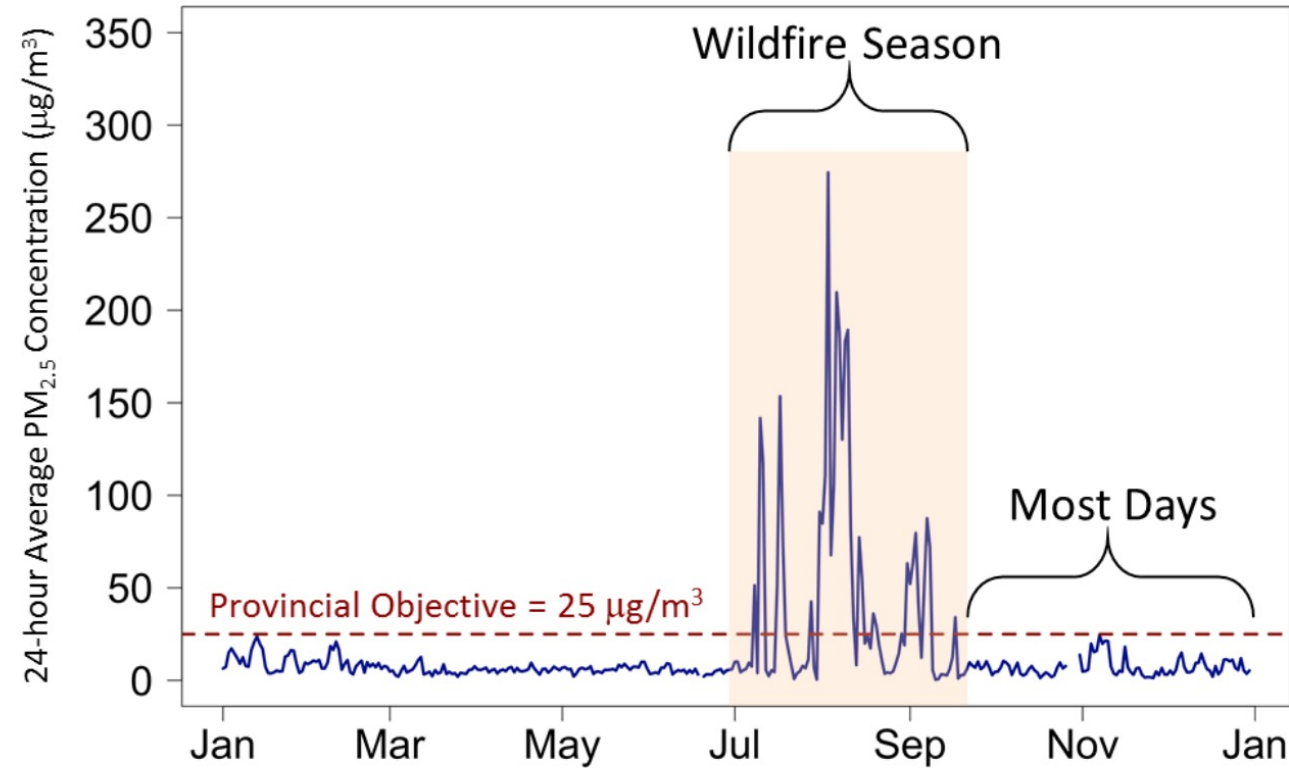
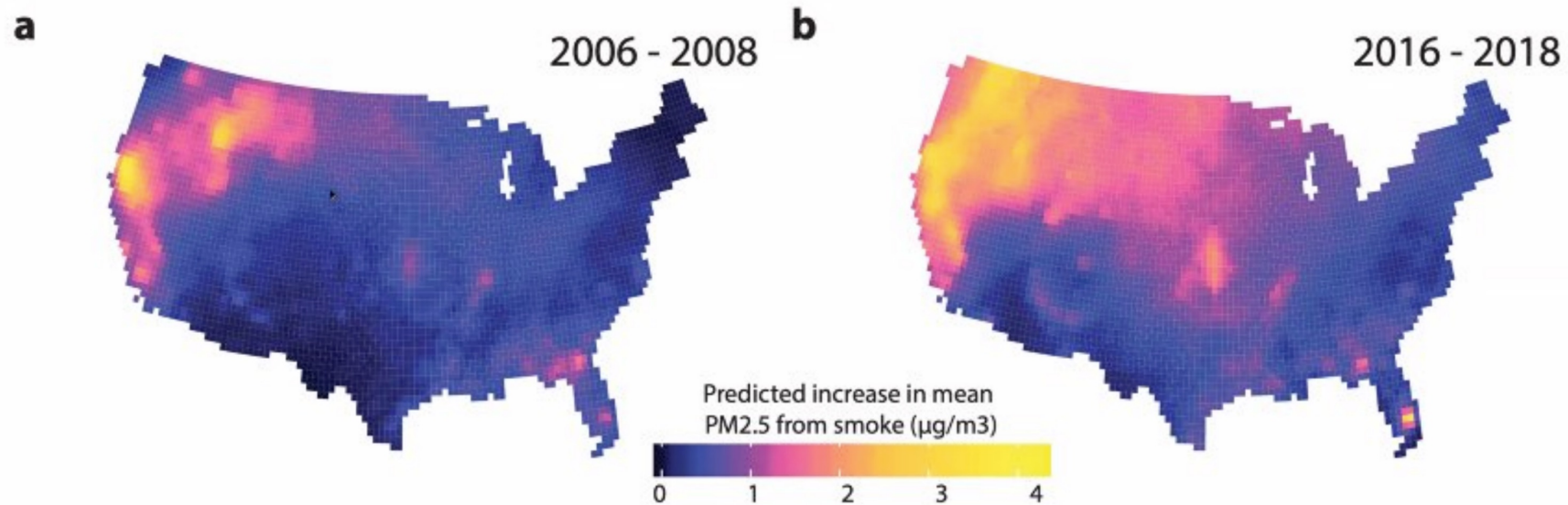


Figure 1: Concentrations of fine particulate matter (PM_{2.5}) air pollution can be more than 20 times higher than usual on days affected by wildfire smoke

Wildfires erase gains in air quality over past decades



Smoke contribution to overall PM_{2.5}



Slide courtesy of Western PEHSU.

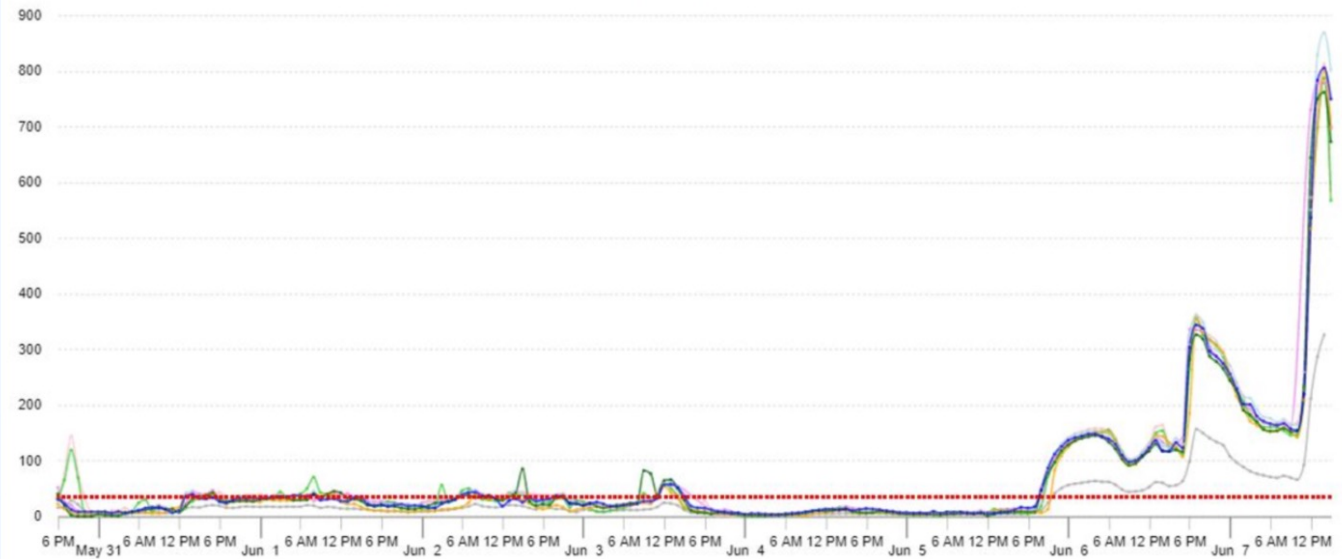


NEW YORK CITY **WORST** AIR QUALITY ON RECORD

WEDNESDAY AFTERNOON: 405
PREVIOUS RECORD: 279 JULY 1981

nyc.gov

Hourly PM2.5 measurements (in $\mu\text{g}/\text{m}^3$) | NAAQS 24-hour PM2.5 standard (35 $\mu\text{g}/\text{m}^3$)





Associations between wildfire smoke exposure during pregnancy and risk of preterm birth in California

Sam Heft-Neal ^a  , Anne Driscoll ^a, Wei Yang ^b, Gary Shaw ^b, Marshall Burke ^{a, c, d}

Key Findings

- Each day of wildfire smoke exposure **increases PTB risk by 0.49 %** (95%CI 0.41-0.59%)
- Average wildfire episode 7 days on average → **3.4% increase in PTB risk**
- Stronger associations in third trimester
- 6974 excess preterm births in CA 2007-2021 attributable to wildfires



The Journal of Climate Change and Health

Available online 2 August 2021, 100035

In Press, Journal Pre-proof ?



Review

Air Pollution as a Social and Structural Determinant of Health

Lisa Patel MD, MEd (Clinical Assistant Professor of Pediatrics)^a ✉, Elizabeth Friedman MD, MPH (Assistant Professor of Pediatrics)^b, Stephanie Alexandra Johannes MD, MA^c, Stephanie Sophie Lee MD, MPH^d, Haley Grace O'Brien MS (Community health and prevention researcher)^e, Sarah E. Schear MD, MS (Pediatric Resident)^f

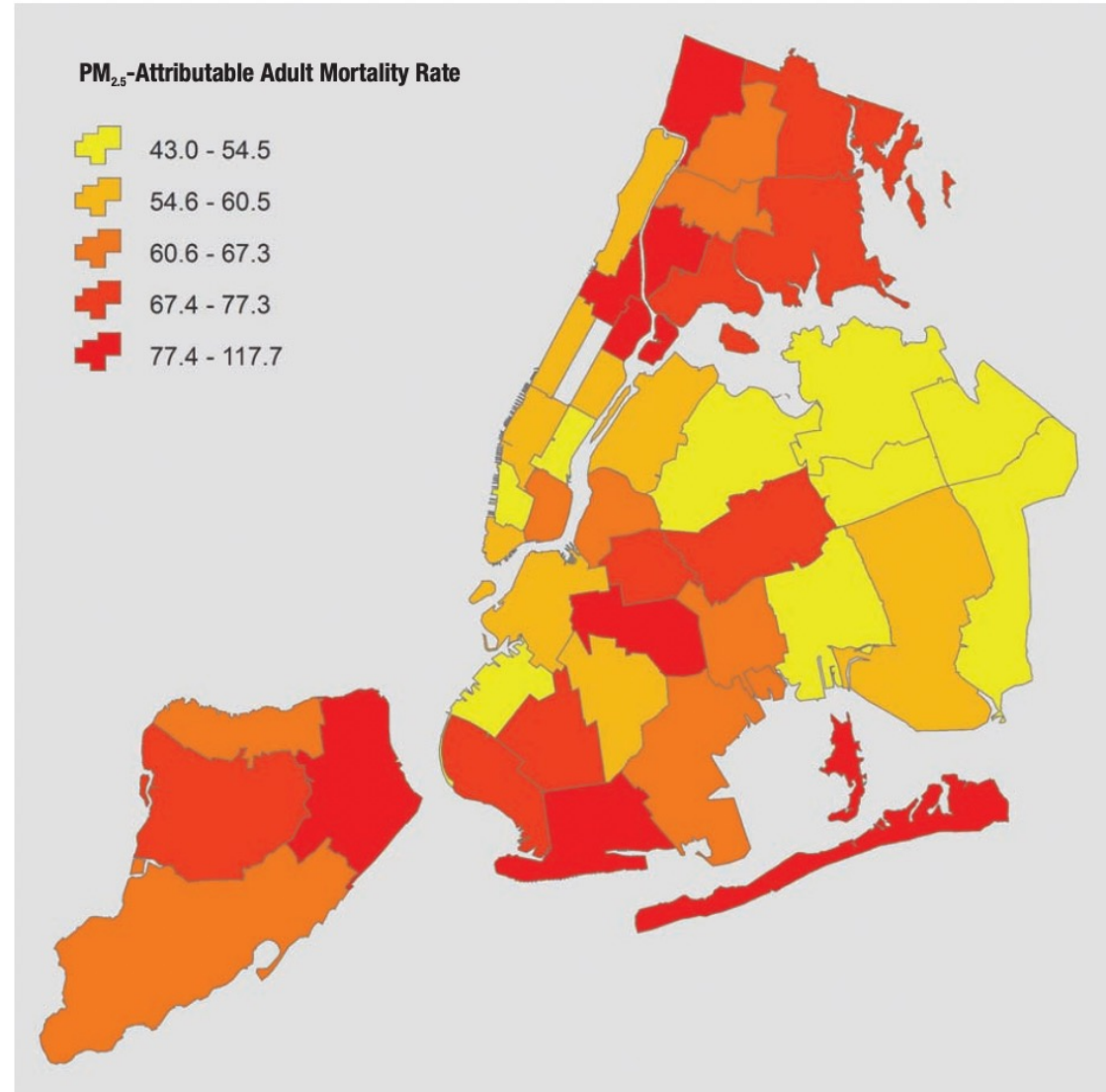
“Exposure to PM_{2.5} in US is inequitably distributed, secondary to public policies rooted in structural racism, which intentionally situate polluting industries in communities of color.”

Unequal distribution of PM_{2.5} in NYC region

Figure 6. Rates of PM_{2.5}-attributable mortality vary by 2.7-fold across New York City neighborhoods.



Geographic distribution of PM_{2.5}-related mortality in NYC



PM_{2.5}=particulate matter

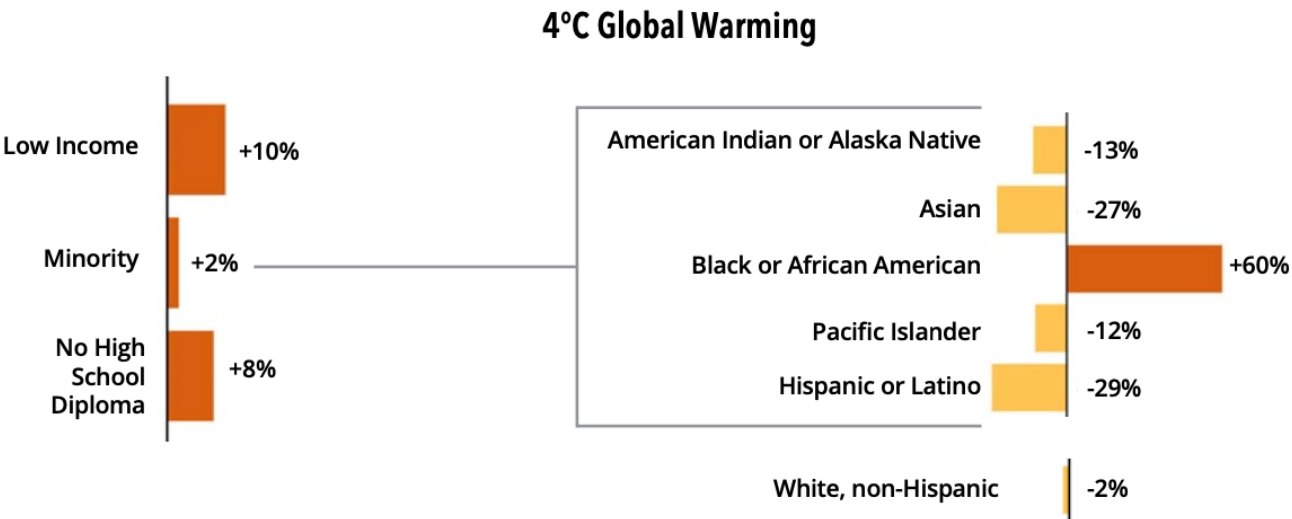
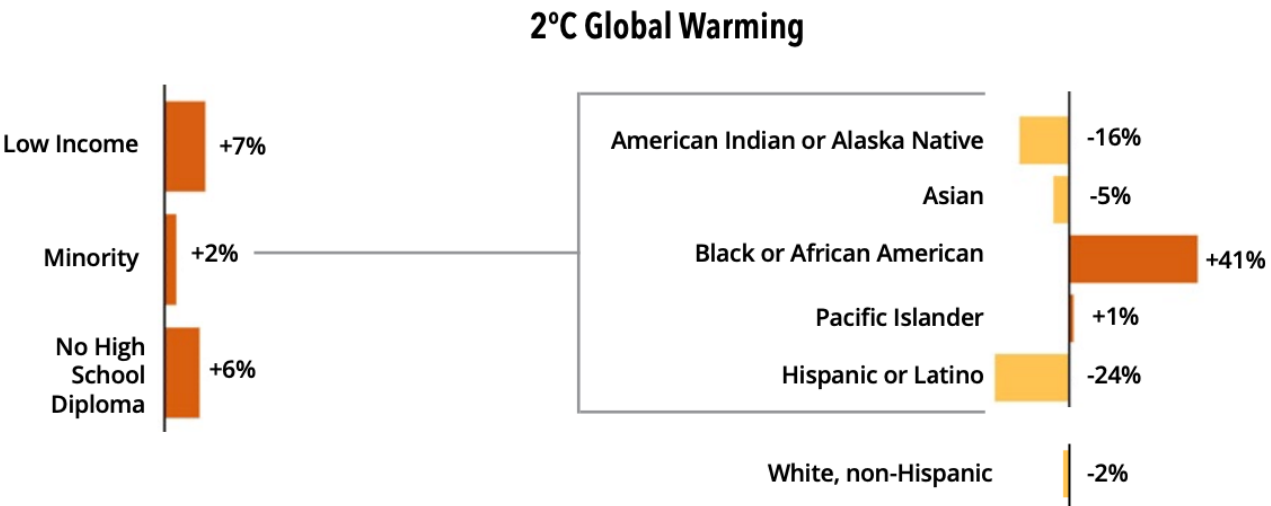


CLIMATE CHANGE AND SOCIAL VULNERABILITY IN THE UNITED STATES

A Focus on Six Impacts

SEPTEMBER 2021

Vulnerability to Climate-driven changes in PM_{2.5}



Reducing exposure with air pollution spikes



 Springer Link

Air Pollution and Health (S Adar and B Hoffmann, Section Editors) | [Open Access](#) |
Published: 26 November 2020

Individual- and Household-Level Interventions to Reduce Air Pollution Exposures and Health Risks: a Review of the Recent Literature

[Ryan W. Allen](#)  & [Prabjit Barn](#)

[Current Environmental Health Reports](#) (2020) | [Cite this article](#)

258 Accesses | [Metrics](#)



Air Quality and Pregnancy



Poor air quality can result from traffic pollution, industrial sources, and wildfire smoke. Air pollution produces toxic gases, volatile organic compounds, and particulate matter.

When you're pregnant, these exposures have been linked to an increased risk of:

- miscarriage
- high blood pressure in pregnancy
- diabetes (high blood sugar) in pregnancy
- preterm birth
- low birth weight
- stillbirth

HOW IS AIR QUALITY MEASURED?

The Air Quality Index (AQI) is a number for reporting how clean or unhealthy your air is every day. You can find it on the Internet at [AirNow.gov](https://www.airnow.gov).



Scan to see
your local
AQI

1-50
GOOD

51-100
MODERATE

101-150
UNHEALTHY
for sensitive
groups

151-200
UNHEALTHY
for all

201-300
**VERY
UNHEALTHY**
for all

RECOMMENDATIONS

If the air is unhealthy, this is what you should do:

1

Use a HEPA air filter in your home



2

Don't have an air filter? Scan the QR code to learn how to make your own air filter at home.



3

Wear a N95 mask outside if AQI >150.



4

If AQI is 51-100, plan outdoor activities in the morning. If AQI is >100, exercise indoors.



5

If AQI is >200, keep your home's windows closed.



6

Call your healthcare provider or 911 if you have contractions, bleeding, less fetal movement or other concerns.



How to Reduce Wildfire Smoke Exposure For Kids * & pregnant people *



▼ ≤ 100%

Go Somewhere
Without Smoke



▼ ~50-80%

Go inside with
(1) HVAC & MERV 13 filter *
or
(2) a portable HEPA air cleaner



▼ ~30%

Go Inside and
Shut Windows

DO NOT spend unnecessary
time outside if the AQI is in
the unhealthy ranges.

Cloth face coverings (like
those for COVID) DO NOT
reliably filter out small
smoke particles.

For Short Periods of Time:



▼ ~80%

Recirculate the
air in your car



▼ ~80%

Wear a small size
NIOSH N95 Mask *correctly*



▼ ~20%

Wear a medical
mask *correctly*

Wildfires



More resources: wspehsu.ucsf.edu

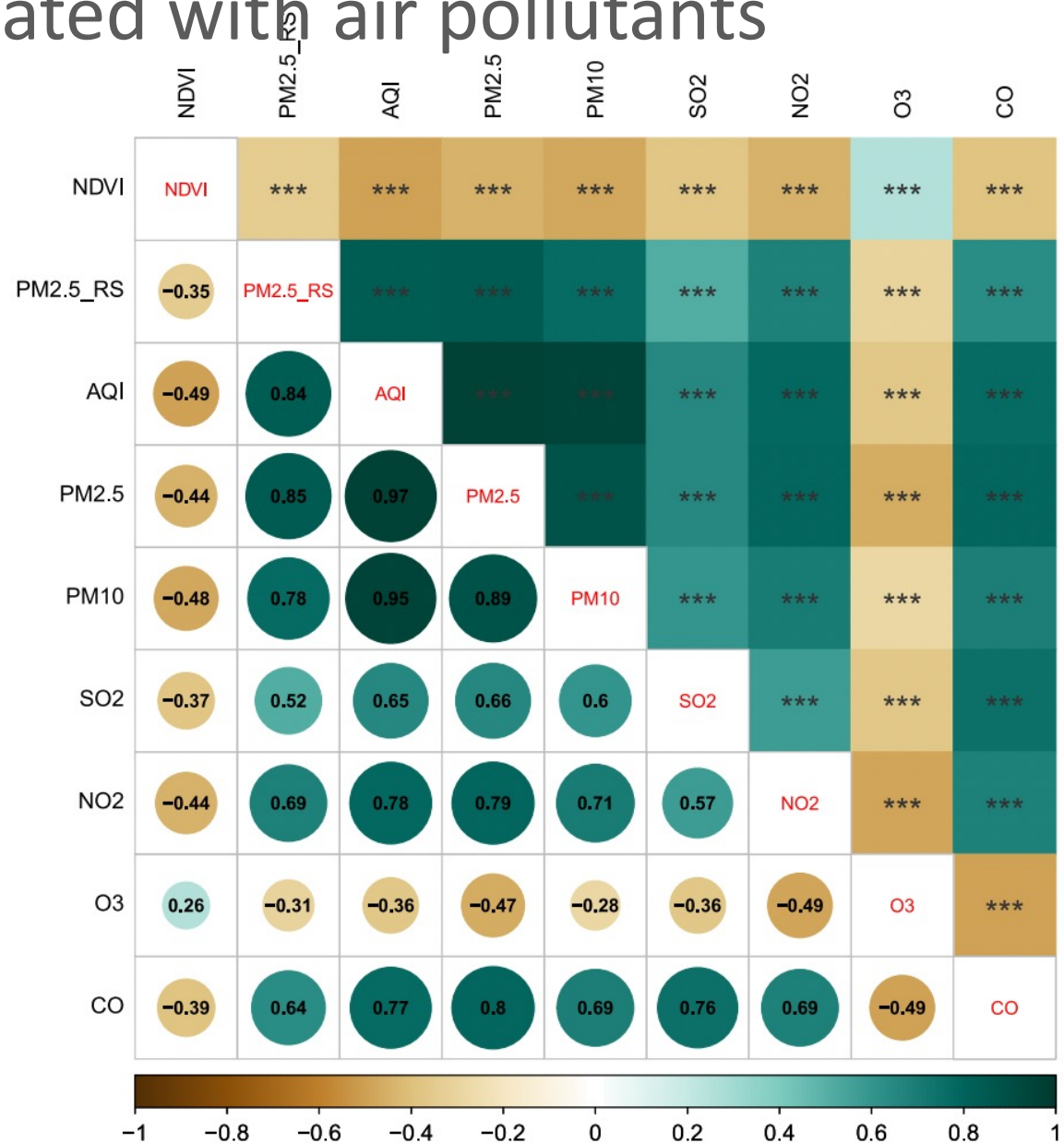
Green space inversely correlated with air pollutants



Increasing NDVI
(normalized
difference vegetation
index) inversely
associated with:

- $PM_{2.5}$
- PM_{10}
- SO_2
- NO_2
- CO

Ai et al, Ecological Indicators, 2023.



Vector-borne illness

Vector-borne diseases (VBDs)

A vector is an organism (typically arthropod)

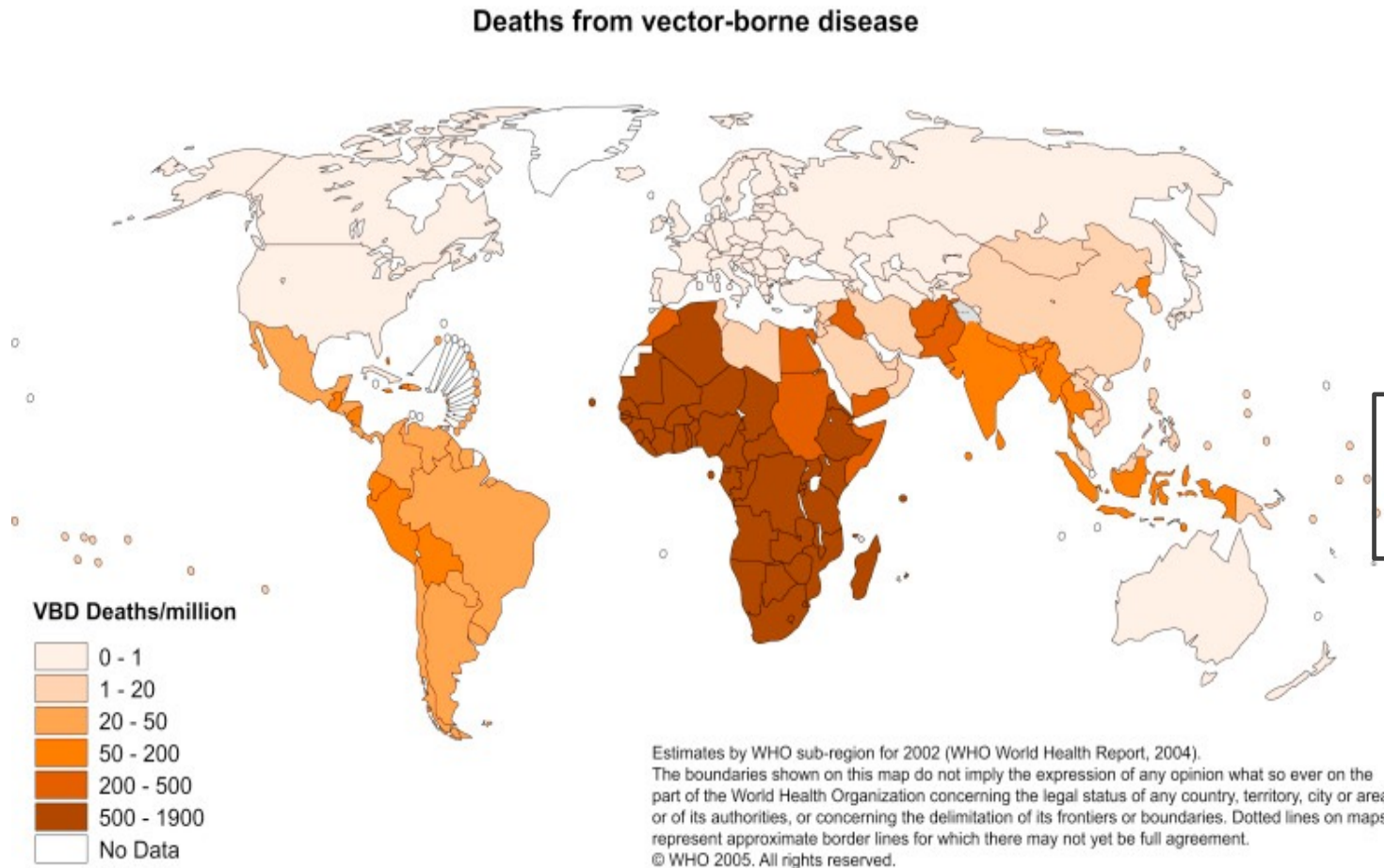
that transmits pathogen from animal host or infected human to an uninfected human



- Malaria
- Dengue
- Chikungunya
- Yellow Fever
- Zika
- Lymphatic filariasis
- Schistosomiasis
- Onchocerciasis
- Chagas
- Leishmaniasis
- Japanese encephalitis
- African trypanosomiasis
- Lyme
- West Nile virus

Global estimates of VBD mortality

**1/6th of
disability
(DALYs)
worldwide
attributed to
VBD**

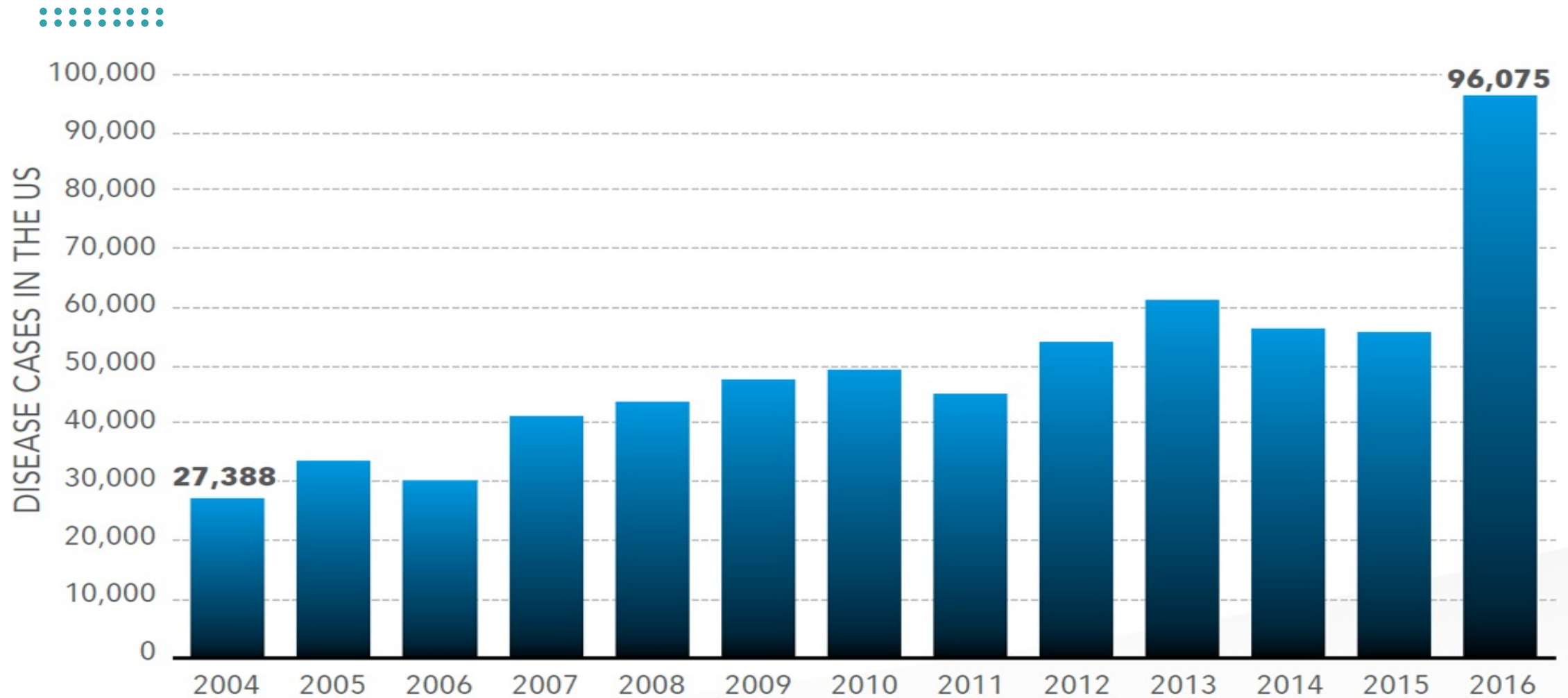


Estimated 1 billion infections
each year

Estimated 1 million deaths
each year

World Health Organization

US Vector-borne disease tripled in just > 10 yrs



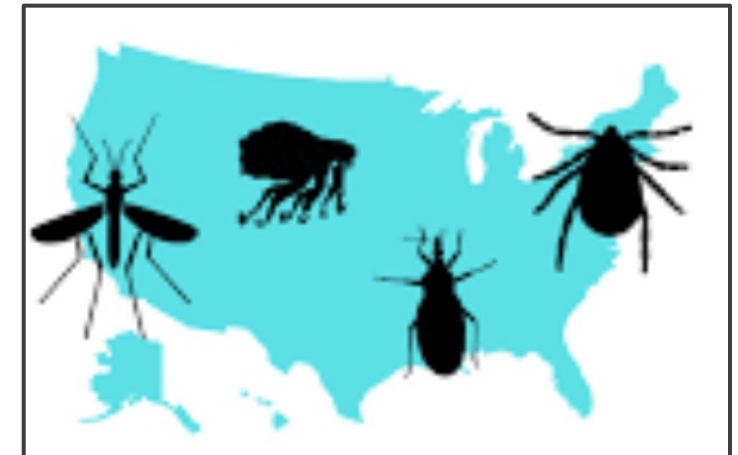
Source: US Centers for Disease Control.

Mechanisms linking Climate Change with VBD



Direct effects

- Increased geographic range or abundance of vectors (or animal reservoirs)
- Prolonged length of transmission cycles/seasons
- Increased importation of disease vectors



Temperature can impact the vector

- Can alter survival of the vector species (& pathogen!)
- Can change susceptibility of the vector to a pathogen
- Can change rate of population growth
- Can change feeding habits
- Can change likelihood of contact with



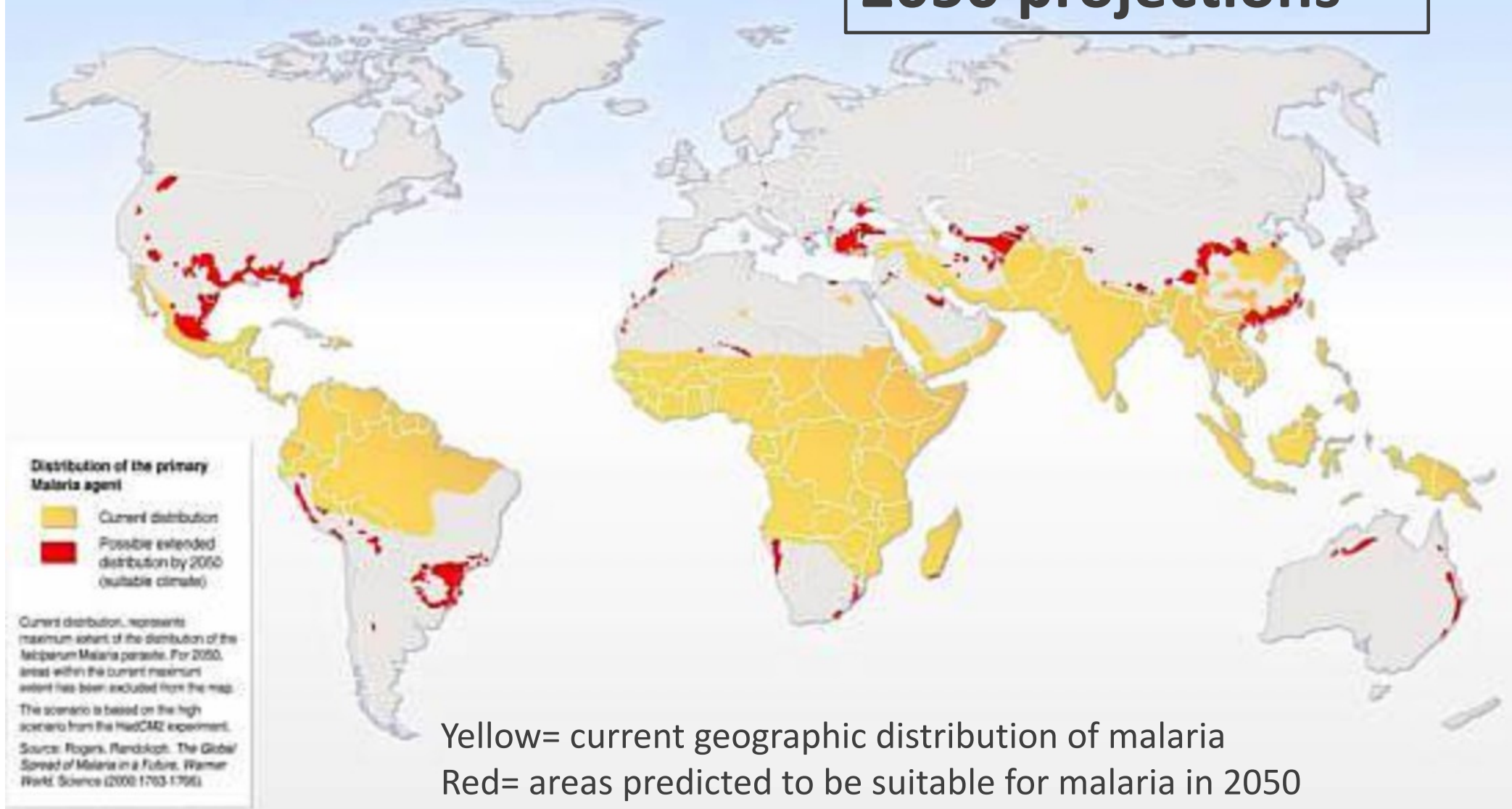
Precipitation can also impact the vector



- Increased rain may increase larval habitat
- Although flooding could eliminate habitats
- Drought and water stagnation may increase habitats (pooling)
- Drought impacting human behavior (containers for water collection)
- Humidity can increase vector survival and activity; extreme precipitation can decrease activity

Climate Change and Malaria

2050 projections





[Home](#) > [News & Insights](#) > [Media Coverage](#) > ...

The hidden inequality of mosquito bites

Abandoned buildings contain lots of nooks and crannies for water to accumulate and for mosquitoes to lay their eggs.

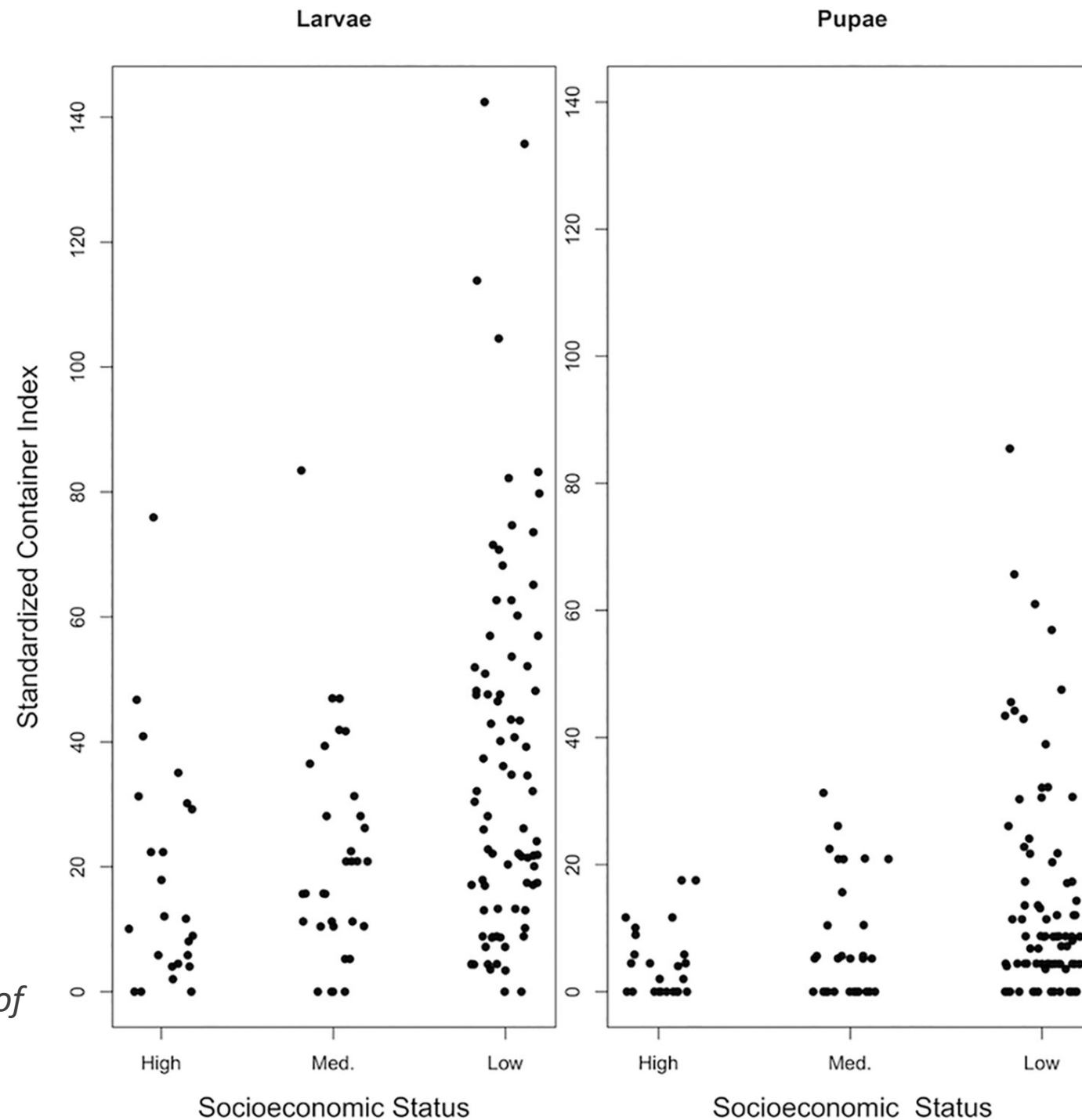
1% buildings in high-income areas abandoned vs 26% in low-income areas
Higher rates of trash accumulation (pooling water) in low income areas



Standing water not equally distributed

Study from Baltimore →
more mosquitos
(larvae, pupae) in low
SES neighborhoods

*Little E, et al,
Mailman School of
Public Health*



Summary of VBD, climate change and perinatal health

- Climate change impacting global vector-borne diseases (including those with relevance in pregnancy)
- Impacts will vary regionally with intensification in some areas, diminishment in others, and emergence in previously unaffected regions
- Increased attention will be needed to identify best control strategies and weigh risks/benefits of approaches (insecticides, vaccines)

*Why and how should Ob/Gyns engage to
mitigate effects of climate change?*

Greenhouse gas contributions of health care



- Health care sector contributes ~ 4.6% GHG emissions
 - → Equivalent to ~515 coal-fired power plants
 - US healthcare sector contributes ~8.5% national GHG emissions
 - Sources include:
 - Energy consumption
 - Product manufacture, use, disposal
 - Food consumption
 - 70% from supply chain
- Top global emitters as % of global health care footprint

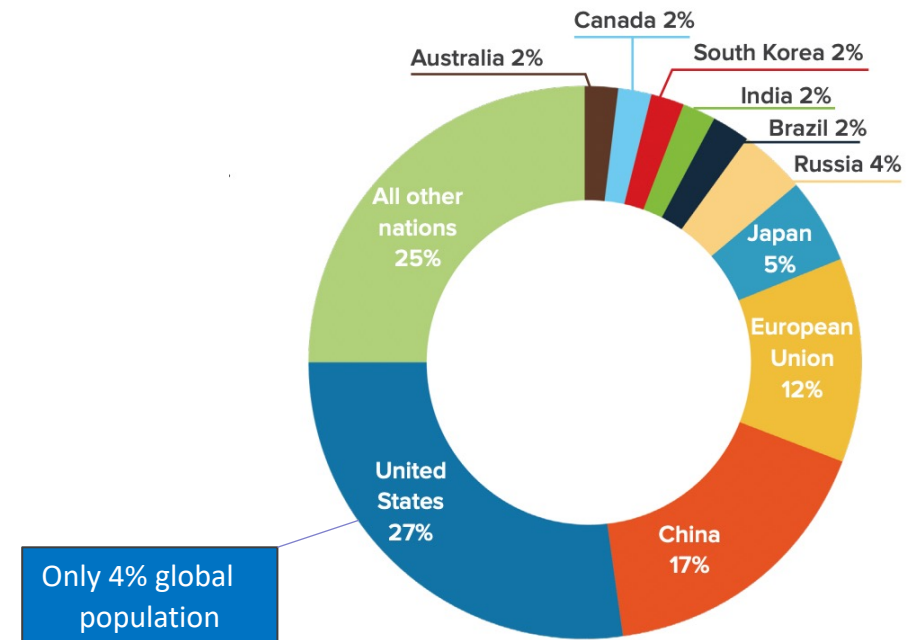


Figure 8: Top ten emitters as percentage of global health care footprint.

Consider joining Ob/Gyns for a Sustainable Future (obg4sf.org), a chapter of Health Care without Harm

NARRATIVE REVIEW

Sustainability in Obstetrics and Gynecology

Wright, Kelly N. MD; Melnyk, Alexandra I. MD, MEd; Emont, Jordan MD, MPH; Van Dis, Jane MD

Author Information

Obstetrics & Gynecology ():10.1097/AOG.0000000000005435, November 9, 2023. | DOI: 10.1097/AOG.0000000000005435

BUY SDC PAP

Out now in [Metrics](#)
Green journal!!

Abstract In Brief

Current practices in the U.S. health care industry drive climate change. This review summarizes the vast research on the negative health effects of the climate crisis on patients as relevant to obstetrics and gynecology. We further propose solutions to decarbonize operating rooms, labor and delivery units, and nurseries and neonatal intensive care units through evidence-based reduction in our single-use supply, energy, and water, as well as anesthetic gases and appropriate waste sorting.



Plastic speculums?

Jane van Dis MD 
@janevandis

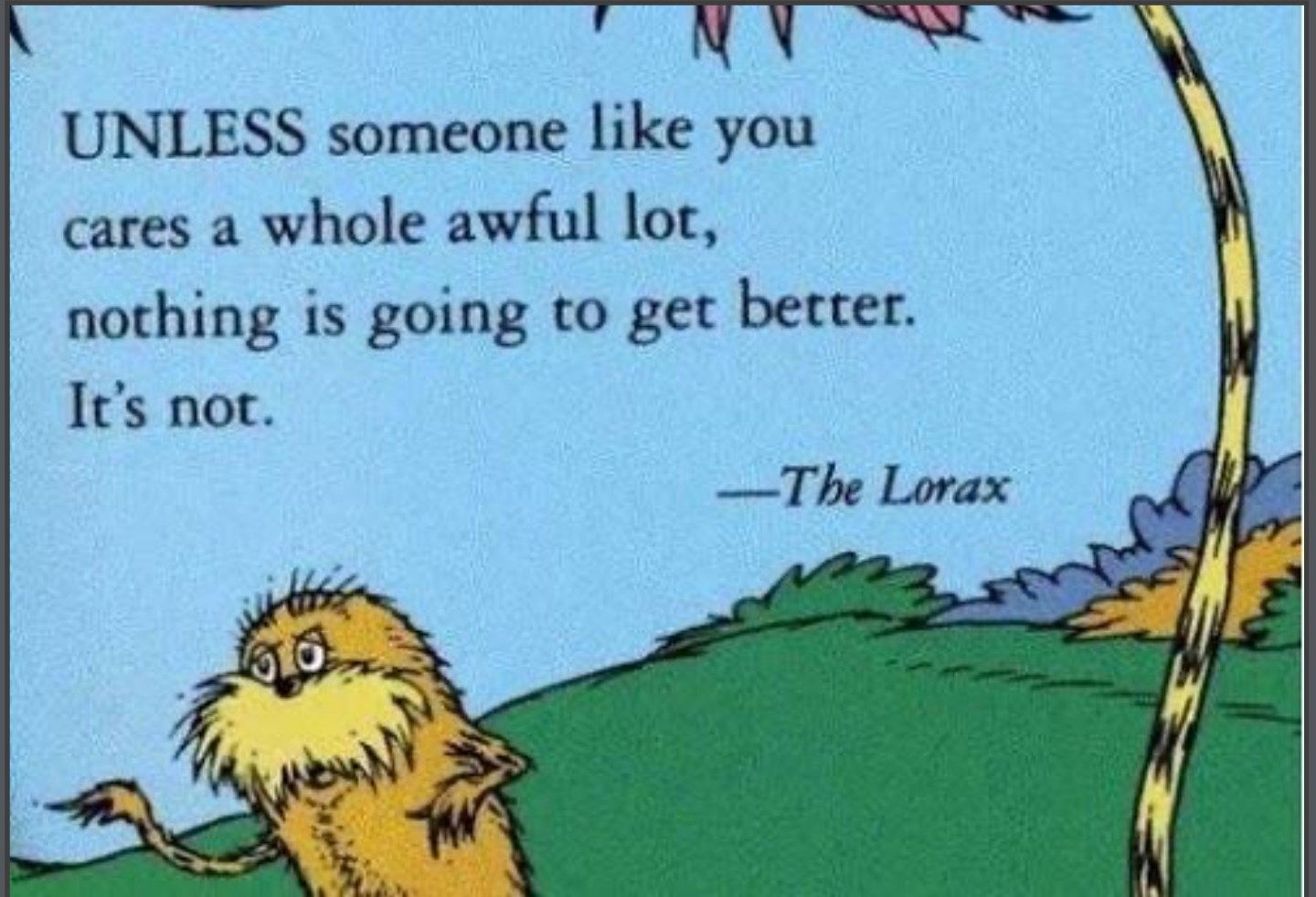
Every one of these plastic speculums has (2) lithium batteries in it. So for 30 seconds of life, these are going in the landfill or incinerator every day. Consider that there are 46000 (or so) OBGYNs appx 120million speculum/yr. And that's just one device.



There will be no equity without sustainability.

UNLESS someone like you
cares a whole awful lot,
nothing is going to get better.
It's not.

—*The Lorax*



Thank you!

Questions → ebj2107@cumc.Columbia.edu

