

Feeling the Heat: Workplace Safety in a Warming World

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July 30, 2025

Aspen Institute Economic Opportunities Program

Global Climate Change



- Disasters – floods, droughts, hurricanes, wildfires
- Increased vector-borne diseases, allergens, air pollution
- **HEAT**
 - ***Fatal illness - outdoor workers and some indoor***
 - ***Non-fatal illnesses – serious under-reporting/ no data***
 - ***Prevention***
 - Decreased productivity
 - Increased occupational injuries
 - Increased all-cause mortality
 - ***During heat waves***
 - ***Among heat stroke survivors***

Heat Related Illness

- Acute
 - Heat rash, heat cramps, heat syncope
 - ***Heat Exhaustion*** – headache/nausea/fatigue/elevated core temp (100.4 F)
 - ***Heat Stroke – lethal, life-threatening (104 F)***
 - ***Distinguished by Central Nervous System abnormality – confusion, delirium, unsteady gait, coma or seizures***
 - ***Classic vs Exertional - may be **hot and dry (ALWAYS heat stroke)** OR still sweating***
 - ***Requires IMMEDIATE first aid/ RAPID cooling and transport to advanced care – coagulopathies, multi system organ failure, death***
- Chronic (emerging information)
 - Chronic kidney disease of unknown etiology (heat, dehydration, rhabdomyolysis, other factors?) ONLY REPORTED IN WORKERS
 - GENERAL POPULATION increased risk of recurrent heat stroke; studies suggest shortened life expectancy, worse CVD, renal and neurologic outcomes

Who Gets Heat Stroke?

- **Healthy Young People Pushing Themselves**
 - Sports – marathons, other –fatalities occur, but LOTS of research, training, prevention
 - Military – surveillance primary and secondary prevention
 - ***Workers (workload, piece rate, pushing)***
- **People with Additional Risk Factors**
 - *Age extremes, poverty, marginalization*
 - Hajj, Urban Heat Islands, Health conditions
 - Unhoused, mental illness, substance use
 - ***Workers (pregnancy, obesity, diabetes, hypertension, etc)***

Workers at Risk for Heat Stroke

- ***Outdoor workers – construction and agriculture. oil and gas extraction, landscaping, postal delivery, public utilities, trash/recycling collection***
- ***Miners***
- ***Indoor with heat sources (foundries, bakeries, etc)***

Photo of Ronald Silver II from AfFRO News
courtesy Renee Meredith



Predisposing Factors

Climate/ Work Risks

- Heat thresholds, humidity
- Exertion level
- Working in direct sunlight or sources of radiant heat
- Work requiring heavy safety gear or encapsulating PPE
- Heat waves – different definitions, such as increased minimum and maximum temperatures (> 90th percentile) for three consecutive days, others
- Lack of water/rest/shade/acclimatization

Individual Risks

- Obesity
- Age
- Pregnancy
- Chronic conditions, including diabetes, hypertension, cardiovascular disease, congestive heart failure, multiple sclerosis, Parkinson's, among others
- Acute – fevers, vomiting, diarrhea
- Medications and drugs
- Lack of acclimatization
- Prior heat stroke

Partial listing of drugs adding risk (source: ACOEM guidelines for preventing heat illness, Tustin et al https://acoem.org/acoem/media/News-Library/Prevention_of_Occupational_Heat_Related_Illnesses-25.pdf)

Alcohol

Amphetamines (eg, methamphetamine, MDMA)

ACE inhibitors ARB

Anticholinergics (eg, benztropine, cyclobenzaprine)

Anticonvulsants (eg, topiramate)

Antihistamines (eg, diphenhydramine)

Antipsychotics (eg, haloperidol and phenothiazine)

Benzodiazepines

Beta-blockers

Cocaine

Diuretics

Opioids

Tricyclic antidepressants

Heat-related deaths among **construction workers** in the U.S.

Dong et al AJIM 2019

- Construction workers in the U.S. are 6% of the workforce but 36% of heat stroke fatalities
- From 1992 – 2016, 285 construction worker heat deaths
- Rates higher among racial and ethnic minorities, cement masons, brick masons, roofers, helpers, and construction laborers



Heat Related Deaths (continued)

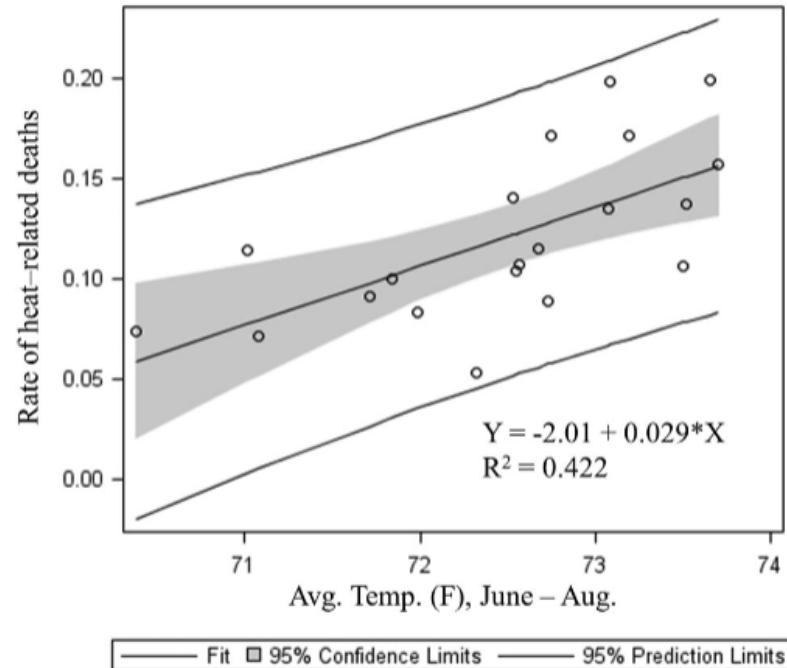


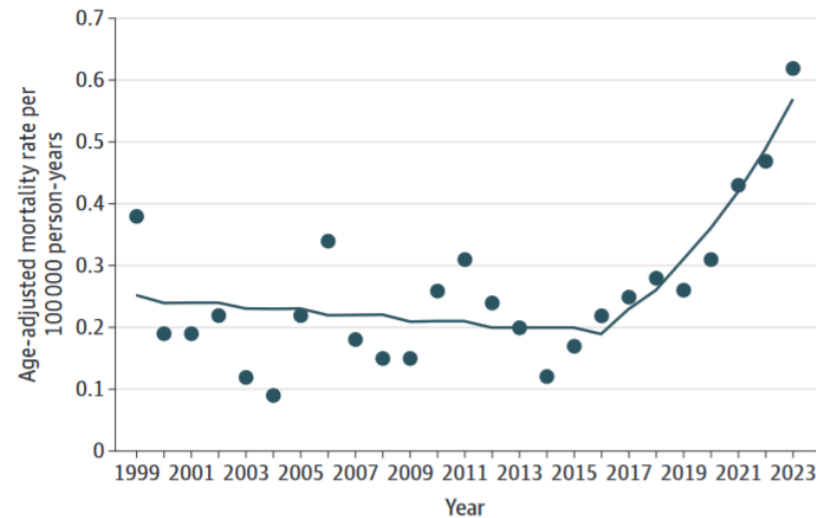
FIGURE 5 Scatter plot and corresponding regression line illustrating the relationship between annual rates of heat-related construction deaths and average summer temperatures in the contiguous United States, 1997 to 2016. Death rates shown per 100 000 construction workers. R^2 = coefficient of determination

- Heat related mortality rates increase with increased average summer temp (June – Aug)
- All cause injury fatalities for all workers and for construction workers decreased or remained flat while heat related deaths increased significantly for both.

Caused and Contributed or Excess Mortality?

General population studies

Figure. Age-Adjusted Mortality Rates With Joinpoint Model Estimates for Heat-Related Deaths as Either Underlying or Contributing Cause From 1999-2023



Data are from the Centers for Disease Control and Prevention's WONDER database. Heat-related mortality rates are plotted as dots, with a joinpoint model fitted to the data. The joinpoint model is a piecewise linear model that allows for changes in the slope of the trend over time. The joinpoint model is fitted to the data using a statistical software package. The joinpoint model is a piecewise linear model that allows for changes in the slope of the trend over time. The joinpoint model is fitted to the data using a statistical software package.

- Trends of Heat-Related Deaths in the US, 1999-2023 Howard JT et al JAMA 2024
- Chronic Diseases Associated With Mortality in British Columbia, Canada During the 2021 Western North America Extreme Heat Event Lee et al GEOHEALTH 2023

Maintaining Core Body Temperature

Heat Balance

Change in heat content =

$$(M - W) \pm C \pm R \pm E$$

M metabolism (raised by EXERTION)

C convection

R radiation

E evaporation

Heat Exchange

Governed by:

- ***Humidity****
- ***Air temperature****
- Wind velocity
- Radiant heat

(WBGT measures range of environmental factors; ****heat index only these***)

- Skin temperature
- Clothing

Heat Acclimatization

- Process of becoming accustomed to exercise/work in the heat
- Physiologic adaptations in sweat amount and composition, heart rate, skin blood flow, other thermoregulatory mechanisms
- Requires work plus heat exposure
 - Some adaptation within 4-7 days,
 - Two weeks for full acclimatization
- After removal for one week, effect is lost
- Not affected by cooling down rest periods or air conditioning
- OSHA series of heat stroke investigations: ***most cases occur within the first three days on the job***

The association between heat stroke and subsequent *cardiovascular diseases* Wang et al Plos one 2019

- Randomly selected longitudinal subset of National Health Research Database (approximately one million subjects followed from 2000 – 2013)
- Heat stroke and other HRI survivors > 20 years old without baseline cardiovascular disease were matched 1:1:1 with controls for age, sex, comorbidities, 150 in each group
- HS survivors > HRI survivors > controls for developing incident
 - CVD (32.67% vs. 23.33% vs. 16.67%, $p = 0.005$)
 - Ischemic stroke (12% vs. 6% vs. 4.67%, $p = 0.038$)
 - Chronic kidney disease (17.33% vs. 14.67% vs. 6.67%, $p = 0.016$)

Risk of *chronic kidney disease* in patients with heat injury: A nationwide longitudinal cohort study in Taiwan

Tseng et al Plos one 2020

- Same randomly selected longitudinal dataset followed between 2000-2013 – up to 14 years of follow up
- No pre-existing kidney or bladder diagnoses
- Heat stroke survivors were matched 1:4 for age, sex, comorbidities and year of entry
- Heat stroke survivors had FOUR TIMES the incidence of **CKD** in follow up compared to controls (adjusted HR = 4.346, $P < 0.001$)
- Heat stroke survivors also had NINE TIMES the incidence of **End Stage Renal Disease** compared to controls (adjusted HR= 9.078, $p < 0.001$)

Prevention

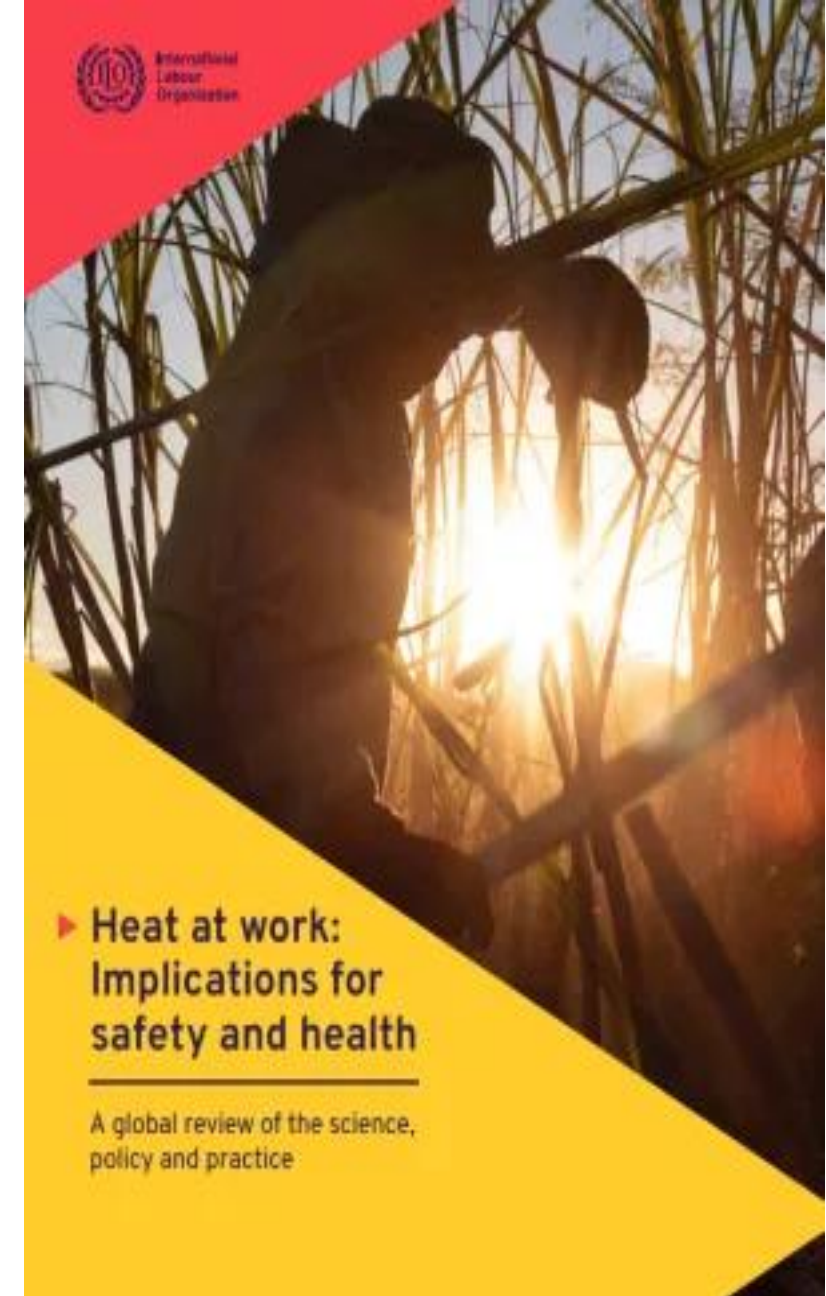
- Acclimatize – “work into the job” – increase by 20% a day on a new job
- Rest/shade – reduce strenuous activities – self-pacing, don’t be a hero – especially during heat waves, back from vacation; take breaks in A/C when possible or at least in shade
- Wear light colored, lightweight breathable clothing where possible, hat with brim
- Review potential medical risk factors, including conditions and medications, with your doctor; Avoid drugs and alcohol (morning coffee ok but not energy drinks)
- Water – drink a lot but not at once (6 oz 3 – 4 times/hr), and even if not thirsty
- Sports drinks good, but normal diet and snacks usually give enough salt
- Aim to need to urinate more than once and keep urine color light
- Consider using iced towels or other ways to cool down

Worksite Heat Illness Prevention: The Aim

- High performing organizations, military or multi-national corporations; ISO 7243:2017(E).
- Medical clearance/ medical and physiologic monitoring
- Industrial Hygiene Measures –WBGT; Engineering controls; PPE for cooling
- Administrative Measures- Acclimatization; Work/rest cycles; Scheduling work for cooler times (prohibiting mid-day work at certain temperatures)
- Training
- Immediate first aid
 - Ice baths – total or partial immersion
 - Transport to emergency medical care

International Labor Organization April 2024 Report -

- **Participatory risk assessment**
- Identify workers at risk
- Use **WBGT**
- Provide **water AND sanitation**
- **Rest breaks/ self-pacing**
- Cool, shaded, ventilated rest area
- Acclimatization
- Heat prevention **PPE**
- Education
- **Medical monitoring**



SAVE A LIFE

- Learn warning signs of heat exhaustion and what to do:
 - Rest in shade or A/C to cool off
 - Drink water
 - Notify supervisor
- Learn warning signs and first aid for- **HEAT STROKE**
 - ***“Hot and dry” is always heat stroke, but people who are sweating may also have heat stroke***
 - ***Confusion = heat stroke! You can’t take care of yourself – buddy system***
 - Life threatening emergency – act immediately
 - Remove from heat, pour ice water if available, COOL AS FAST AS POSSIBLE
 - Call 911, get person to an ER = save a life!