Interconnection of Global Challenges: Climate Change, Population Aging, and Infectious Disease

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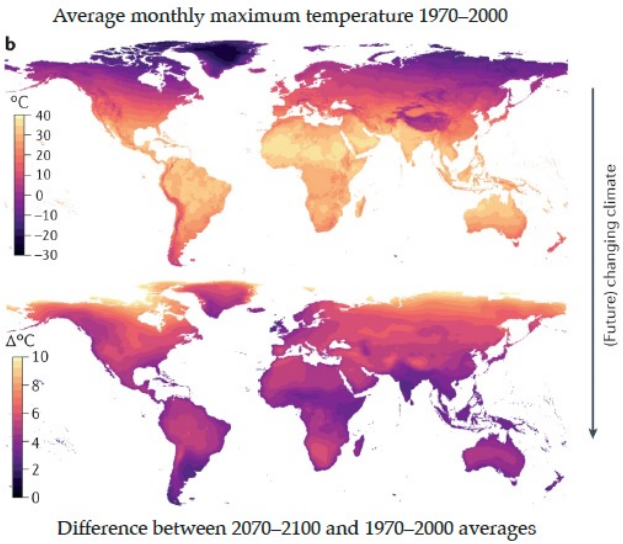
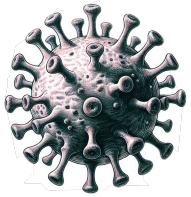
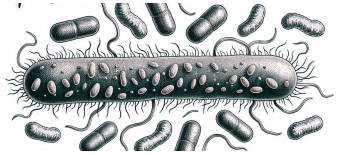
Climate Change, Population Aging, Infectious disease

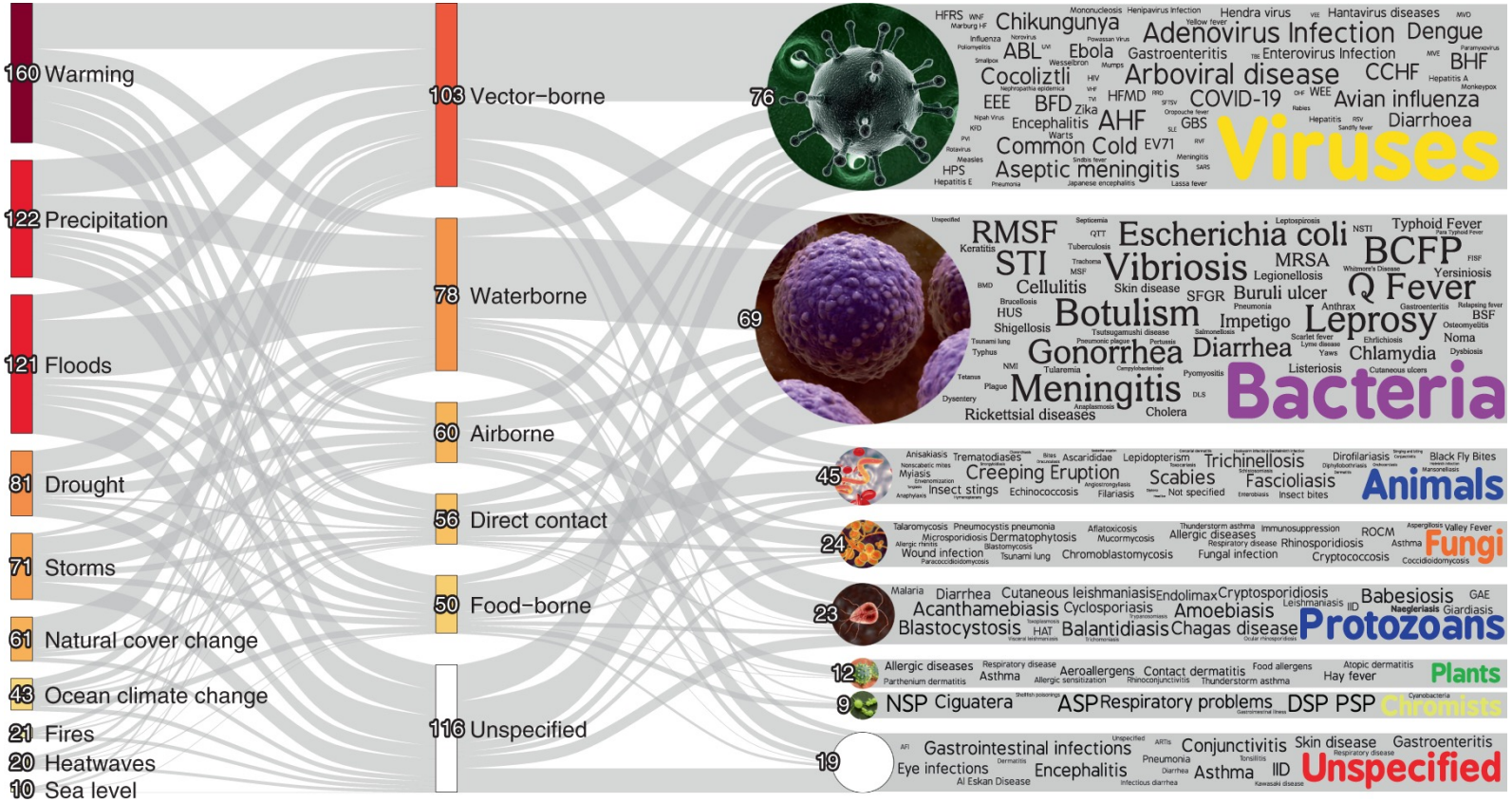


Source: Baker, Mahmud et al. (2022) *Nature Reviews Microbiology*





Growing evidence that climate change impact infectious disease pathogens



Source:
Mora et al. (2022) in *Nature Climate Change*

Climate Change/Hazards bring pathogens closer to people

Increased risk of spillover/disease emergence:

- Novel interactions between species, increases the risk of zoonotic emergence

Change the range or density:

- Warming associated with increased range for mosquitoes, ticks, fleas, birds → dengue, plague, West Nile, cholera outbreaks

Habitat destruction:

- Reductions in snow cover caused by warming forced voles to find shelter in human inhabitations, triggering hantavirus outbreak

Climate Change/Hazards associated with changes in human mobility and behavior

Population displacements/disruptions to health care:

- Warming temp associated with increase in modeled proportion of individuals at higher risk (migrants) for HIV (Baker 2020 in *Climate Change*)

Changes in social contacts in response to climate/climatic events:

- Rainfall or temperature affecting human social gatherings

Changes in physical environment that change exposure

- Air conditioning

Pathogens strengthened [or weakened] by Climate Change

Reproduction

- Ocean warming/ precipitation → cholera
- Temperature can increase West Nile Virus replication rates in mosquitoes

Acceleration of the life cycle

Increasing seasons/length of likely exposure

- Warming at higher latitudes allowed vectors and pathogens to survive winter, aggravating outbreaks by several viruses (for example, Zika, dengue)

Enhancing pathogen vector interactions (for example, by shortening incubations)

Increased virulence

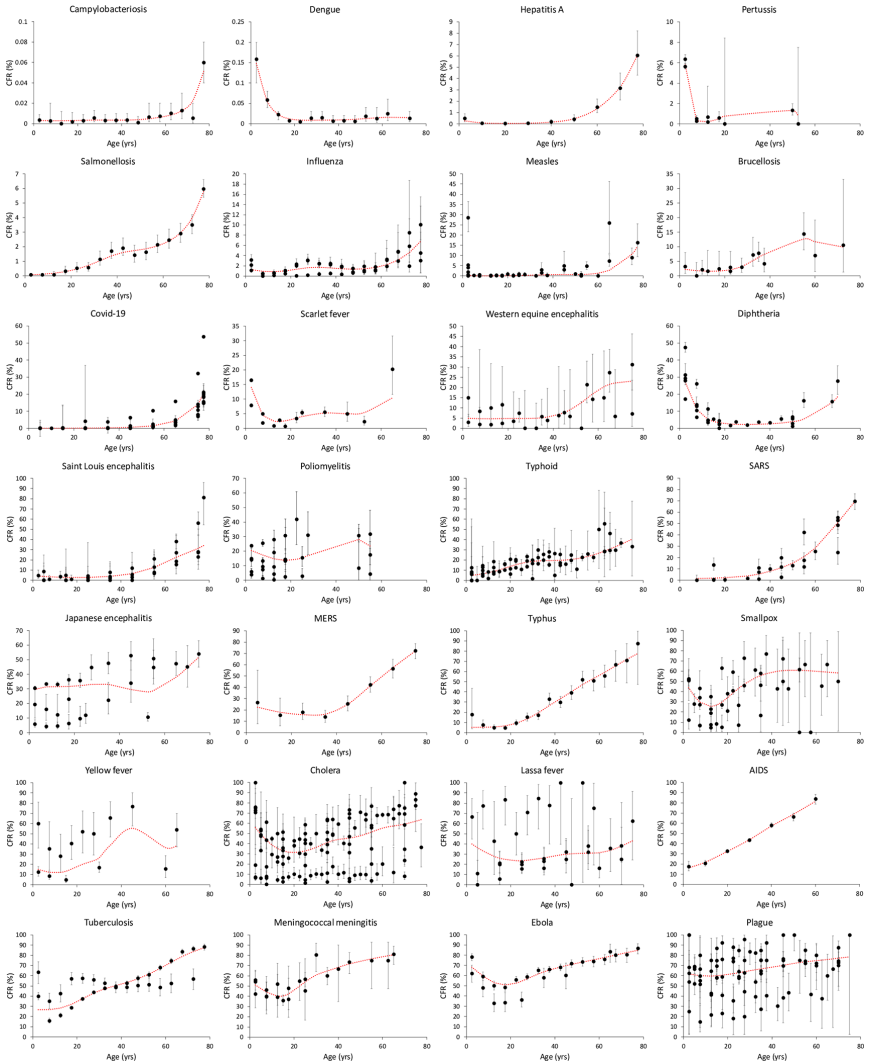
- Heat wave → selection for heat-resistant viruses → spillover events (emergence because better suited to human bodies)

Elderly are particularly at risk for infectious disease

Figure showing age dependent Case Fatality Rates for 28 infectious diseases.

(Sorci and Faiver 2022 in *Plos Pathogen*)

- Mortality is higher at the extremes of age spectrum.
- Emerging pathogens associated with higher mortality risks among elderly



Rising elderly population = increase in population susceptible to infections

Immune Senescence:

- Increases the risk of spillovers (**research gap**)
- Increased susceptibility, higher morbidity and mortality
- Reduced effectiveness of vaccines

Co-morbidities:

- Evidence from Covid-19: Patients with chronic CVD, HPT, CPD, Immunosuppression, Obesity, Chronic Neurological disease = ⬆️ viral load (Maltezou et al 2021 JID)

More frequent interactions with healthcare and living in communal settings

- Increased risk of exposure to antimicrobial resistant (AMR) pathogens
- Close living quarters which can increase disease spread

Process of Pop. Aging → infectious diseases

- Population aging → lower birth rates → increased age of infection for dengue hemorrhagic fever (Cummings et al 2009)
- Population aging will cause changes in contact patterns, which in turn can influence disease dynamics.
  - **research gap**

Infectious diseases→ Elderly population

- Infectious disease outbreaks
  - Reduction in social contacts, social isolation, limit access to health care

Climate-influenced infectious diseases of particular concern for elderly

Antimicrobial Resistance

Rising temps increases AMR

- Accelerate bacterial growth
- Increase bacterial infection rates
- Expand geographic distributions

More frequent **flooding** events

- Increased agricultural runoffs and chances for gene transfers

Increase in elderly population

- Increased antimicrobial use

Respiratory Diseases

Temperature/humidity shifts change timing and severity of:

- RSV (Baker and Mahmud et al 2019)
- Influenza (Shaman et al. 2021)

Rising temps could lead to extended use of evaporative cooling systems

- Increasing risk of Legionnaires' disease ()

Urinary Track Infections (UTIs)

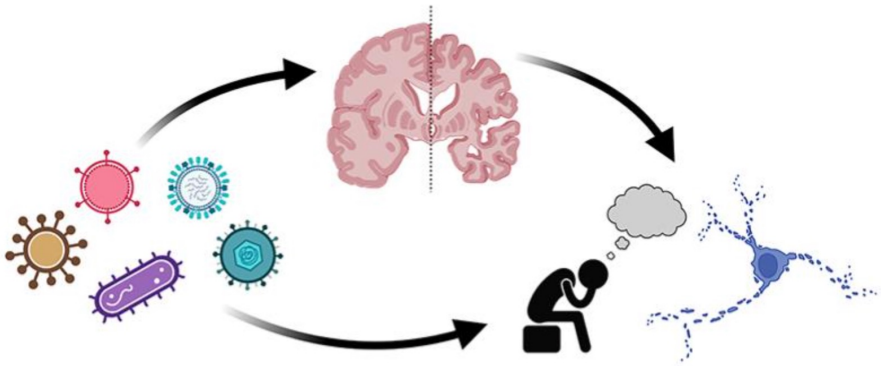
Higher temps associated with risk of UTIs (Simmering *et al* (2018) in Epidemiology and Infection)

Infectious disease in elderly associated with other outcomes of interest to NIA

RESEARCH HIGHLIGHTS

Infections and immune-specific proteins may increase dementia risk and brain atrophy

November 7, 2024



Infections can promote the development of dementia and other negative neurocognitive outcomes (lower arrow) and can directly lead to brain atrophy and neurodegeneration (upper arrows). Illustration courtesy of Michael Duggan.

Future directions

- Better evidence needed to quantify magnitude and impact of climate change on infectious diseases
- Some of the largest most important impacts of climate change on elderly infectious disease risk may be through impact on human behavior
  - impact of climate induced migration on disease spread, burden
- One health/surveillance in places with large elderly population?
- Differential exposure to infectious diseases reinforces health disparities