Potential Impacts of Climate Change on Foodborne and Waterborne Infections

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Diseases that Could be Impacted by Climate Change

- **Foodborne**
  - Anisakiasis
  - Botulism
  - Campylobacterosis
  - *Echinococcosis*
  - *E. coli* infection
  - Paralytic shellfish poisoning
  - Salmonellosis
  - Shigellosis
  - Toxoplasmosis
  - Trichinellosis
  - *Vibrio parahaemolyticus* infection

- **Waterborne**
  - Cryptosporidiosis
  - Giardiasis
  - Hepatitis A infection
  - Legionellosis
Mechanisms

- Increased temperature
  - Increased replication
  - Increased persistence
- Changes in local rainfall
  - Flooding $\rightarrow$ contamination
  - Drought $\rightarrow$ concentration
- Melting permafrost
  - Infrastructure damage
- Rising sea levels
  - Flooding $\rightarrow$ contamination
  - Infrastructure damage
Seasonal Trends

- Incidence of many enteric pathogens peak during the summer months.
- Often due to inappropriate food preparation and storage.
- Temperatures the week prior to illness onset tend to predict disease incidence.
Salmonellosis

(Kovats et al.; *Epidemiology and Infection*, 2004)

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Fig. 1. Seasonal patterns of reported cases of infection with *Salmonella*, in order of country by mean summer temperature. ---, average temperature (by week or month). ---, no. of cases (by week or month).
Temperature and Enteric Disease

Investigators examined the relationship between ambient temperature and weekly reports of confirmed cases.

- **RR of Salmonella** increased by 1.2% per degree above -10°C
- **RR of Campylobacter** increased by 2.2% per degree above -10°C
- **RR of E. coli** increased by 6.0% per degree above -10°C

(Fleury, et al. IJBiometrol, 2006)
The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948–1994

Frank C. Curriero, PhD, Jonathan A. Patz, MD, MPH, Joan B. Rose, PhD, and Subhash Lele, PhD

Note. Outbreak locations represent the centroid of the affected watershed.

FIGURE 1—Waterborne disease outbreaks and associated extreme levels of precipitation (precipitation in the highest 10% [90th percentile]) within a 2-month lag preceding the outbreak month: United States, 1948–1994.

(AJPH, 2001)
Emergence of *Vibrio parahaemolyticus* in Alaska

- **Summer 2004**
- **Outbreak:** 62 cases of Vp
- **Diarrheal illness caused by eating raw oysters from Prince William Sound**
- **Outbreak appeared to have been associated with warming ocean water temperatures**
Foodborne Botulism

- Caused by ingestion of botulinum toxin produced by *Clostridium botulinum*
- Rate of foodborne botulism tripled from 1950s to 1990s
- Changing food preparation practices favor *C. botulinum* spore formation and toxin production
Paralytic Shellfish Poisoning

- Shellfish concentrate neurotoxin from algal blooms (red-tides)
- Consumption of shellfish → gastroenteritis, paralysis
- PSP incidence could increase due to
  - Warming water
  - Increased precipitation → nutrient-laden run-off
Parasitic Diseases

Examples
- Anisakis
- *Echinococcus*
- *Toxoplasma gondii*
- *Trichinella spiralis*

Warmer temperatures →
- Increased amplification cycles
- Longer hunting seasons
Giardiasis

- **Giardia lamblia**
  - Infection of the GI tract
  - Diarrheal illness following consumption of contaminated water
  - Beaver are a common reservoir

- Incidence may increase due to northern migration of beaver population
Legionellosis

**Legionella pneumophila**
- Gram negative bacillus
- Grows best in warm water
- Airborne transmission, aspiration
- Can cause severe pneumonia (i.e., Legionnaires’ disease)

**Incidence increases in**
- Warmer months
- Rainy weather
How to Prepare?

- Strengthen our public health infrastructure related to:
  - Disease, vector, and reservoir surveillance
  - Public health outbreak response
  - Food and water safety
  - Community-based networks for monitoring local changes in the
    - Climate
    - Ecosystem
    - Physical infrastructure
How to Prepare?

- Improve interdisciplinary communication
  - Between public health professionals, health care providers, veterinarians, environmental scientists, ecologists, geographers, economists, etc.
  - To identify and trouble-shoot emerging problems

- Perform research
  - To predict the transmission dynamics of diseases under different climactic scenarios
  - To estimate the cost-effectiveness of mitigation strategies
Thank you!

Questions?

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Farm A July–August Daily Water Temperatures by Year

Trend line: $y = 0.21x$; $r^2 = 0.14$; $p < 0.001$
Mean Daily Farm A Water Temperature by Date, and Number of Farm A-associated Case-patients by Harvest Date of Consumed Oysters

- Number of Cases (n=51)
- Temperature (Celsius)

![Graph showing the relationship between water temperature and number of case-patients.]
Theory on Increase of Foodborne Botulism in Alaska

- Grass-lined hole in dirt
- Grass-lined, sealed plastic bucket