Centers for Disease Control and Prevention
National Center for Emerging and Zoonotic Infectious Diseases

Dengue Epidemiology: Globally and in the United States

ACIP Dengue Vaccine Workgroup

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Outline

- Routes of transmission
- Clinical spectrum
- Global burden
- Epidemiology in the United States
  - Endemic areas
  - Non-endemic areas

Dengue Virus

- DENV-1, 2, 3, 4
  - Lifelong DENV type-specific immunity
  - Short-term cross-immunity (~1–3 years)

DENV Transmission

- Vector-borne
  - Saliva of infected *Aedes spp* mosquito
- Other modes
  - Vertical from mother to baby
  - Blood transfusion or organ transplantation
  - Needle stick, mucocutaneous, or hospital/laboratory accident
  - Breast milk
  - Sexual

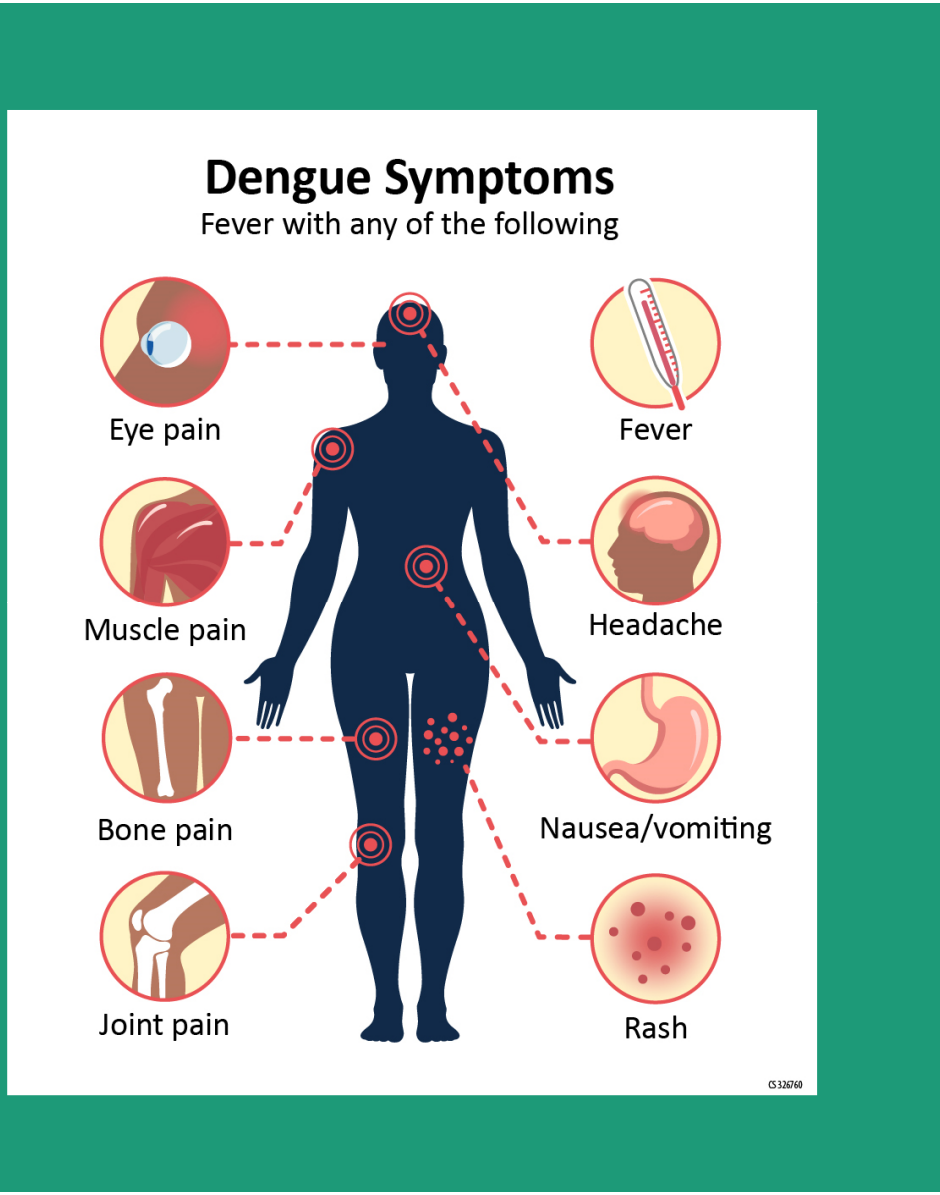
Aedes aegypti

Aedes albopictus

DENGUE CLINICAL SPECTRUM

Dengue Clinical Manifestations

- ~1 in 4 DENV infections are symptomatic
- Often a mild, undifferentiated febrile illness.
- Mortality ranges from <1% if treated appropriately to 15% if untreated



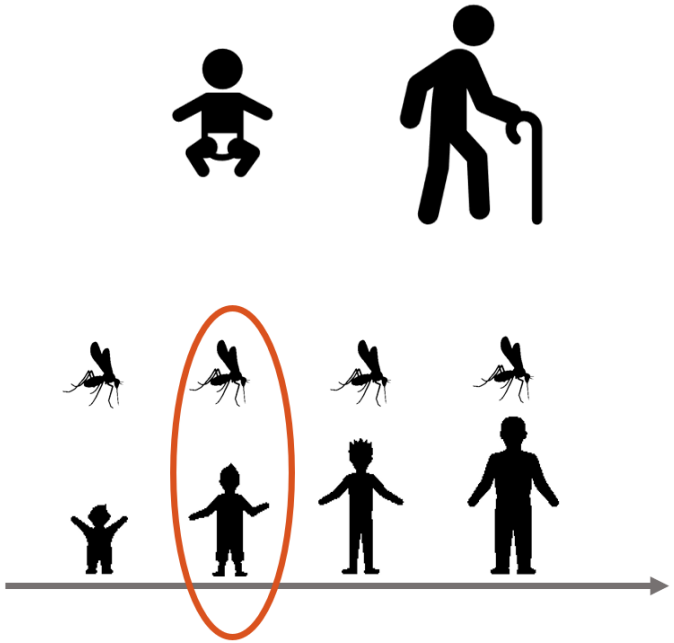
Clinical Manifestations of Severe Dengue

- Occurs in ~1 in 20 dengue patients
- Characterized by:
  - Severe plasma leakage
  - Severe bleeding
  - Severe organ impairment

Hospital chapel converted to a dengue ward during dengue outbreak in Honduras in 2019.

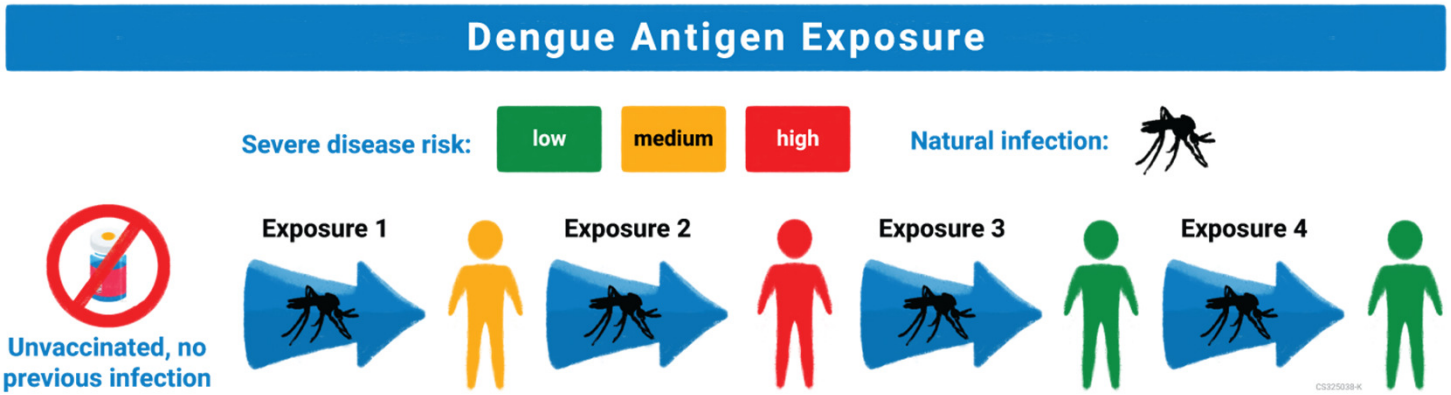
Image from: Paz-Bailey G. Dengue vaccine draft recommendations using the evidence to recommendation framework. Advisory Committee on Immunization Practices (ACIP); 2021 June 24, 2021; Atlanta, GA.

Risk Factors for Severe Dengue



- **Age**
  - Infants born to seropositive mothers
  - Elderly
- **Number of dengue infections**
  - 2nd >> 1st, 3rd, 4th infection
- **Comorbidities**
  - Asthma, diabetes, obesity, hypertension, sickle cell disease, kidney disease, hypertension, or on anticoagulant therapy

Severe Dengue and Multiple DENV Infections



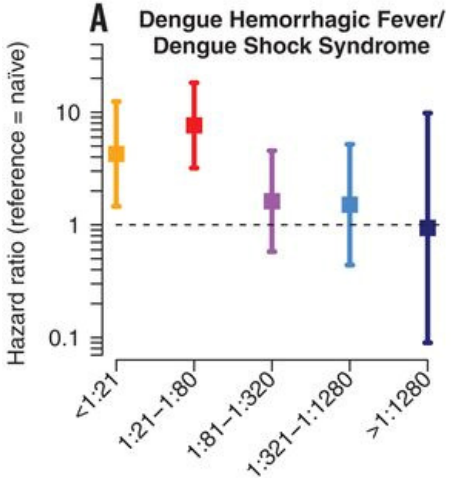
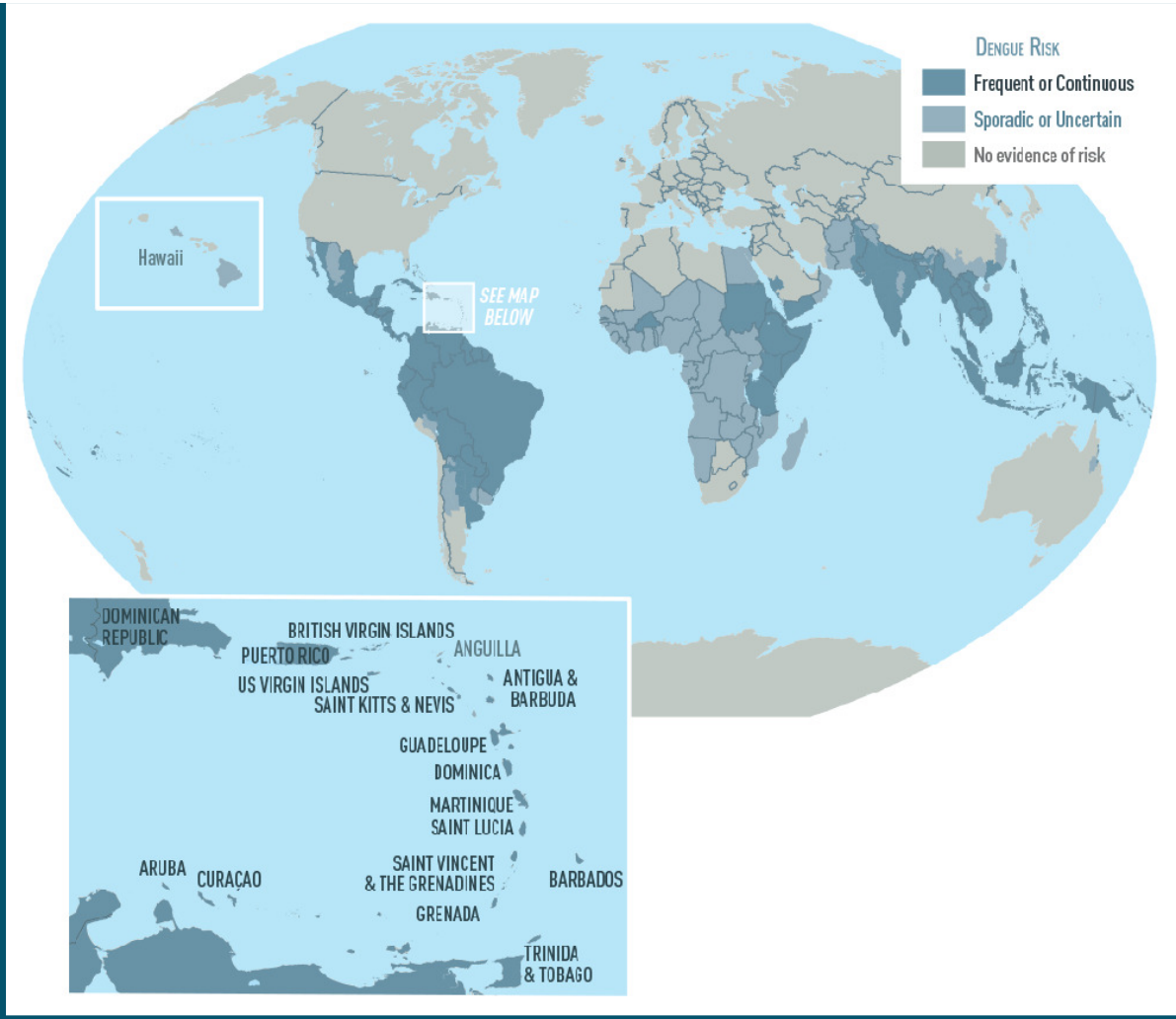
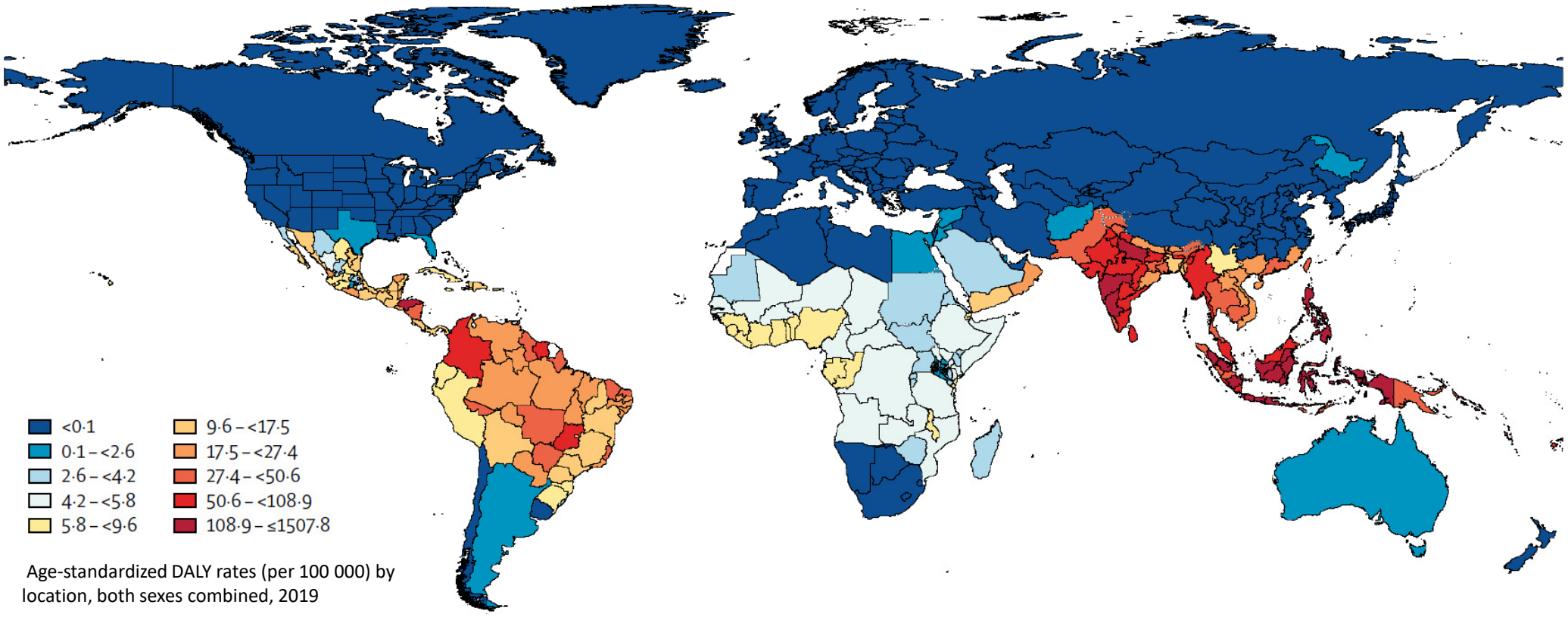


Fig. 1 Longitudinal analyses of the hazard of severe dengue disease or any dengue case by preexisting DENV-Ab titer for the full pediatric dengue cohort. Leah C. Katzelnick et al. Science 2017;358:929-932

Dengue Global Burden



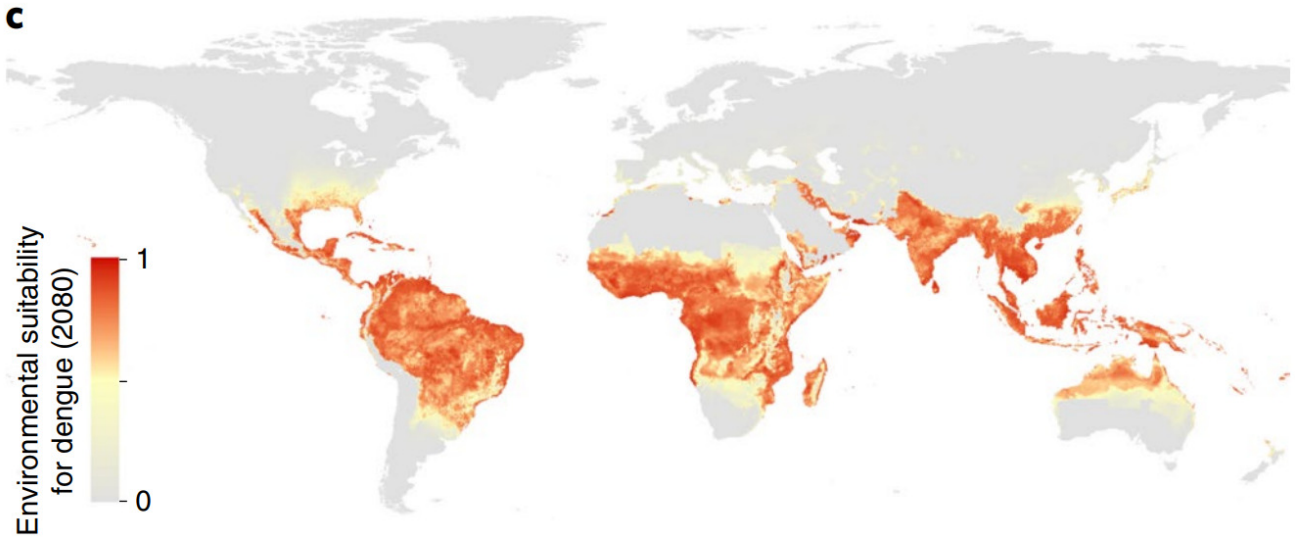
Dengue is the most common arboviral disease and causes **significant disability and death**



Age-standardized DALY rates (per 100 000) by location, both sexes combined, 2019

Dengue — Level 3 cause | Institute for Health Metrics and Evaluation (healthdata.org)

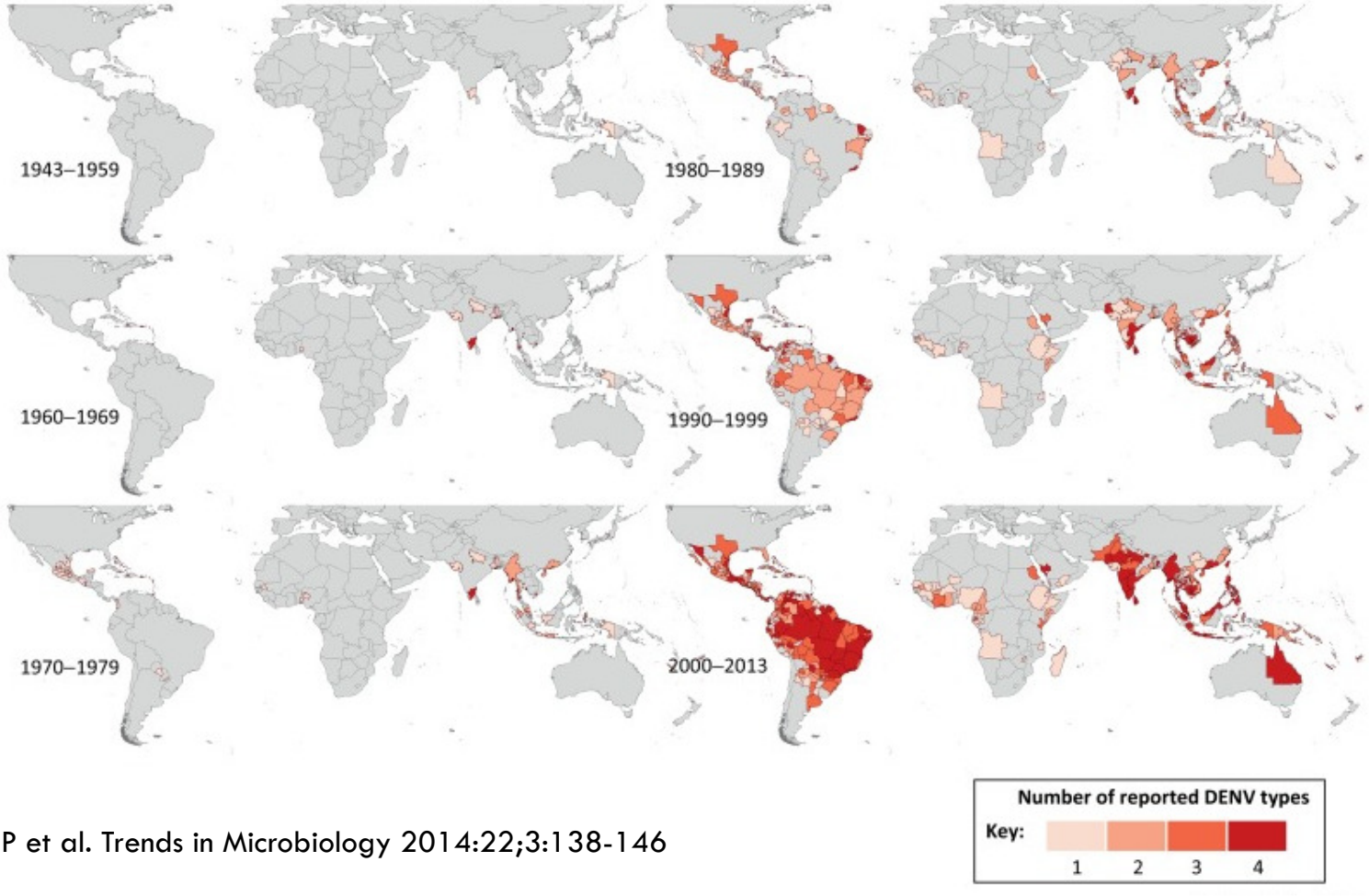
Dengue incidence is **likely to increase** as the climate warms.



A total of 6.1 (95%CI 4.7–6.9) billion people will be at risk for dengue by 2080, an increase of 2.25 billion compared to 2015.

The current and future global distribution and population at risk of dengue (nature.com)

Co-circulation of dengue virus serotypes

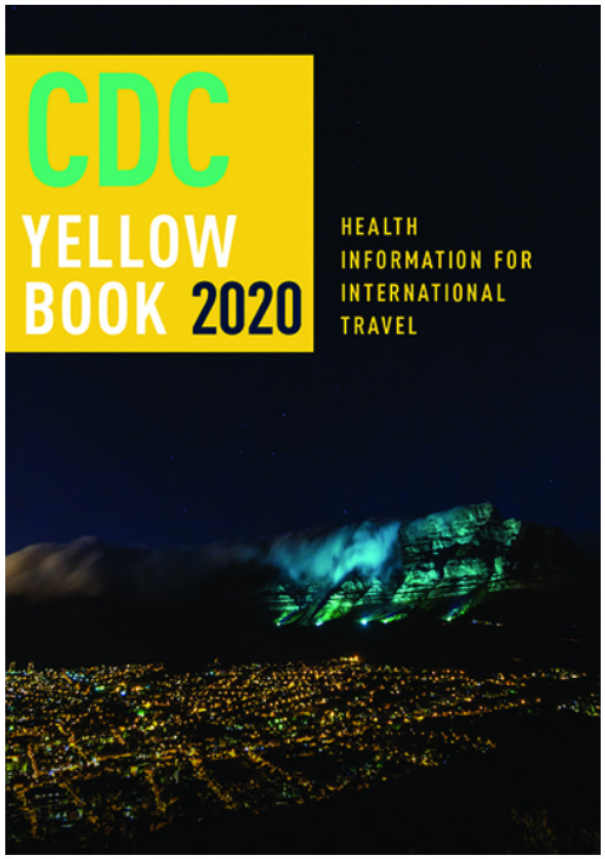


Messina JP et al. Trends in Microbiology 2014:22;3:138-146

Dengue Epidemiology in the United States

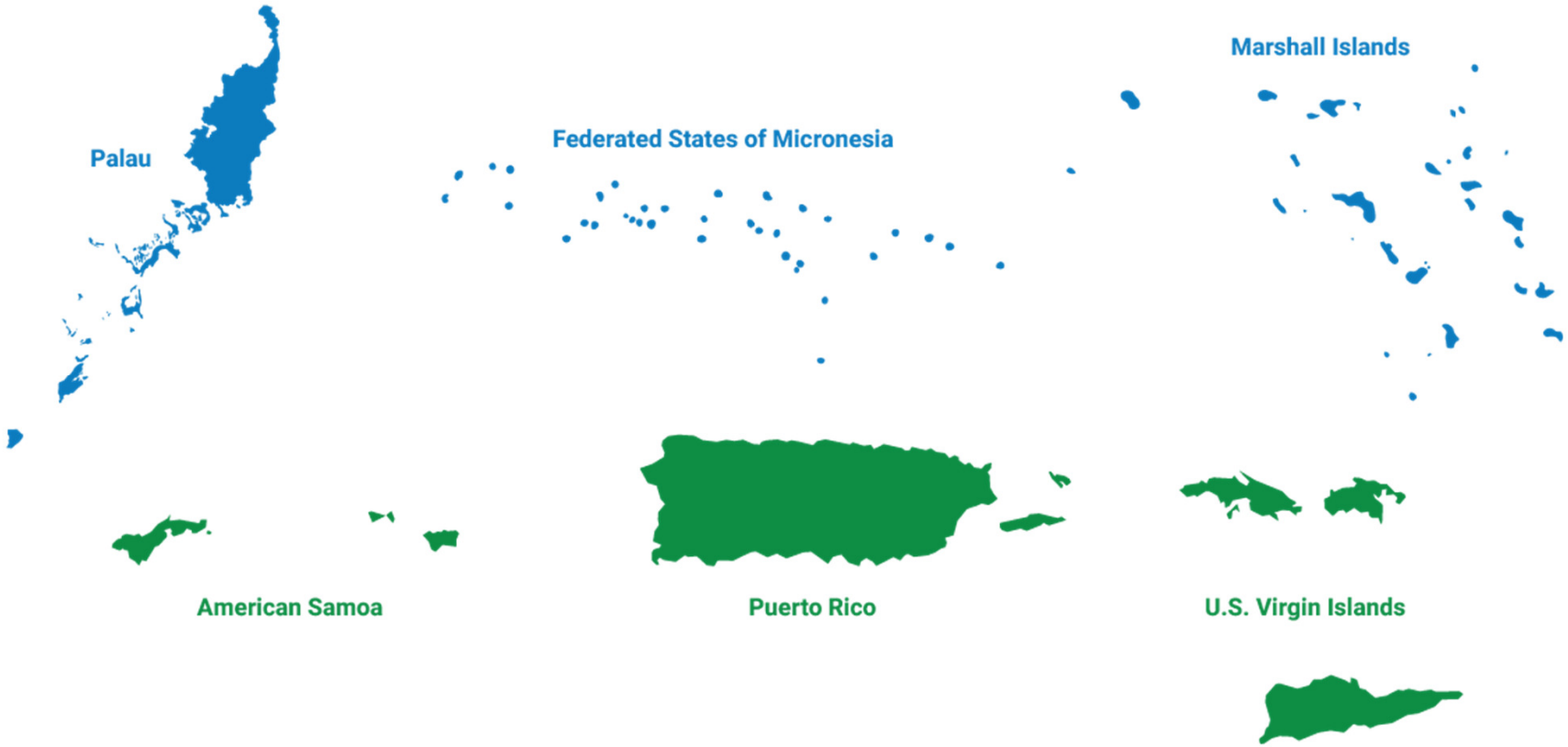
Yellow Book criteria to assess dengue risk levels

- **Frequent/continuous risk (endemic):**
  - 10 dengue cases in at least three distinct years over the most recent 10-year period.
- **Sporadic/uncertain risk:**
  - At least one reported, locally acquired case in the previous 10 years.
- **No evidence of risk:** no reports of DENV transmission.

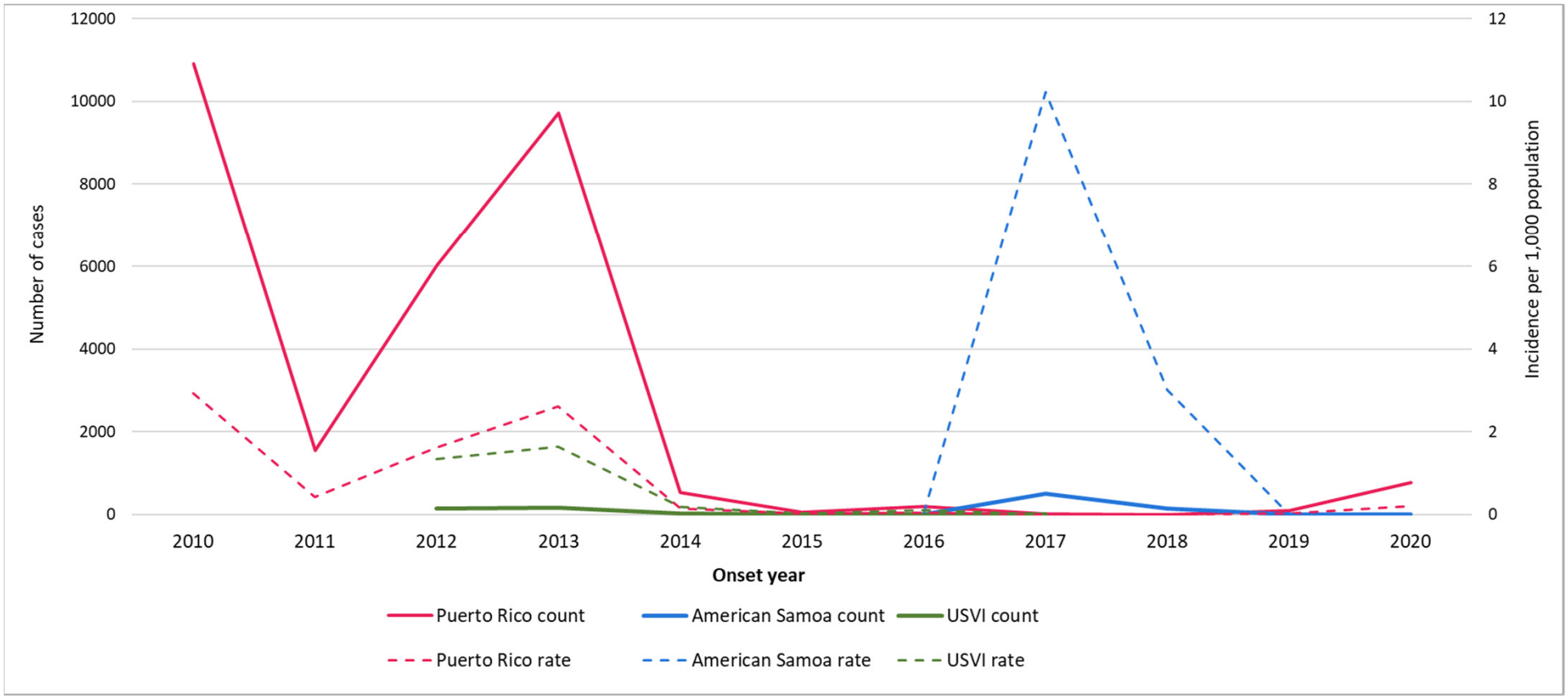


Jentes et al. Journal of Travel Medicine 2016; 23, 6, 1-5.

Dengue is endemic in **six** U.S. territories and freely associated states



Dengue cases* and rates per 1,000 population in Puerto Rico, American Samoa, and USVI, 2010–2020



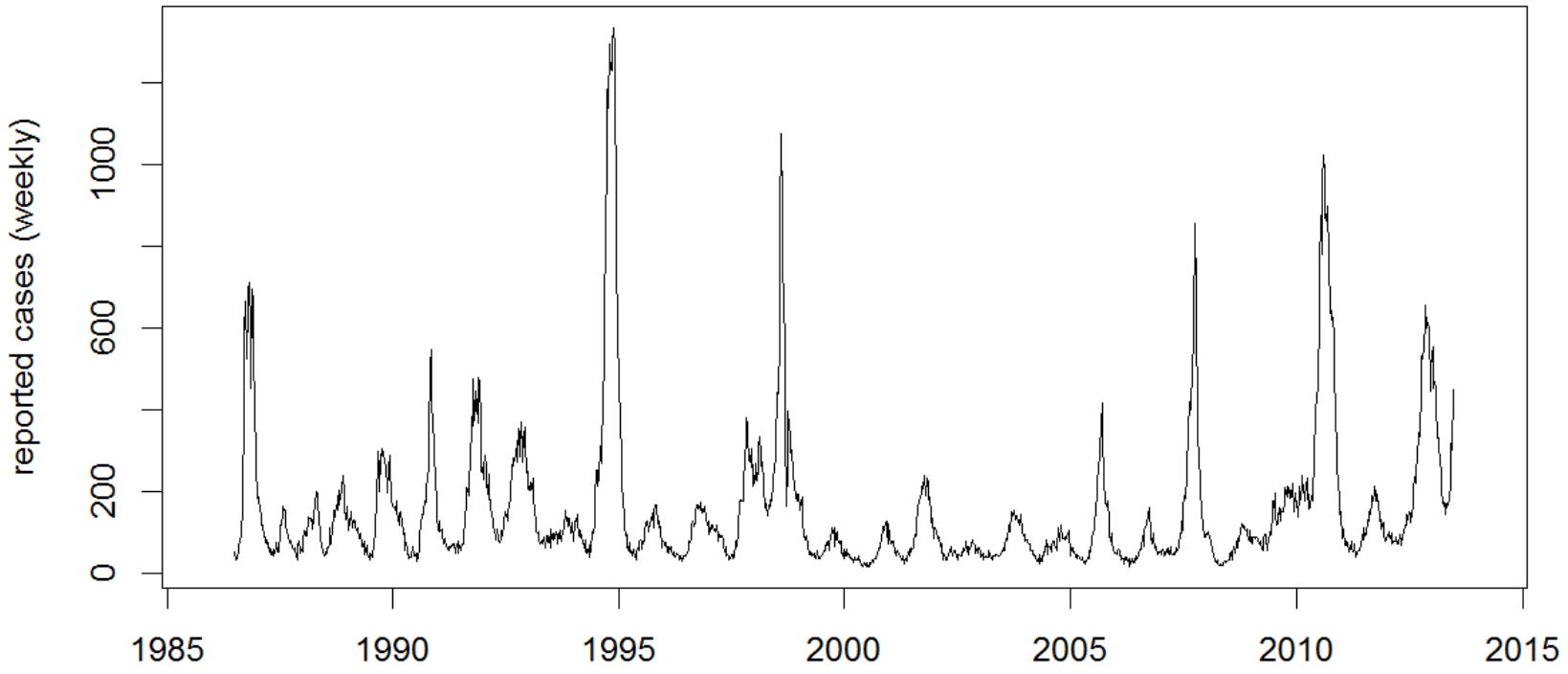
Source: confirmed and probable dengue cases reported to ArboNET, unpublished data

Dengue in Puerto Rico

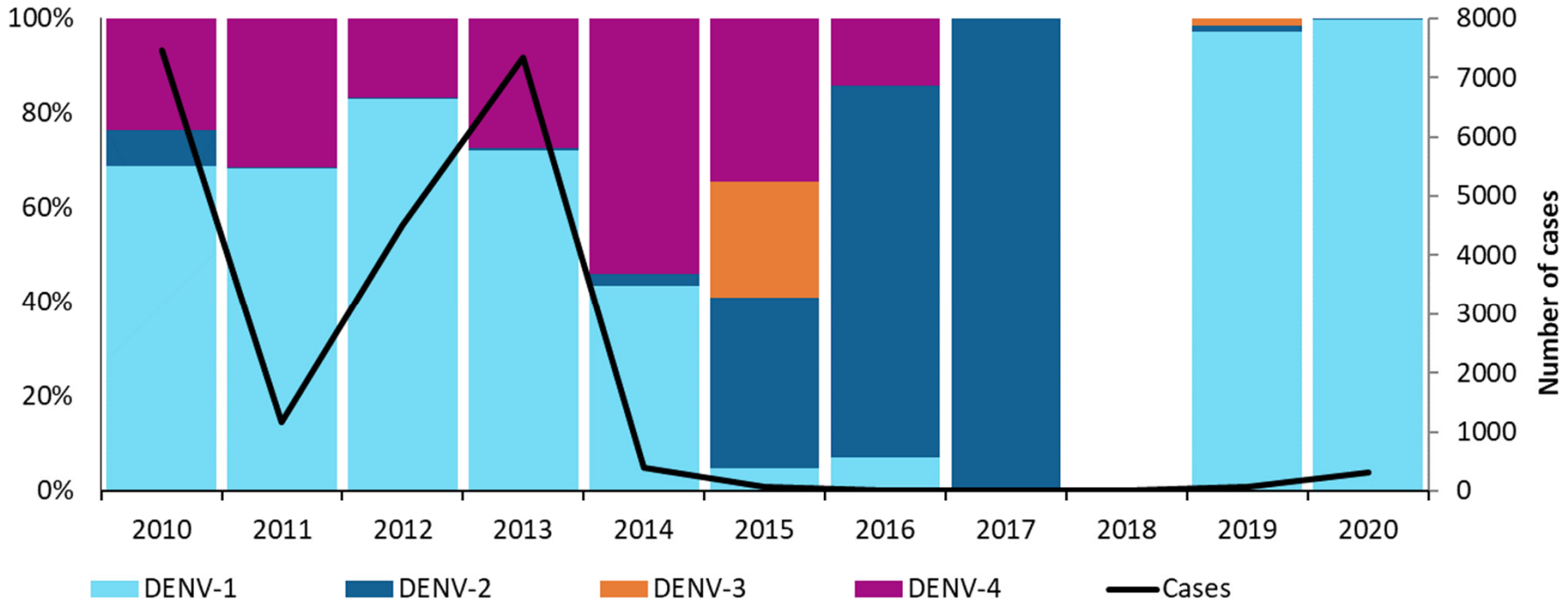
- **>95%** of dengue cases from endemic areas of the United States during 2010–2020 were reported from Puerto Rico (n=29,862)

Source: CDC ArboNET, 2010-2020, unpublished data

Suspected dengue cases, Puerto Rico, 1986-2013



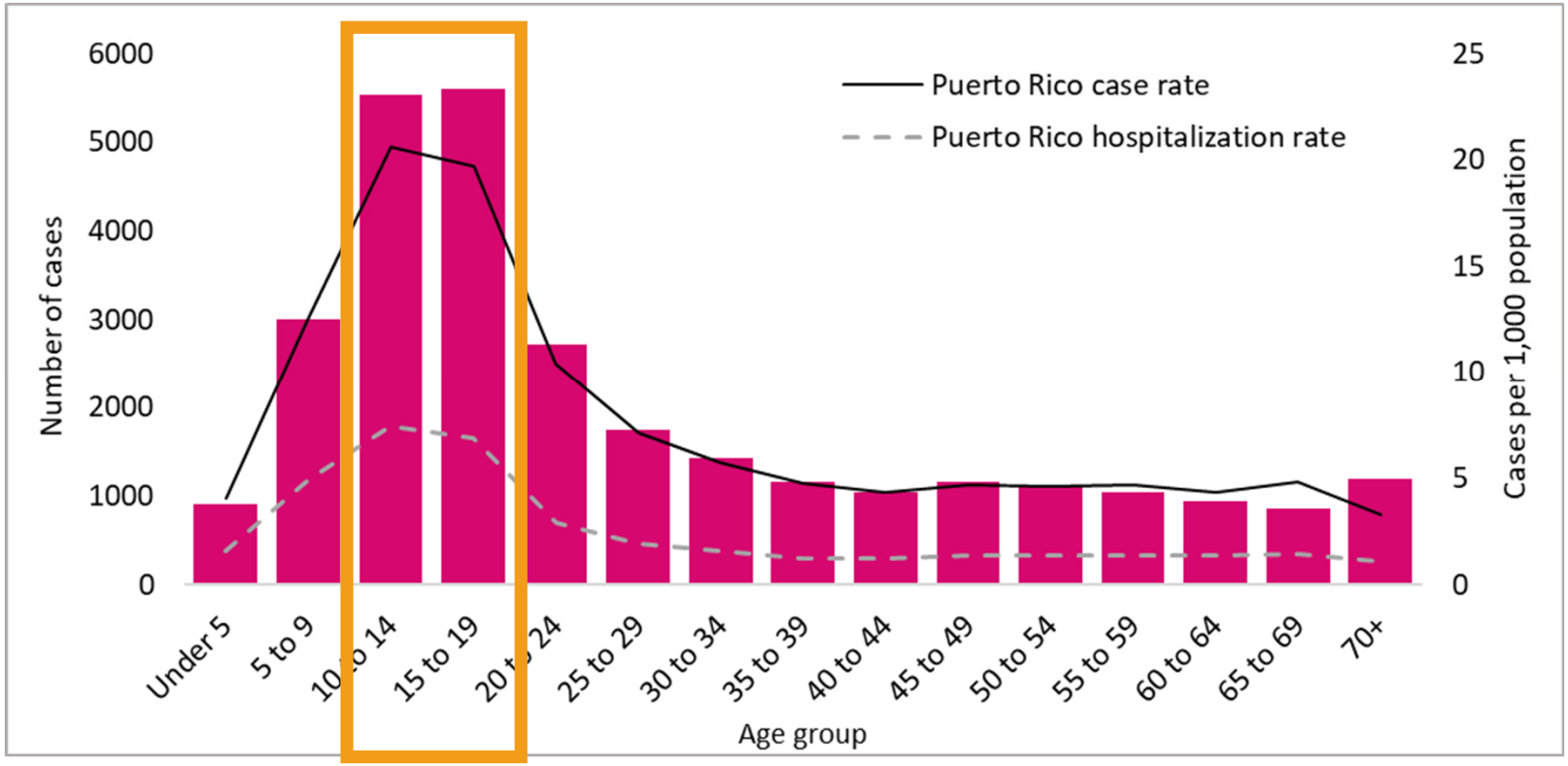
DENV Serotypes by Year in Puerto Rico, 2010–2020



Source: CDC Dengue Branch laboratory, unpublished data

Dengue cases and hospitalizations by age group in Puerto Rico, 2010–2020

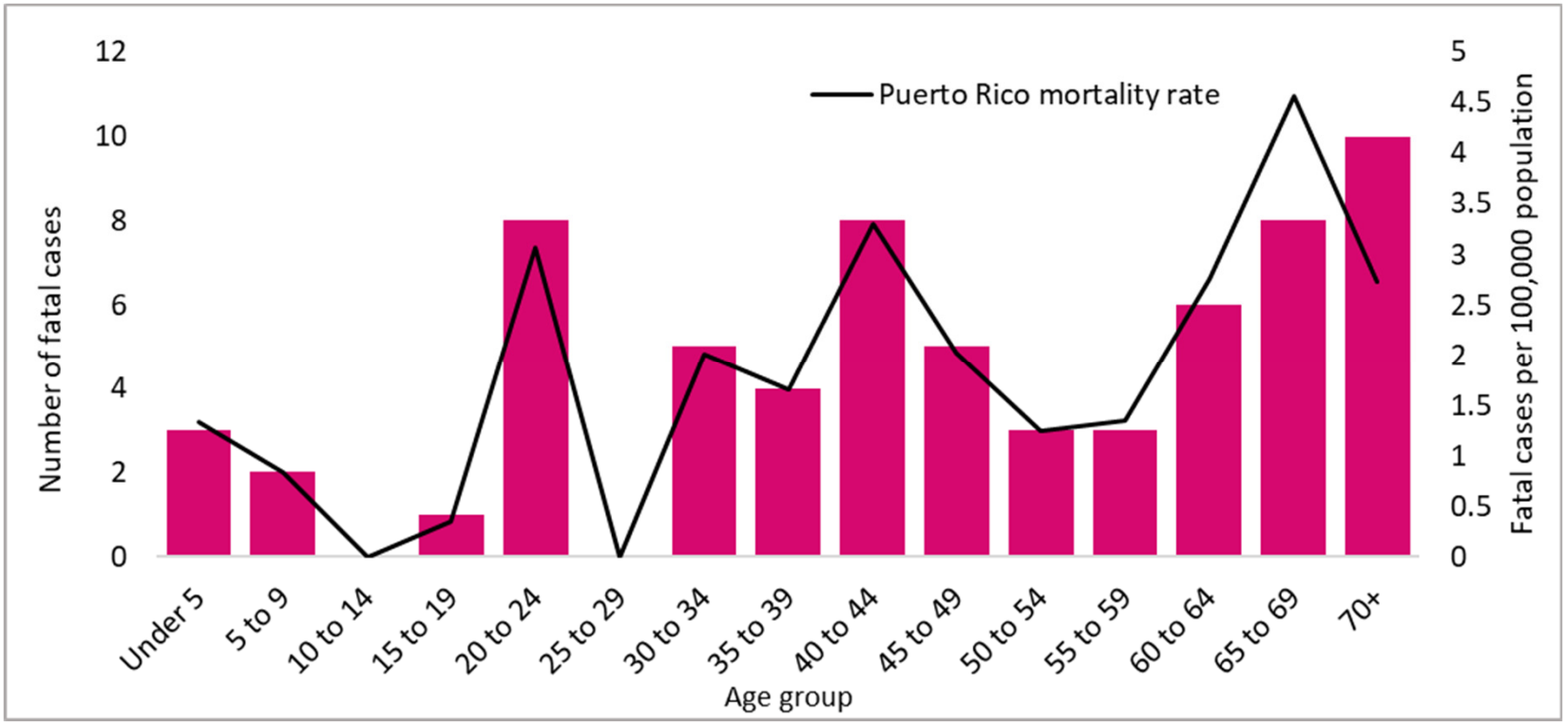
Highest case rates occurred among children 10–19 years old



Source: CDC ArboNET, unpublished

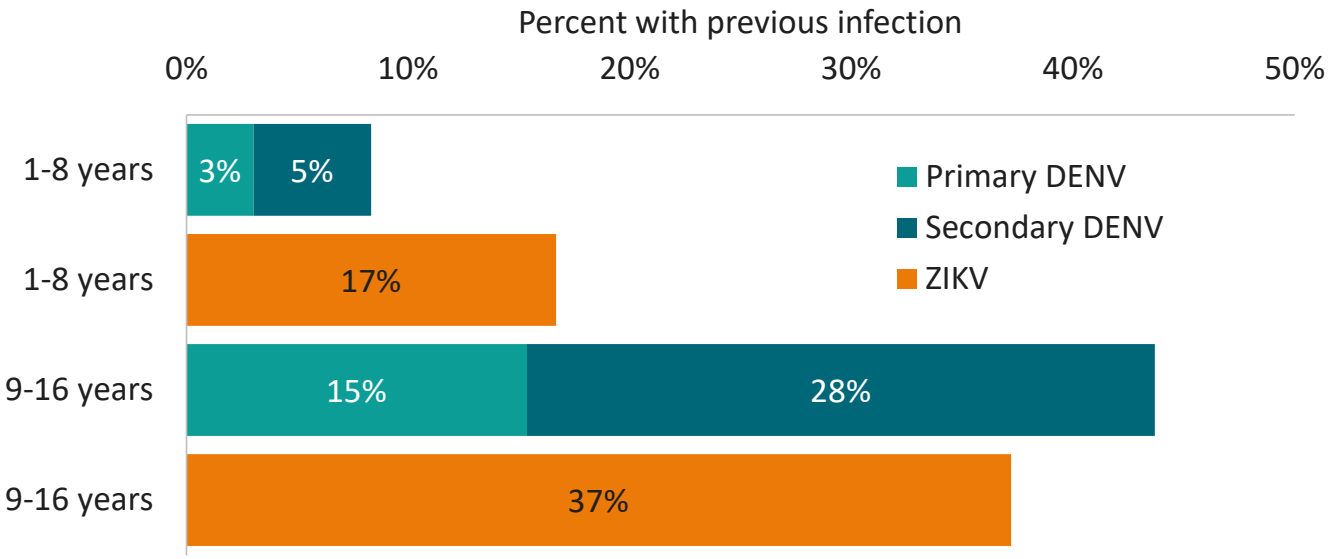
Fatal dengue cases by age group in Puerto Rico, 2010–2020

Higher mortality rates occurred among adults



Source: CDC ArboNET, unpublished

Previous DENV and ZIKV infection status among children 1–8 and 9–16 years old in southern Puerto Rico (n = 718), 2018–2019



8% of children 1–8 and **44%** of children 9–16 years old had evidence of previous DENV infection

Source: Communities Organized to Prevent Arboviruses (COPA) seroprevalence study, 2018–2019; unpublished data

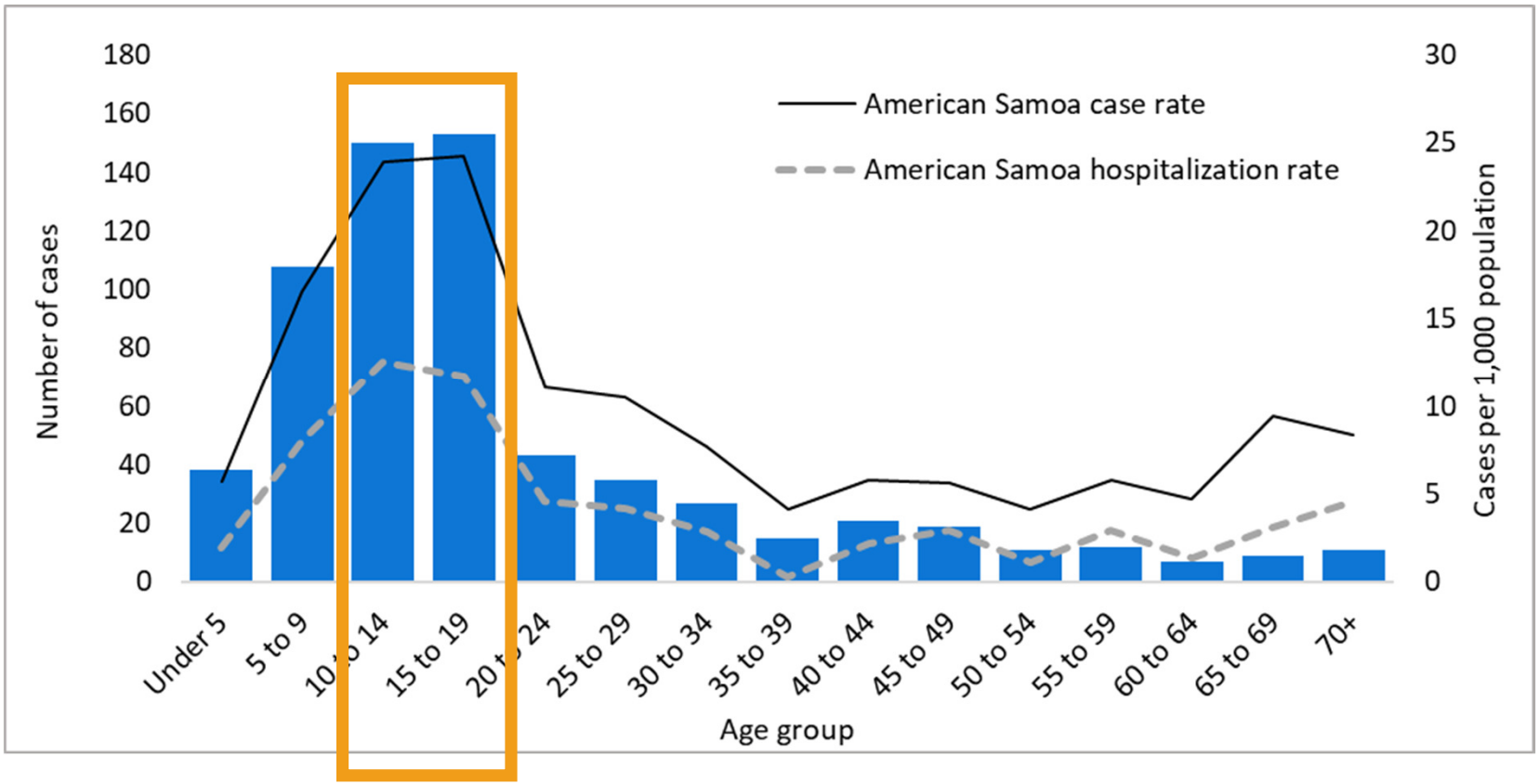
Dengue in American Samoa

- 2010 serosurvey in American Samoa (adults only): 96% seropositive[1]
- 2016–2018 DENV-2 outbreak in American Samoa with over 1,000 confirmed cases[2]

[1]Duncombe J, Lau C, Weinstein P, Aaskov J, Rourke M, Grant R, Clements A. Seroprevalence of dengue in American Samoa, 2010. EID. 2013 Feb;19(2):324.

[2]Cotter CJ, Tufa AJ, Johnson S, Matai'a M, Sciulli R, Ryff KR, Hancock WT, Whelen C, Sharp TM, Anesi MS. Outbreak of Dengue Virus Type 2—American Samoa, November 2016–October 2018. Morbidity and Mortality Weekly Report. 2018 Nov 11;67(47):1319.

Dengue cases and hospitalizations by age group in American Samoa, 2010–2020



Source: CDC ArboNET, unpublished

Dengue in US Virgin Islands

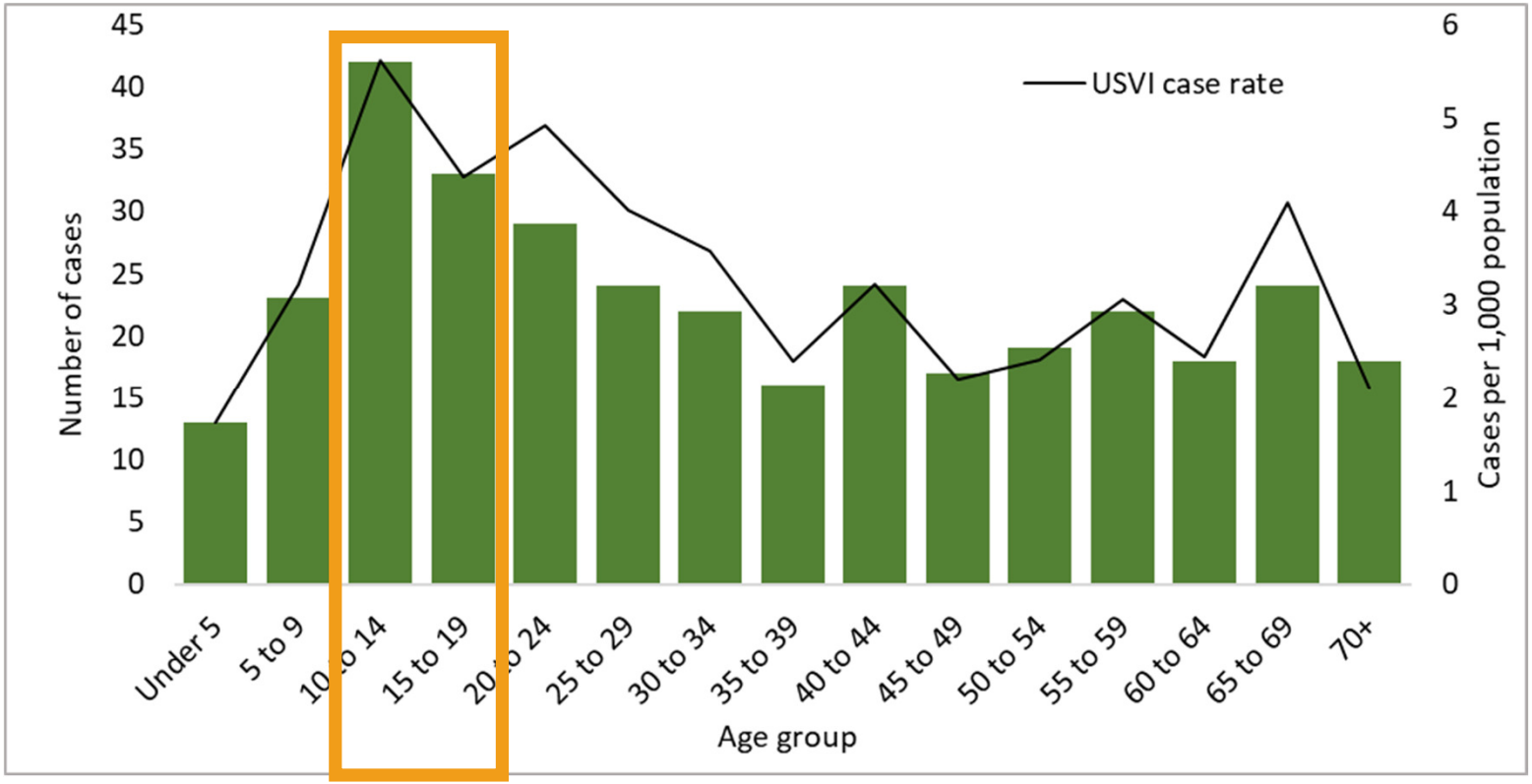
- St. Croix, St. Thomas, and St. John

- Periodic outbreaks
  - 1986-1987 (DENV-2, -4), St. John
  - 1990 (DENV-1, -2, and -4), all islands
  - 2004 (DENV-2), St. Thomas
  - 2005 (DENV-2), St. Croix
  - 2012-2013 (DENV-1, -4), St. Croix

- School survey in 2012
  - ~20% recent infections

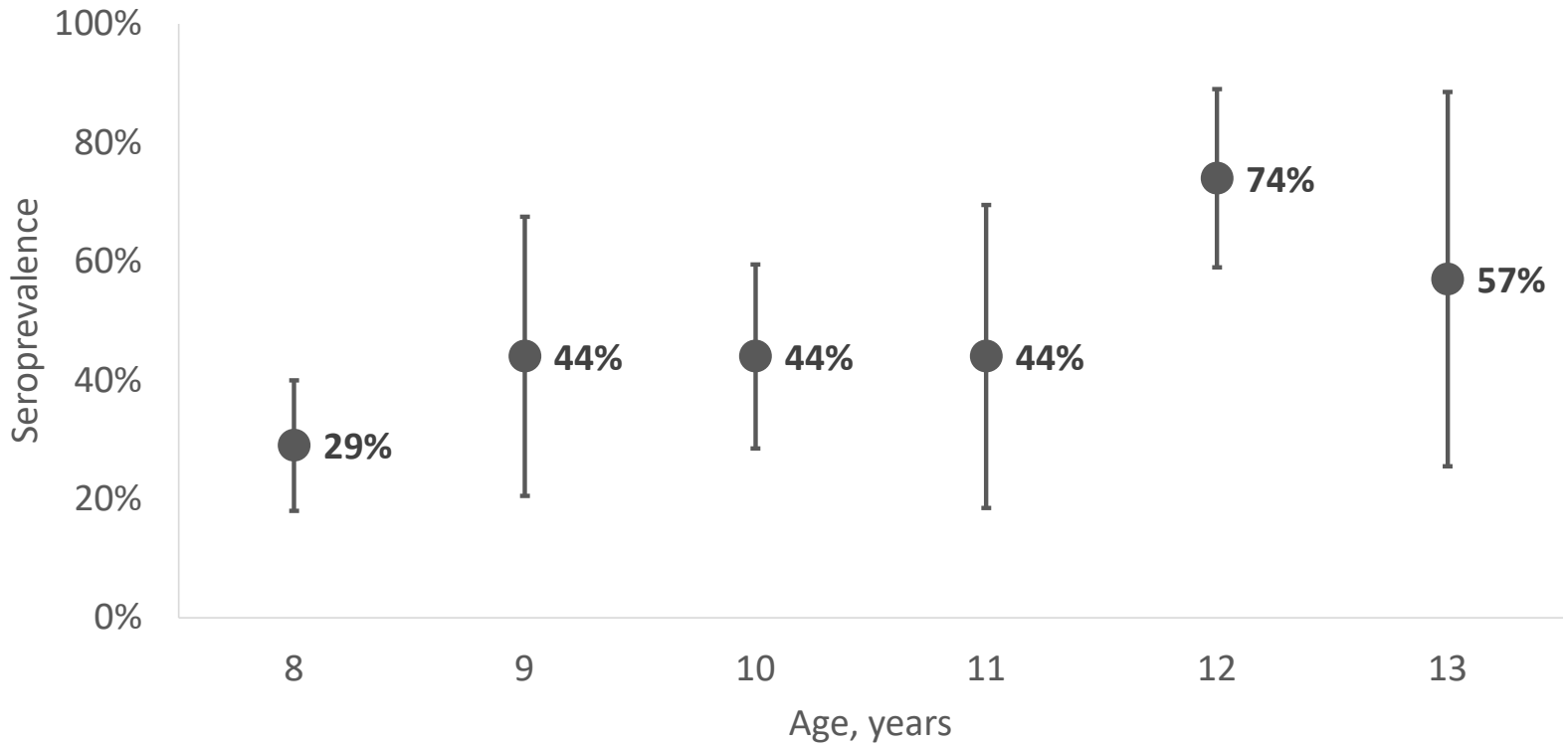
Data Source: Arbonet, National Arbovirus Surveillance System
CDC. MMWR 2013;62 (9): 171-172.

Dengue cases and hospitalizations by age group in US Virgin Islands, 2010–2020



Source: CDC ArboNET, unpublished data

Estimated dengue seroprevalence (IgG antibodies) by age — US Virgin Islands, 2022 (n=372)



Source: CDC EpiAid, unpublished data. Data are preliminary and subject to change.

Dengue Endemic Freely Associated States

- **Federated States of Micronesia**
  - >200 dengue cases during DENV-4 outbreak in Kosrae, 2012–2013[1]
  - >500 dengue cases reported during DENV-3 outbreak in Yap, 2019[2]
- **Republic of the Marshall Islands**
  - >1,987 dengue cases during DENV-3 outbreak, 2019–2021[3]
- **Palau**
  - >800 dengue cases reported during DENV-3 outbreak in 2018–2020[4]

1. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6228a3.htm
2. https://www.cdc.gov/mmwr/volumes/69/wr/mm6948a6.htm
3. https://reliefweb.int/report/marshall-islands/dengue-3-outbreak-republic-marshall-islands-june-25-2019-february-28-2021
4. https://www.palauhealth.org/MOHpages/MOHDengueSituation1.aspx

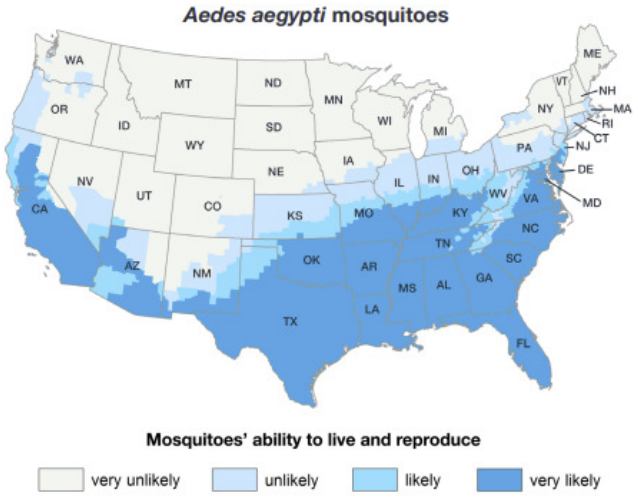
Dengue in the US States

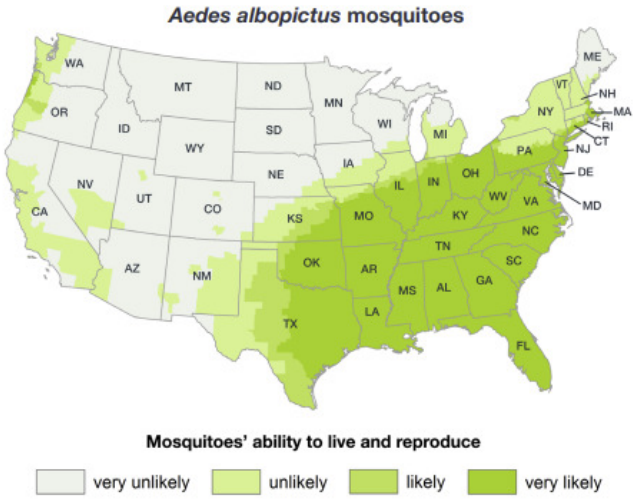
Dengue Cases in the US States

- Competent vectors (*Aedes* spp) present in many states

- Most cases (>94%) reported during 2010–2022 were associated with travel to endemic areas
  - Local transmission reported from HI (n=250), FL (n=201), TX (n=39)
  - Other sporadic cases not associated with travel reported from CA, DC, NC, NY, WV

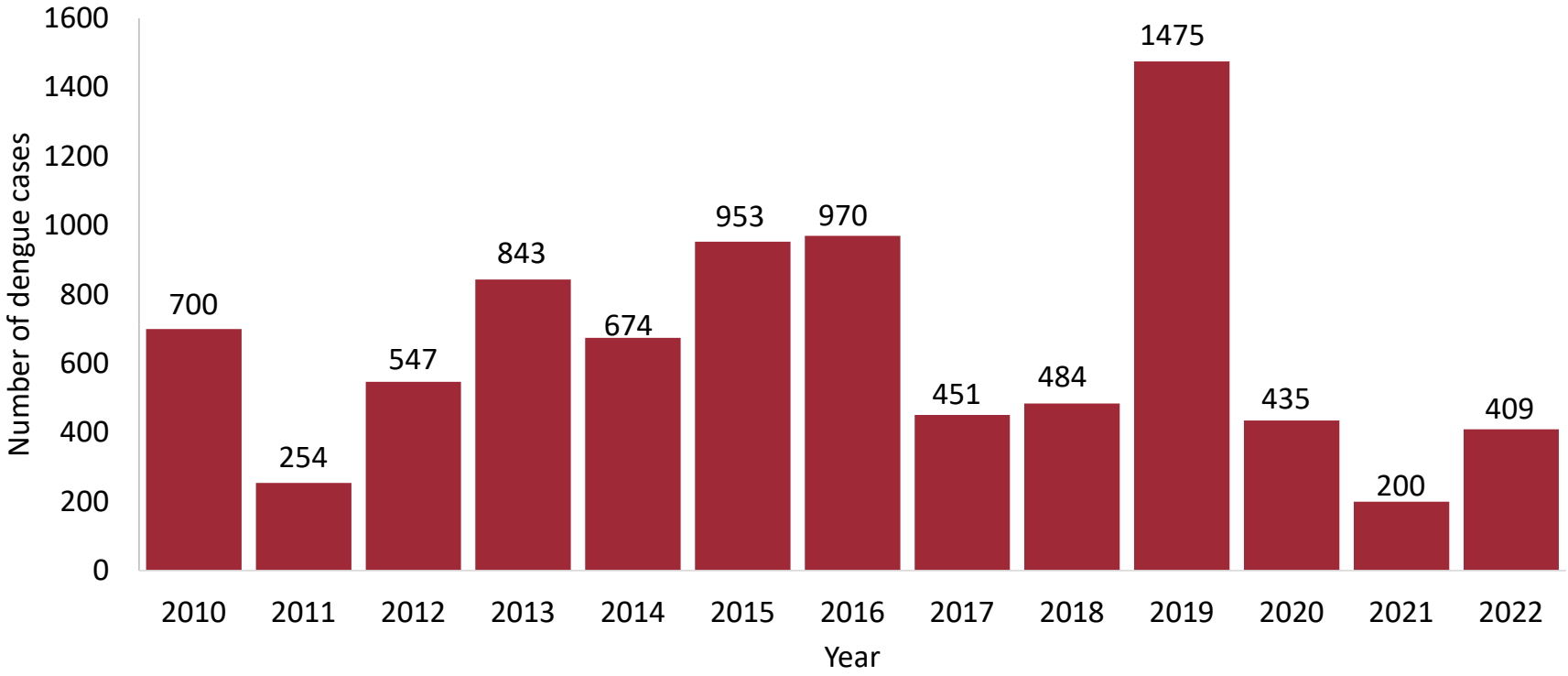
*2021–2022 numbers are preliminary and subject to change.





Dengue cases (N = 8,395) reported to ArboNET from US states by **year**, Jan 2010–Sept 2022*

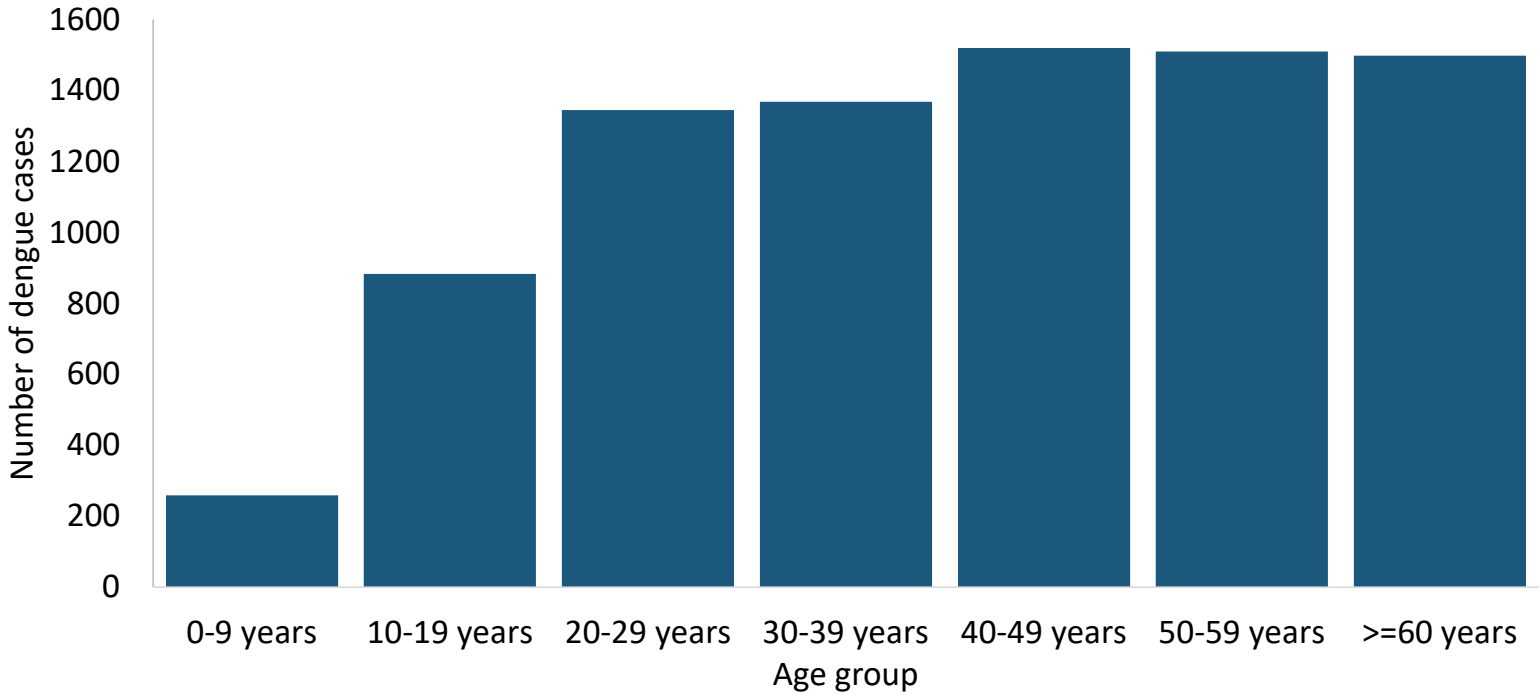
Average 665 cases annually



*2021–2022 numbers are preliminary and subject to change.

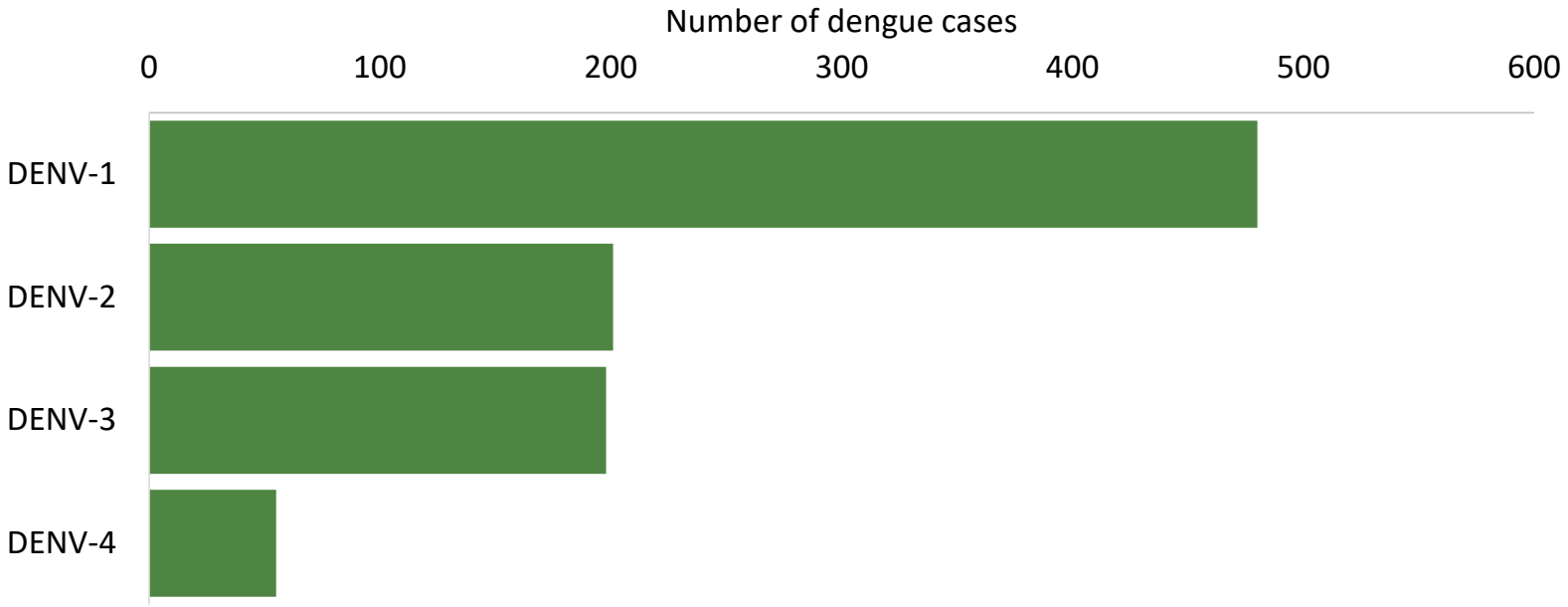
Dengue cases (N = 8,395) reported to ArboNET from US states by **age group,** Jan 2010–Sept 2022*

More cases seen in adults compared to endemic areas



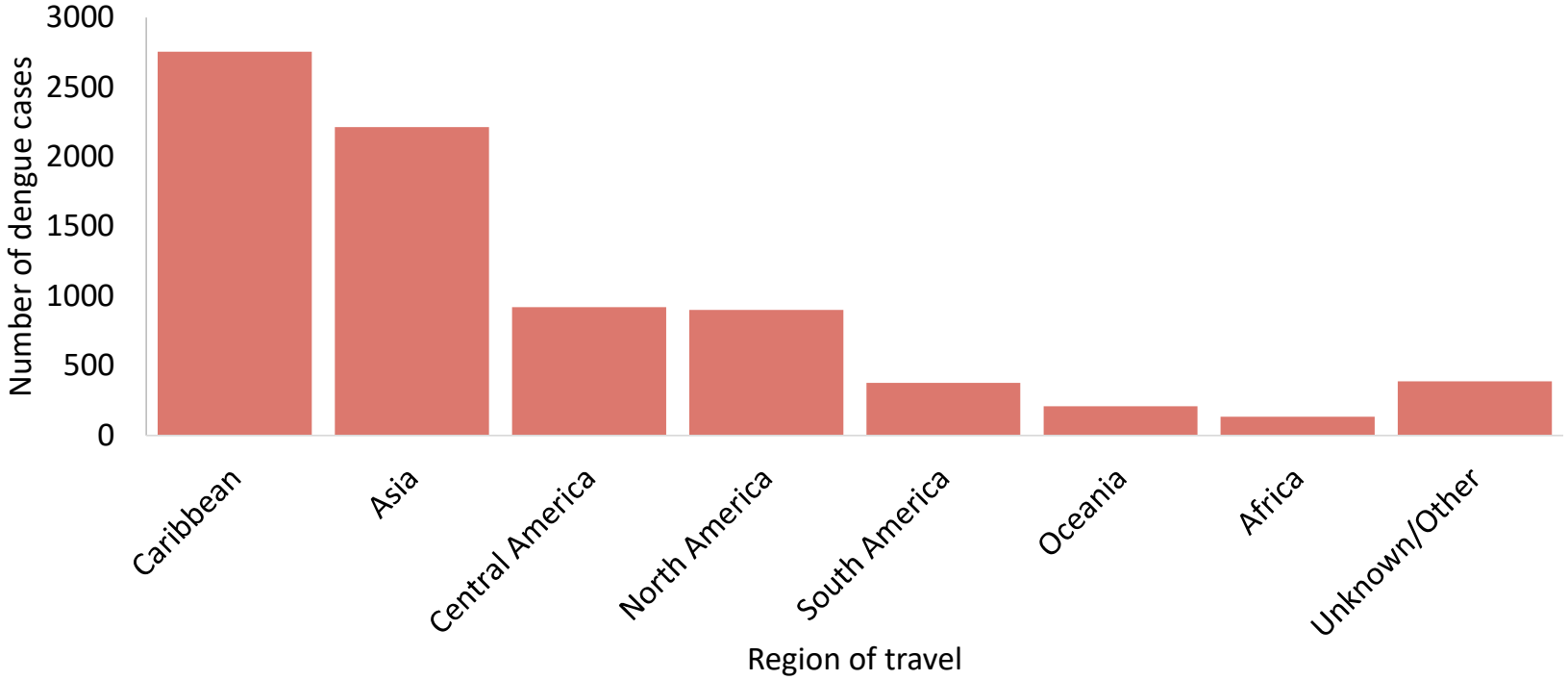
*2021–2022 numbers are preliminary and subject to change.

Dengue cases (N = 934) reported to ArboNET from US states by **DENV serotype,** Jan 2010–Sept 2022*



*2021–2022 numbers are preliminary and subject to change.

Travel-associated dengue cases (N = 7,899) reported to ArboNET from US states by **region of travel**, Jan 2010–Sept 2022*



*2021–2022 numbers are preliminary and subject to change.

Summary

- Dengue is a **public health problem** throughout the tropics and subtropics
- Dengue is **considered endemic** in **six** US territories and freely associated states
  - Cases and incidence rates are highest in children and adolescents 10–19 years old, but many cases and deaths occur in adults.
- Most cases in US states are associated with **travel to endemic areas**
  - Sporadic local DENV transmission documented in FL, TX, and HI

Thank you