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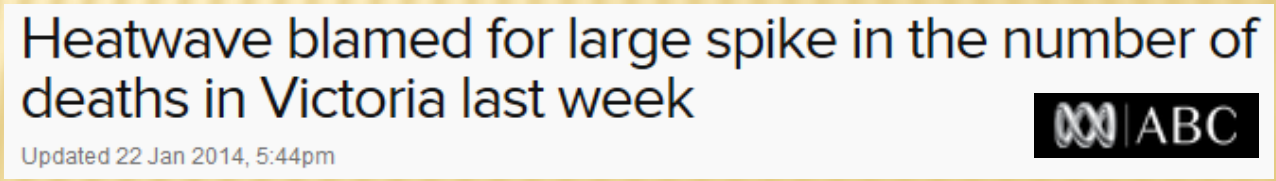
HEAT-RELATED MORTALITY AND MORBIDITY IN CALIFORNIA

RECENT INTERNATIONAL HEADLINES



RECENT CALIFORNIA HEADLINES

130 Deaths Blamed on California Heat Wave

By John Pomfret
Washington Post Staff Writer
Saturday, July 29, 2006

California Heat Wave Ends With a Death Toll Near 25

Irfan Khan/The Los Angeles Times, via Associated Press

California Heat Deaths: State Investigating Six Who Died From Heat-Related Causes

HUFF POST

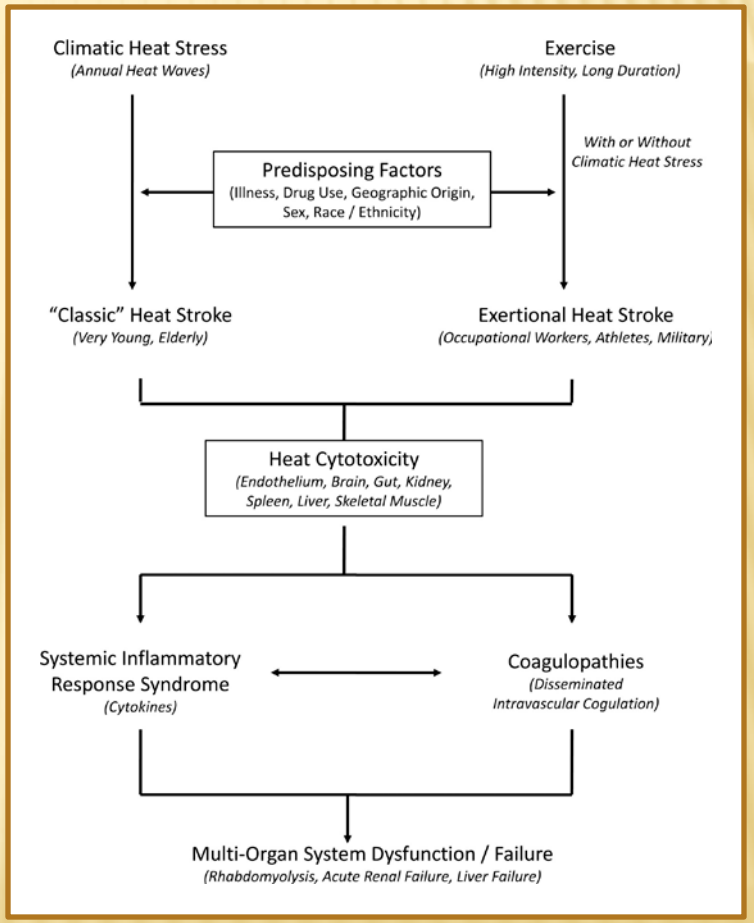
Central Valley Man First Reported Death From Heat Wave

CBS

July 3, 2013 9:19 PM

HEAT ILLNESS DEATHS

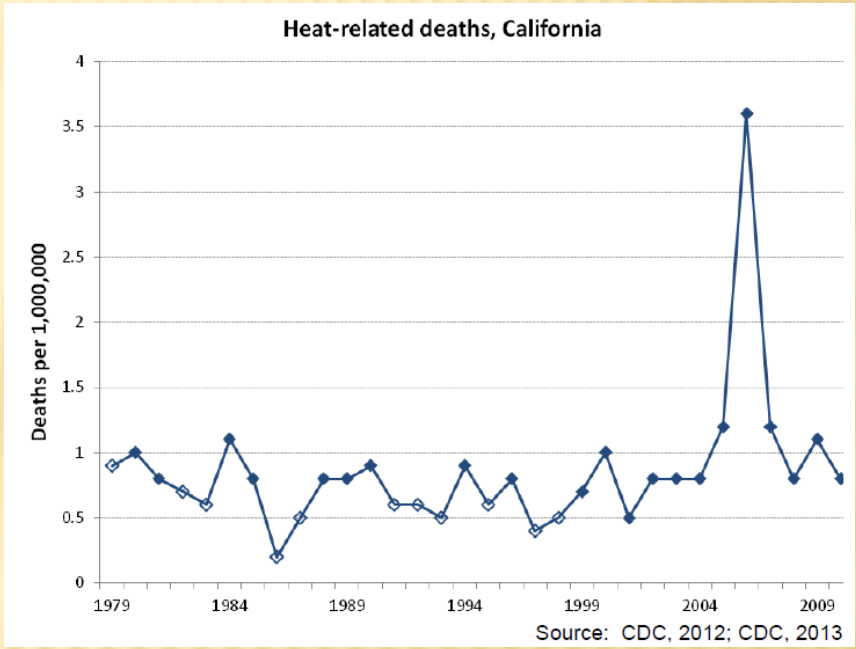
- Heat stroke
  - Ambient heat exceeds body's ability to thermoregulate, leading to high core body temperature
  - Can cause organ failure, loss of consciousness, death



(Leon & Helwig 2010)

HEAT ILLNESS MORTALITY

- Compiled from death certificate data
  - queryable data from 1999 on, data possibly available as far back as ~1970
  - Also has basic demographic data
- Underlying cause of death:
  ICD-9: E900.0/E900.9 (Accident due to excessive heat of natural/unknown origin)
  ICD-10: X30 (Exposure to excessive natural heat)



Source: CDC WONDER database

ISSUES WITH HEAT ILLNESS DEATHS

- Yearly counts are small
- Case identification can vary by locale
  - Sample coroner criteria
    - Stringent: antemortem body temperature >= 105F without other reasonable explanation
    - Excludes heat deaths if body temperature not measured soon enough
    - Modified definition examples
      - Body found in enclosed high temperature environment (closed windows, no air conditioning)
      - Body found decomposed without other evidence of cause of death
    - Efforts to standardize around 1998
  - Contingent on awareness of heat as an influence
    - Heat waves vary in definition, coroners/medical providers may not be explicitly notified
- Circumstances and information (or lack thereof) can influence determinations, and some subjective element of judgement is often involved

(Donoghue 1997)

HEAT STRESS ON OTHER SYSTEMS

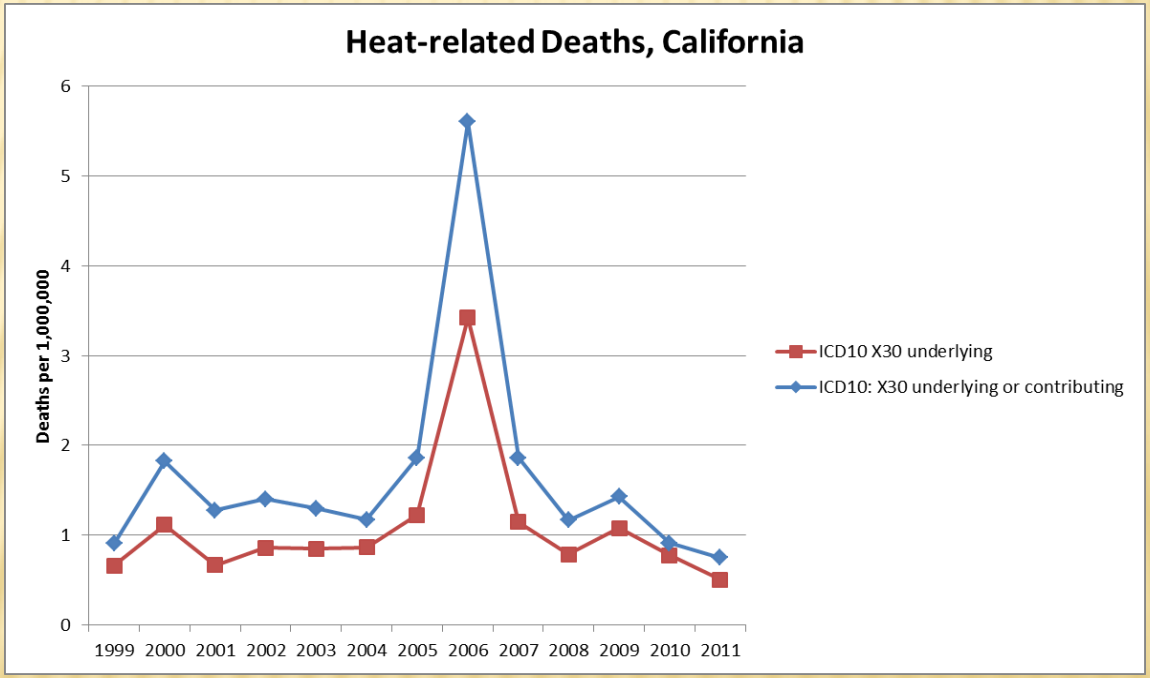
- 2006 California heat wave
  - 140 deaths attributed to hyperthermia (126 “classic”, 14 “exertional”) (Trent 2007)
  - Comparisons to similar periods estimate 655 excess heat wave deaths when considering all causes (Hoshiko 2010)
- Large underestimates of impact because heat stress impacts other systems and can manifest in mortality from causes other than heat stroke
  - E.g. Thermoregulation during heat stress
    - Blood flow shunted to skin to maximize heat dissipation
    - Requires increased heart rate and stroke volume, taxing cardiovascular system and possibly leading to events like heart attack
    - Limits availability of blood to other organs, impacting function

HEAT DEATH DETERMINATION

- Underlying vs. contributing causes
  - Nationwide, including deaths where excessive heat mentioned as contributing cause but not named the underlying cause increased heat death count 64% for years 2006-2010 (Berko 2014)
  - Multiple cause of death information queryable from 1999 on (CDC WONDER), available files from as far back as 1979

HEAT ILLNESS MORTALITY

- Underlying or contributing cause: ICD-9: E900; ICD-10: X30



(Source: CDC EPHTP database 2015; WONDER database)

OTHER MORTALITY OUTCOMES

- Epidemiological studies in California have linked temperature to:
  - 9% increase in all-cause mortality per 10F in all deaths during 2006 heat wave period (Ostro 2009)
  - Increased non-accidental and cardiovascular mortality risk in CA with higher warm season temperatures (Basu 2008; Basu and Ostro 2008; Basu and Malig 2011)
- Similar links seen in other places (Basu 2009)

MORBIDITY DATA

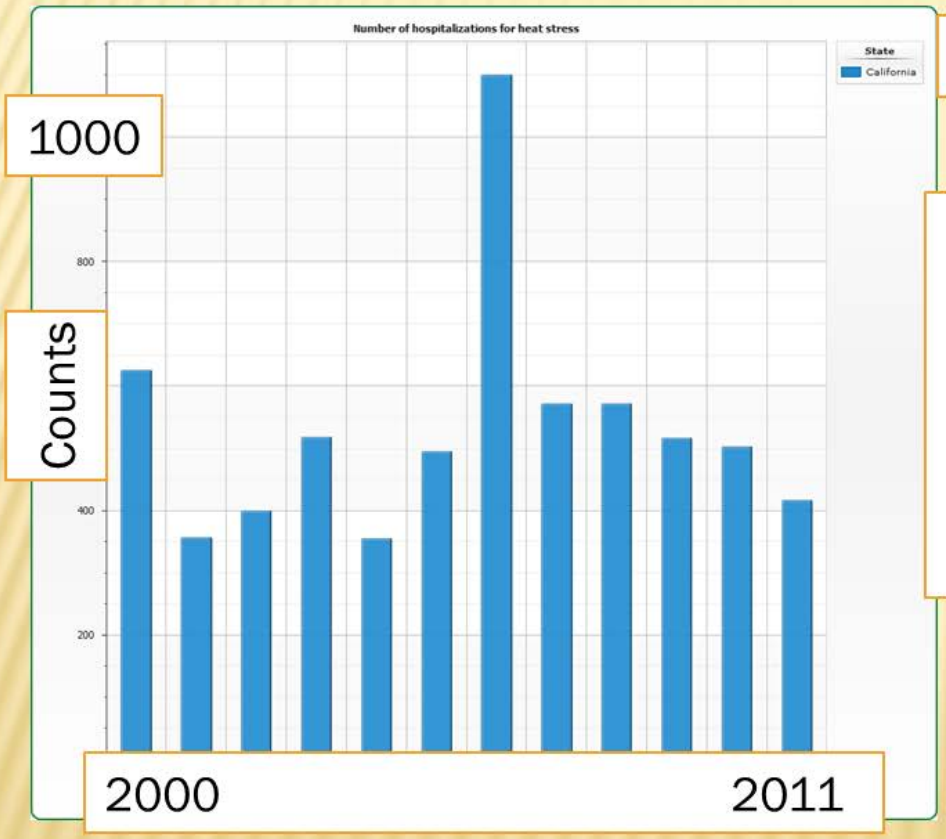
- Records from Office of Statewide Health Planning Data
- Hospitalization data
  - Inpatient discharges from CA-licensed hospitals
  - Available from 1982
- Emergency visit data
  - Emergency
  - Available from 2005
- Records information on principal diagnosis and other diagnoses

HEAT ILLNESS MORBIDITY

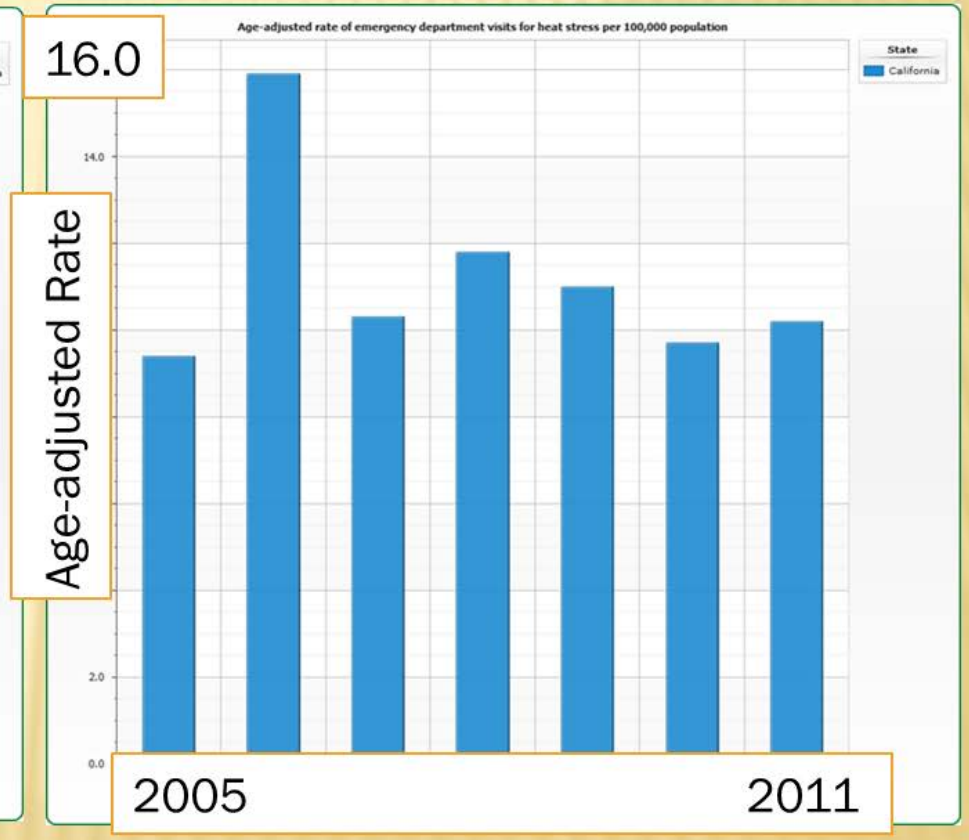
- ICD-9-CM: 992: Effects of heat and light
  - Heat stroke
  - Heat exhaustion
  - Heat syncope
  - Heat cramps
  - Heat fatigue

HEAT ILLNESS MORBIDITY

Hospitalizations



Emergency Department Visits



(Source: CDC EPHTP database 2015; ICD-9s: 992, E900.0 & E 900.9)

OTHER MORBIDITY OUTCOMES

- For 2006 heat wave, hospital admissions increased for:
  - Nephritis
  - Electrolyte imbalance
  - Acute renal failure

  (Knowlton 2009)

- For 1999-2009 peak heat wave days, hospitalizations increased for:
  - Cardiovascular diseases
    - Including specifically ischemic heart disease and stroke, acute myocardial infarction, dysrhythmia
  - Respiratory diseases
  - Acute renal failure
  - Mental health
  - Dehydration
  - Heat illness

  (Guirguis 2014)

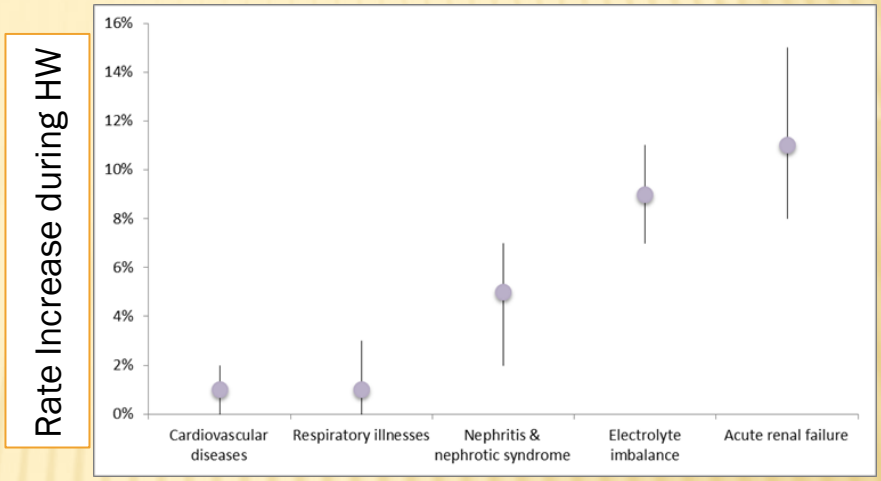
- For 1999-2005, higher temperatures associated with increased hospital admissions for:
  - Cardiovascular disease
    - Ischemic heart disease
    - Ischemic stroke
  - Respiratory diseases
    - Pneumonia
  - Volume depletion
  - Diabetes
  - Acute renal failure

  (Green 2010; Ostro 2010)

- Links to these outcomes seen in studies of other locations (Ye 2012)

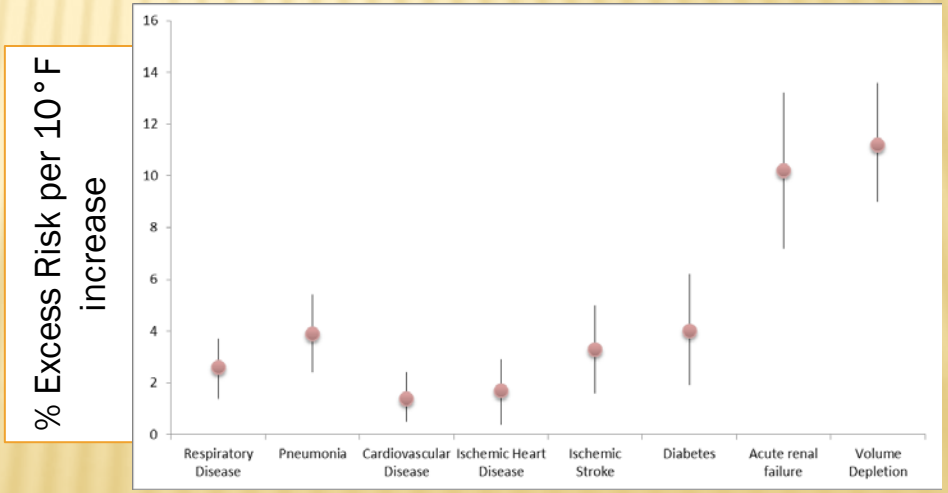
OTHER MORBIDITY OUTCOMES

Hospitalization rate increases in California for selected outcomes during the 2006 heat wave compared to periods immediately before and after (Knowlton 2009)



Heat-related illnesses: ~920%

Relationships between warm season (May – Sept) apparent temperatures and hospital admissions for various outcomes in California, 1999-2005 (Ostro 2010)



Heat-related illnesses: ~360%

OTHER MORBIDITY OUTCOMES

- For 2005-2009, higher warm season (May-Sept) temperatures associated with increased emergency visits for:
  - Ischemic heart disease
  - Ischemic stroke
  - Dysrhythmia
  - Intestinal infection
  - Hypotension
  - Dehydration
  - Diabetes
  - Acute renal failure

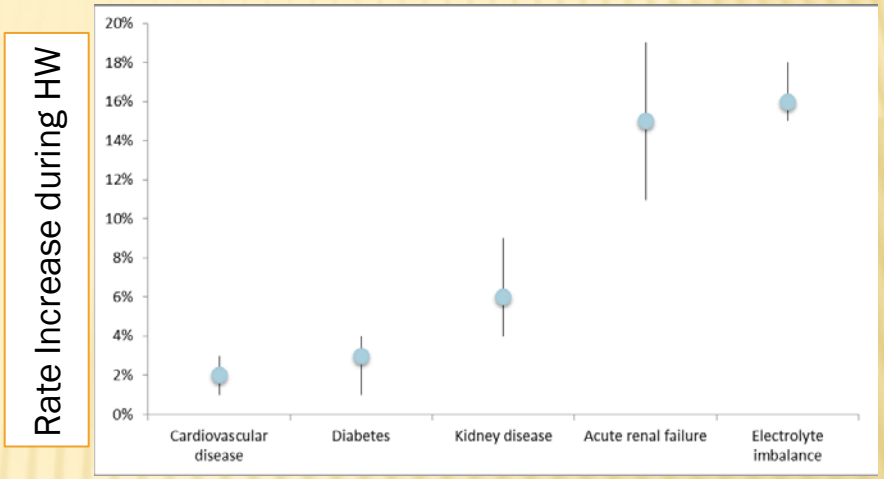
(Basu 2010)

- For 2006 heat wave, emergency visits increased for:
  - Electrolyte imbalance
  - Acute renal failure
  - Nephritis & nephrotic syndrome
  - Diabetes
  - Cardiovascular disease

(Knowlton 2009)

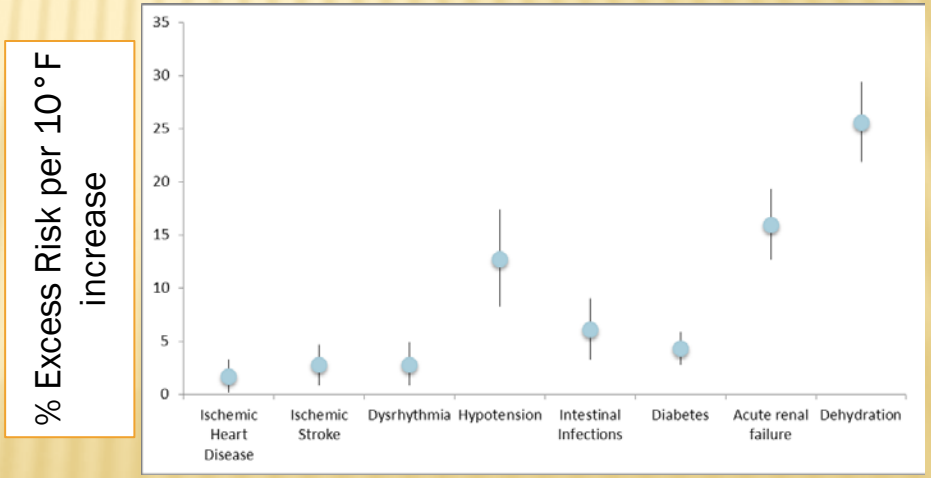
OTHER MORBIDITY OUTCOMES

Emergency visit rate increases in California for selected outcomes during the 2006 heat wave compared to periods immediately before and after
(Knowlton 2009)



Heat-related illnesses: ~530%

Relationships between warm season (May – Sept) temperatures and emergency department visits for various outcomes in California, 2005-2009
(Basu 2012)



Heat-related illnesses: ~400%

OTHER MORBIDITY OUTCOMES

- Preterm birth/delivery
  - Warm season risks of preterm birth increased 8.6% per 10F increase in average apparent temperature in the week prior (Basu 2010)
  - Links between temperature/heat waves and preterm birth/delivery also reported in Sweden, Spain, Alabama, Italy, Australia (Vicedo-Cabrera 2015, Vicedo-Cabrera 2014, Kent 2014, Schifano 2013, Strand 2012)
  - Long history of tracking through birth certificates

INFLUENCES ON INDICATOR TRENDS

- Medical coding changes (ICD changes)
  - Death coding switched ICD-9 to ICD-10 in 1999
  - Hospitals switching from ICD-9-CM to ICD-10-CM this year
  - Individual changes occur between versions
    - e.g. “Dehydration” born of volume depletion category in Oct. 2005
- Changes in population-level susceptibility/vulnerability
  - Demographics (e.g. age, socioeconomic status)
  - Pre-existing medical conditions
- Behavioral changes and adaptation
  - Individual choices
    - Shift in heat-adaptive behaviors (e.g. greater AC ownership, heat avoidance)
  - Policy-level changes
    - Influences from interventions (e.g. enhanced warning systems, urban heat island mitigation)

INFLUENCES ON INDICATOR TRENDS

- Heat wave timing and location
  - early season vs. late season
  - regions acclimatized to hot weather vs. not
- Air pollution
  - Can influence some previously mentioned outcomes independently
  - Levels influenced by climate change

SUMMARY

- Heat illness mortality and morbidity are reasonable choices for indicators
  - May be limited by numbers, case identification consistency issues
- Other mortality and morbidity indicators may also be useful
  - Need to balance:
    - Numbers/years of availability
    - Sensitivity/specificity to climate changes

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