HUDSON COLLEGE OF PUBLIC HEALTH
The UNIVERSITY *of* OKLAHOMA HEALTH SCIENCES CENTER

The Public Health Importance of the Current Monkeypox Epidemic

August 27, 2022

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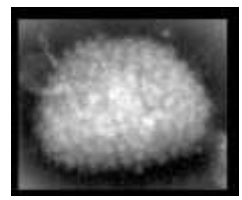
Professor of Epidemiology

Attribution

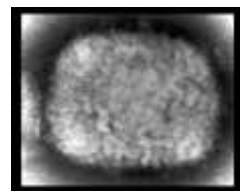
- I would like to extend sincere appreciation to Dr. Doug Drevets and Dr. Donna Tyungu for sharing their slides with me.
  - I have annotated a DD or DT on their slides in the lower left

Outline

- Describe clinical and virological context for monkeypox (MPX)
- Review history of monkeypox in relation to current epidemic
- Provide an update on current epidemiological situation
- Discuss public health importance of monkeypox



Electron micrograph of vaccinia virus from clinical specimen

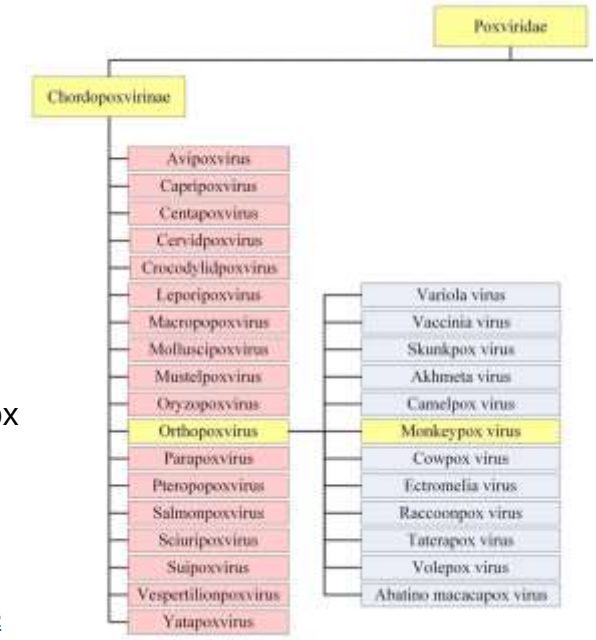


Electron micrograph of monkeypox virus from clinical specimen

https://www.cdc.gov/smallpox/lab-personnel/specimen-collection/negative-stain.html

Orthopox viruses

- Large, double stranded DNA viruses that replicate in cytoplasm
- Typically found in mammals
- Variola virus is causative agent of smallpox
- Cowpox virus was the original smallpox vaccine by Jenner
- Vaccinia virus is the current smallpox vaccine



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Viruses 2017, *9*(6), 142; https://doi.org/10.3390/v9060142

Cureus 14(7): e26531. doi:10.7759/cureus.26531

Natural/competent hosts of monkeypox virus

Host (species)	Location/Country
Gambian-pouched rat	Africa
Rhesus macaques	Copenhagen
Cynomolgus Macaque	Singapore/Copenhagen
Asian Monkeys	Copenhagen
Southern opossum	South America
Sun squirrel	Zaire
African hedgehogs	Africa
Jerboas	USA
Sooty mangabey	Côte d'Ivoire

Host (species)	Location/Country
Woodchucks	USA
Short-tailed opossum	USA
Porcupines	Zaire
Giant anteaters	Rotterdam
Prairie dogs	USA
Elephant shrew	DR Congo
Domestic pig	DR Congo
Rope squirrel	Zaire/DRC
African dormice	USA

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Viruses 2020, *12*(11), 1257; https://doi.org/10.3390/v12111257

A brief history

- **1958:** identified in 2 colonies of laboratory monkeys with a pox-like illness
- **1970:** human monkeypox infection identified in Dem. Rep. of Congo (formerly Zaire)
- **1970**–**early 2000's** - sporadic disease/epidemics in Central and W. Africa
  - Majority of cases were found in children, case fatality rates of 1-17%
  - Considered a zoonotic infection acquired from mammals (rodents, non-human primates)
  - 2 clades, Congo Basin and West African
  - 2003: 71 cases in USA linked to infected rodents imported from Ghana that spread MPX virus infection to co-housed prairie dogs
- **2017:** Outbreak in Nigeria with >100 suspected cases with epidemiological features that diverged from prior outbreaks

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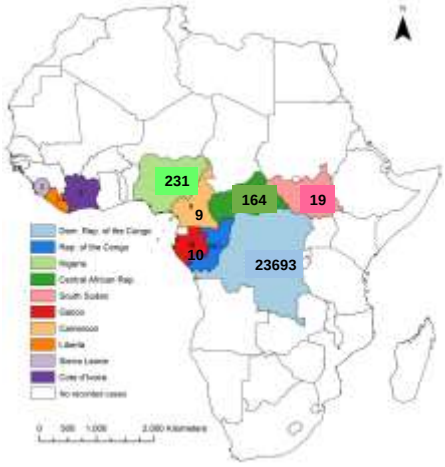
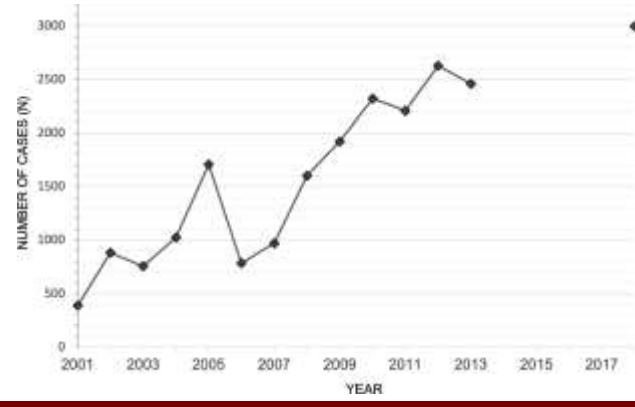
https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5227a5.htm

Map of countries and total number of suspected cases 1970–2018





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PLOS NTD 2019 https://doi.org/10.1371/journal.pntd.0007791

Human MPX infection: Historical features

Series	N	Median age (range)	M:F ratio	Case fatality rate	Reference
1970-79 DRC	47	4 yrs (7 mo–35 yrs)	1.24:1	17%	Breman et al., Bull WHO, 1972
1980-85 DRC	282	5 yrs (1 mo–69 yrs)	1.03:1	11%	Jezek, et al., JID, 1987
1996-97 DRC	88	10 yrs (1 mo–62 yrs)	1.32:1	3.7%	Hutin et al., EID, 2001
2011-15 DRC	1057	14 yrs (1 mo–79 yrs)	1.21:1	Not reported	Whitehouse et al., JID, 2021
2017-8 Nigeria	122	29 yrs (2 d–50 yrs)	2.21:1	6%	Yinka-Ogunleye et al., Lancet Inf Dis, 2019

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Exportation of MPX from Nigeria 2018

Case	Age (years)	Nationality	Sex	Reported Exposure & Risks	Other
UK1	32	Nigerian	M	None	Lesions first appeared in groin
UK2	36	Nigerian	M	Consumption of bushmeat and sick contact	Lesions first appeared in groin
UK3	40	British	F	HCW who had contact with UK2	Sequencing confirmed same virus
ISR	38	Israeli	M	Disposed of 2 rodent carcasses while traveling in Nigeria	Lesions first appear on penis
SING	38	Nigerian	M	Reported potentially eating BBQ bushmeat at a wedding	Lesions on penis
BAY	30	Nigerian	M	Occupational (HCW) from Bayelsa state	Bayelsa is adjacent to states (visited by export cases)

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JID 2022, https://doi.org/10.1093/infdis/jiaa559
Eurosur 2018 https://doi.org/10.2807/1560-7917.ES.2018.23.38.1800509
EID 2020 10.3201/eid2608.191387
EID 2019 https://doi.org/10.3201/eid2505.190076

Transmissibility

- Contact is primary mode of transmission
  - Some suggestion for aerosolization, sores in respiratory tract
- Estimates of R_0 for epidemic monkeypox: 1.25–2.1
  - Estimates for endemic R_0 as low as 0.36
- Rapidly mutating virus

https://www.dhs.gov/sites/default/files/2022-07/22_0712_st_monkeypox_mql.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7463189/

Secondary attack rates (SAR) from 6 studies, 1980-2012

Exposure	Sub-group	SAR %
Household contacts	All	0-9.3
	Unvaccinated	0-12
	Vaccinated	0-1.7
Non-household contacts	All	0-9.0
	Unvaccinated	0-4.8
	Vaccinated	0-0.4

PLOS NTD 2019 https://doi.org/10.1371/journal.pntd.0007791

Human MPX infection: Israel 2018

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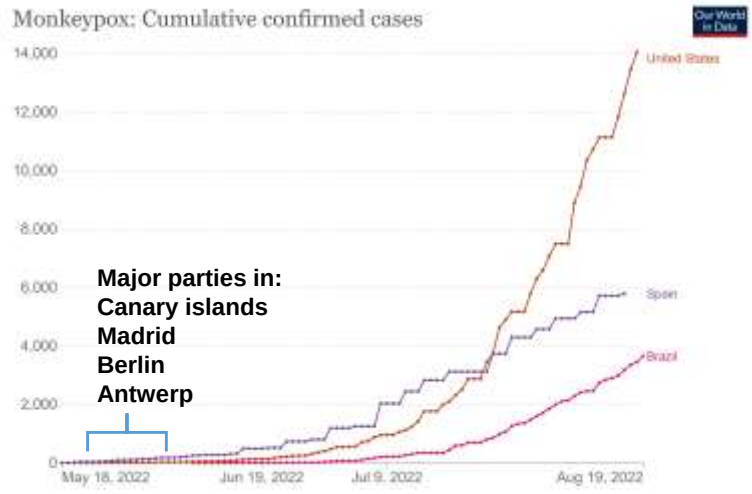
EID 2019 https://doi.org/10.3201/eid2505.190076

Current Epidemic/Pandemic

Exponential Increase

- 7 May: the United Kingdom reported a case in a traveler from Nigeria
- 13–16 May: 6 cases reported in London in gay or bisexual men who have sex with men (MSM)
- 17 May: 7 suspected cases of MPX at STD clinic in Madrid
- 18 May: Portugal reported 14 cases of MPX in men



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Eurosurveillance 2022 https://doi.org/10.2807/1560-7917.ES.2022.27.27.2200471

Case characteristics and exposures: Aug 1 – 14, 2022

- 98.5% of 17,943 cases with available data are male
- 96.9% of 9,171 were MSM among cases with known sexual orientation
- 395 cases were reported to be health workers, but most were infected in community
- 91.2% of 6,693 cases with reported transmission events identified a sexual encounter

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Human MPX infection 2022: Clinical features

- **Skin lesions**
  - Progress more or less uniformly from papules → vesicles → pustules → scabs → scars
  - Lesions are infectious!!!!!
  - 85% of individuals had ≤ 20 skin lesions
- **4–13% of individuals admitted to hospital**
  - Pain control (anorectal)
  - Super-infection of skin lesions
  - Severe pharyngitis
  - Corneal lesions
  - Acute kidney injury
  - Myocarditis

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Eurosurveillance 2022 https://doi.org/10.2807/1560-7917.ES.2022.27.27.2200471
NEJM 2022 DOI: 10.1056/NEJMoa2207323

Human MPX infection 2022: Clinical features

Symptom	WHO (n=21,748)	CDC (n= 1,007)	Madrid (n=508)	Multi-country (n=529)
Fever	71.2%	63.3%	63.8%	62%
Any rash	69.6%	100%	98%	95%
Lymphadenopathy	20.7%	58.5%	61.2%	56%
Fatigue	15.4%	57.1%	46.9%	41%
Headache	14.5%	50.8%	31.9%	27%
Muscle ache	14.1%	55%	36.4%	31%
Oral rash	6.3%	24.9%	NR	NR
Genital rash	26.4%	46.4%	NR	NR
Anogenital rash	NR	31.3% perianal	72.1%	73%
Facial rash	NR	38.4%	35.5%	25%
Palms/soles	NR	21.9% palms 10.7% soles	24.9%	10%

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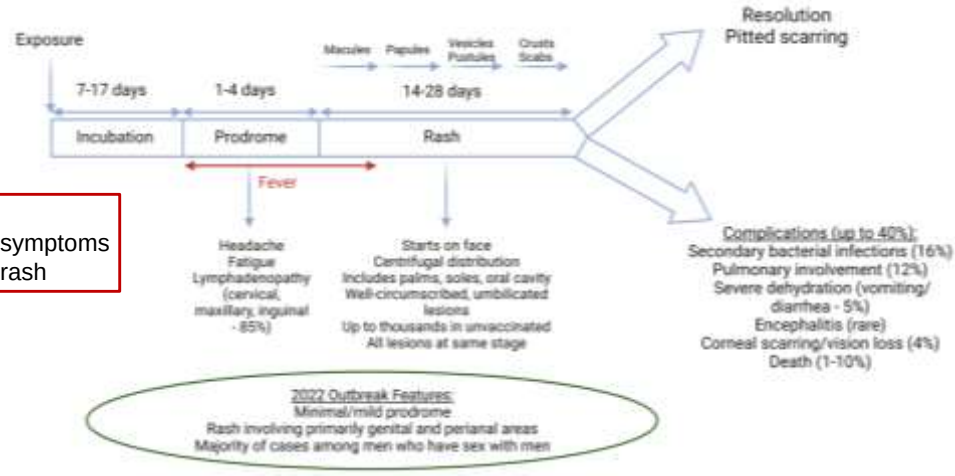
https://worldhealthorg.shinyapps.io/mpx_global/
Eurosurveillance 2022https://doi.org/10.2807/1560-7917.ES.2022.27.27.2200471

NEJM 2022 DOI: 10.1056/NEJMoa2207323
http://dx.doi.org/10.15585/mmwr.mm7132e3

Clinical timeline



CDC estimates
7.6 ± 1.8 days to symptoms
8.7 ± 1.6 days to rash

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Siegrist and Sassine, CID 2022 https://doi.org/10.1093/cid/ciac622
https://www.cdc.gov/poxvirus/monkeypox/clinicians/technical-report.html#epi-parameters

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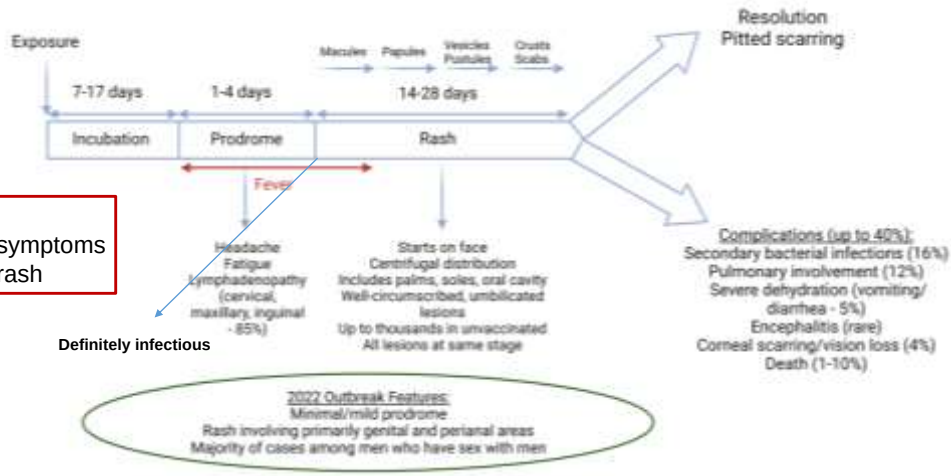

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Prevention of transmission

- Skin lesions are infectious-keep covered until completely healed
- Oral/mucosal lesions shed virus in oral secretions
- Lesions in airways can shed virus (classic smallpox transmission), but seems to be less prevalent with MPX
- Fomite transmission is possible
- Virus can be detected in blood, stool, urine, semen
  - Infectivity of virus is not established
- Vaccination
  - JYNNEOS/ACAM 2000 thought to be 85% protective
  - Prior smallpox vaccination in those of a certain age MAY provide some protection

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How to mitigate your risk as adults?

- **Limit exposure in high-risk settings**
- **Pre-exposure prophylaxis**
  - Occupational exposure, e.g. laboratory, healthcare, public health
  - At high risk due to sexual activity
  - Vaccination
- **Post-exposure prophylaxis**
  - Close contact with active/suspected case
  - Vaccination

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https://www.cdc.gov/poxvirus/monkeypox/considerations-for-monkeypox-vaccination.html
https://aspr.hhs.gov/SNS/Pages/JYNNEOS-Distribution.aspx

Vaccination: 2 choices, but really only 1

- **JYNNEOS**, approved by U.S. FDA for prevention of **MPX virus** infection
  - Uses a **non-replicating vector** and is safe for immunocompromised individuals
  - 2 doses s.c./intradermal 28 days apart
  - Considered fully immunized 14 days after second dose
- **ACAM2000**, approved by FDA for use against **smallpox** and made available for use against monkeypox under an Expanded Access IND
  - Uses a **replicating vector** and is **contraindicated** in people with a weakened immune system, exfoliative skin conditions, or pregnancy
  - 1 dose percutaneous using a bifurcated needle, a "take" is manifest by a lesion
  - Considered fully immunized 4 weeks after ACAM2000 dose
  - In clinical trials, about 1 in every 175 people who got vaccine for first time had myocarditis and/or pericarditis within 3 weeks after vaccination

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https://www.cdc.gov/poxvirus/monkeypox/considerations-for-monkeypox-vaccination.html

https://doi.org/10.1016/j.vaccine.2015.06.075

Monkeypox in children

- Historically: in endemic countries, there have generally been more cases of monkeypox documented in children than adults
- As of August 22, 140 cases have been reported in children worldwide
  - Many of these in endemic countries
- As of August 26, 2022:
  - 17 cases in children age ≤15 years in US
  - 131 cases in people age 16-20 years in US; 91% in males
- Recently an Illinois daycare worker was confirmed to have Monkeypox
- We are currently unaware how many children have been exposed

DT

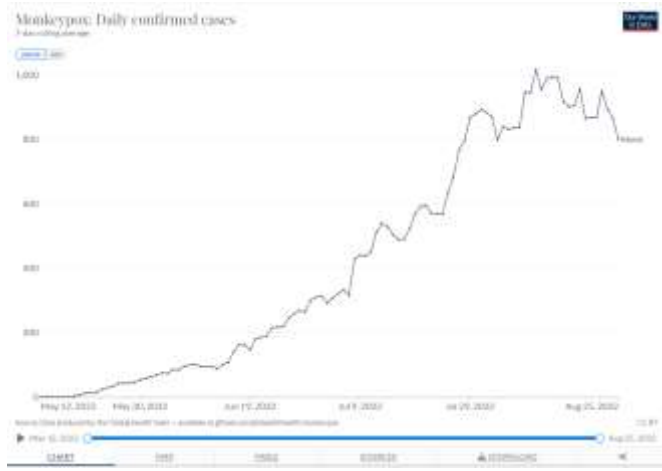
Public Health Emergency

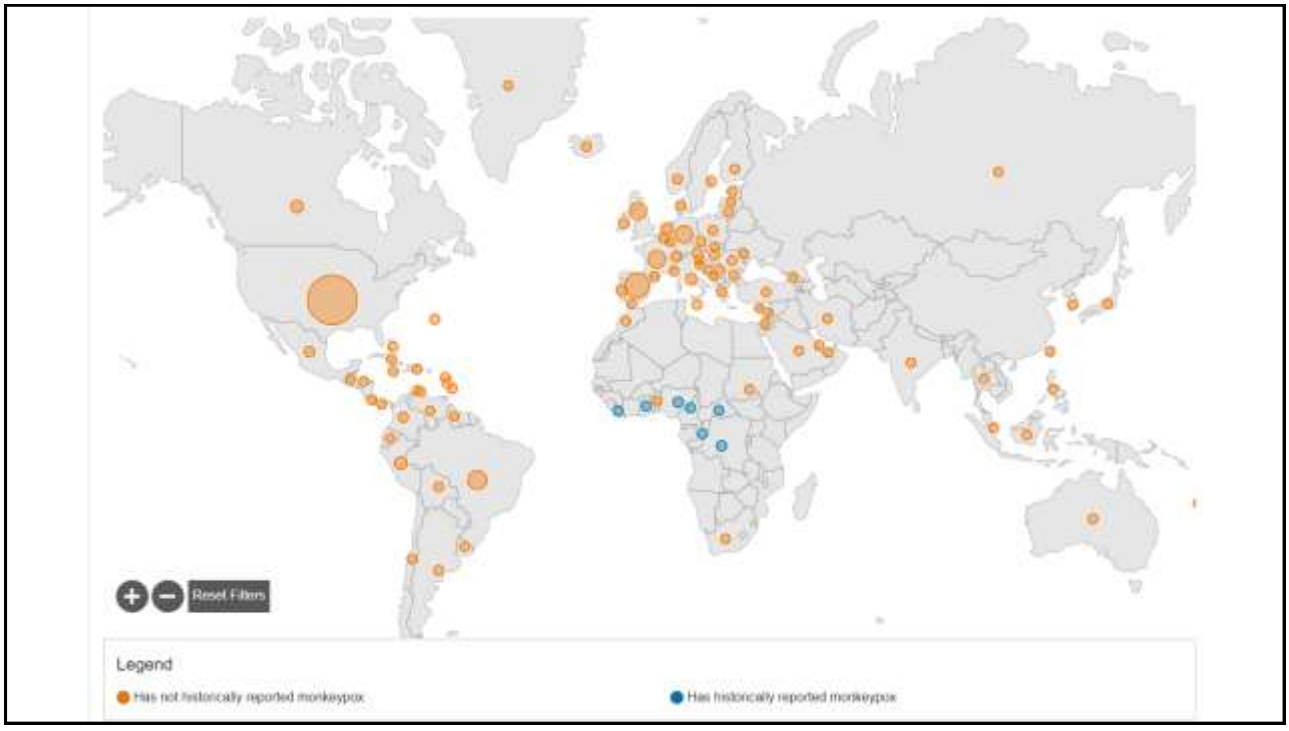
- WHO declared monkeypox a Public Health Emergency of International Concern: July 23, 2022
  - >46,724 cases in 91 non-endemic countries as of August 26, 2022
    - 6 deaths in non-endemic countries
- US declared monkeypox a Public Health Emergency on August 4, 2022

Criteria for Public Health Emergency of International Concern

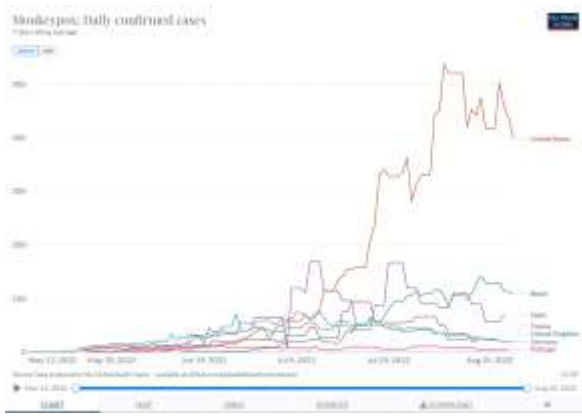
- Is the public health impact of the event serious?
- Is the event unusual or unexpected?
- Is there significant risk for international spread?
- Is there significant risk for international travel or trade restrictions?

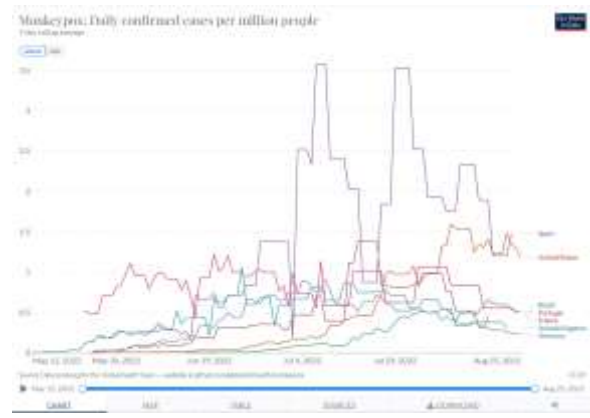
World: 7-day average of daily confirmed cases of Monkeypox: August 26, 2022



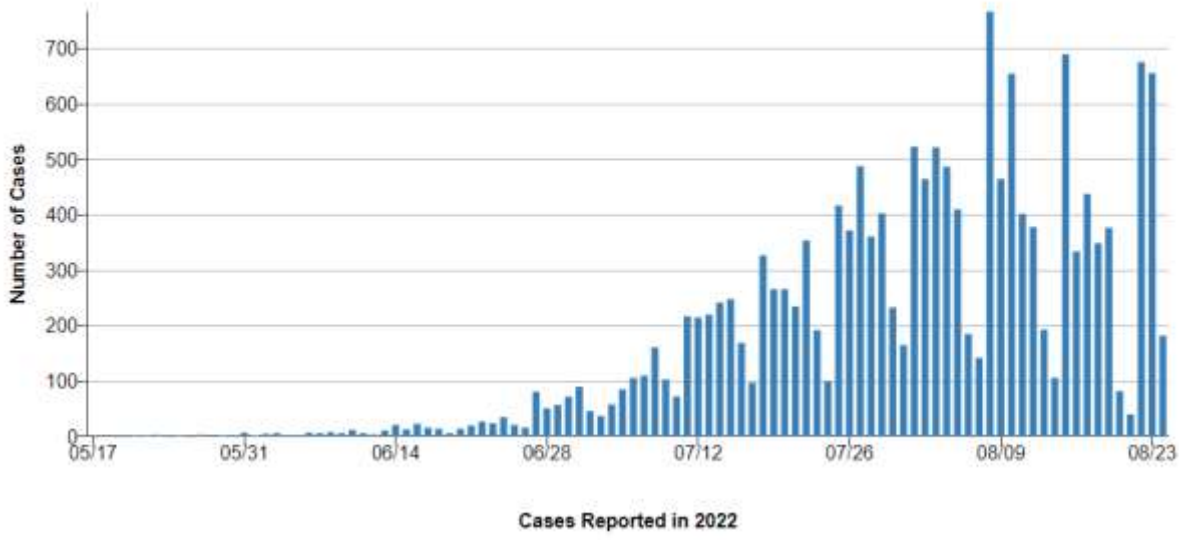

Reset Filters
Legend
Has not historically reported monkeypox
Has historically reported monkeypox

Countries with highest number (left) and rates (right) of Monkeypox

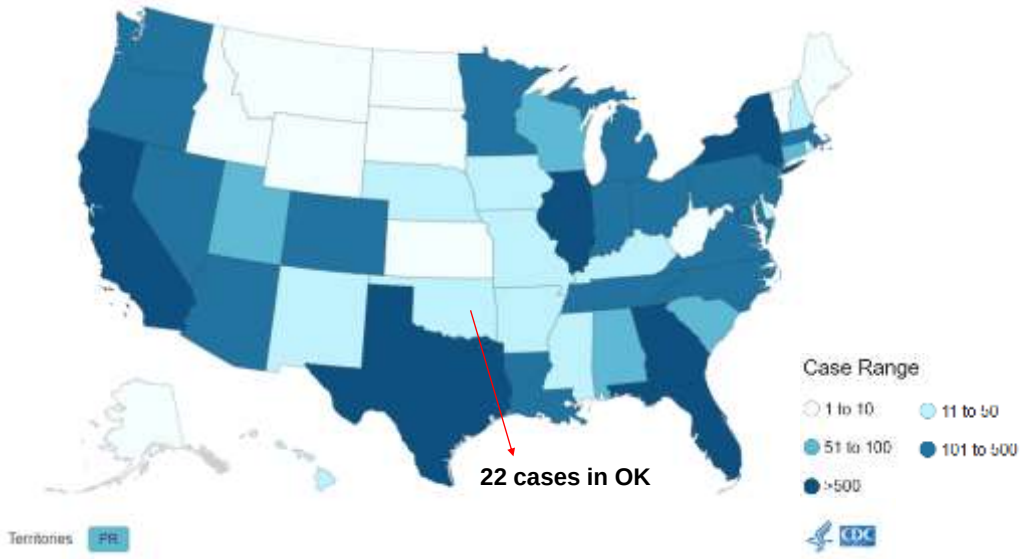




U.S. Monkeypox Case Trends Reported to CDC (n= 16,926)



Aug 26, 2022: 16,926 Total confirmed monkeypox/orthopoxvirus cases



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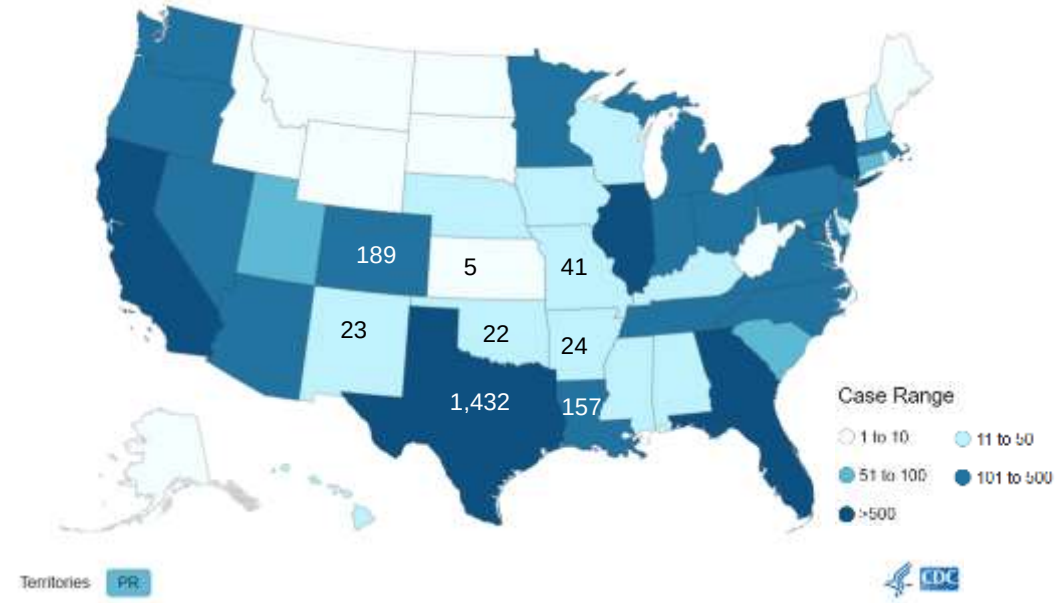

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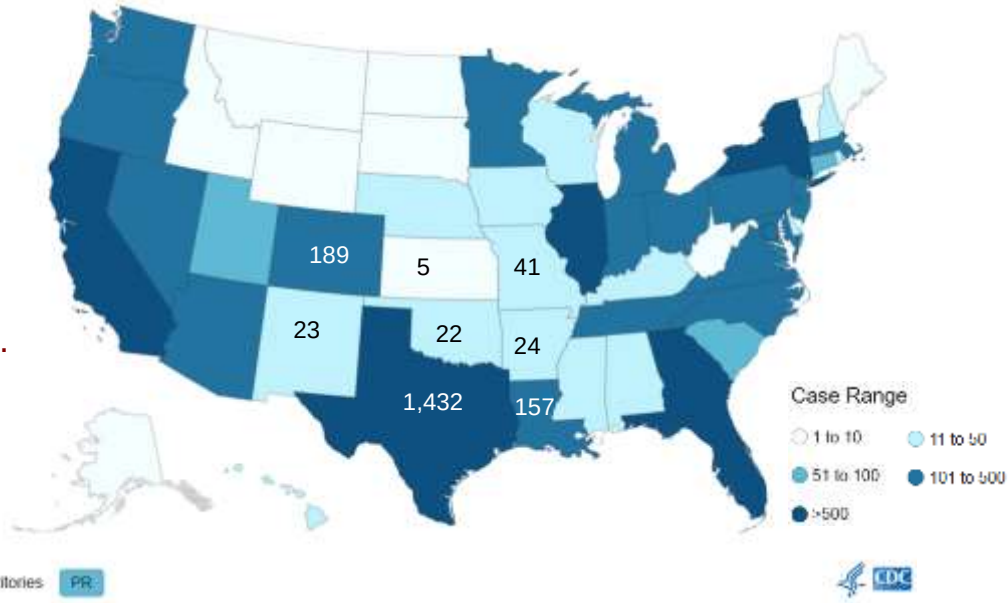
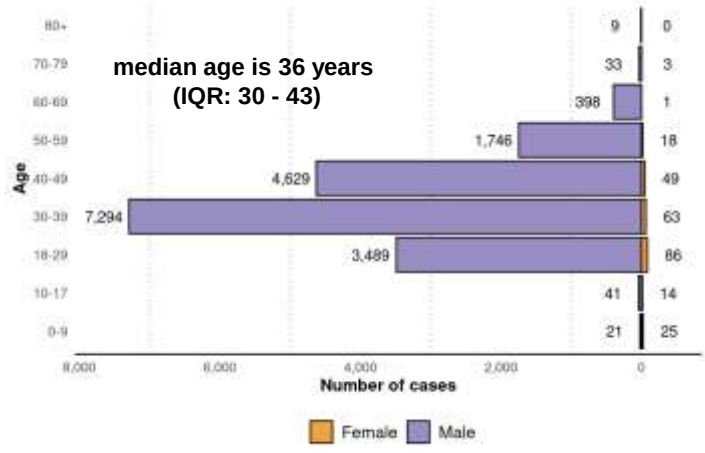
CDC reporting 0 deaths in U.S.



Age distribution of current epidemic



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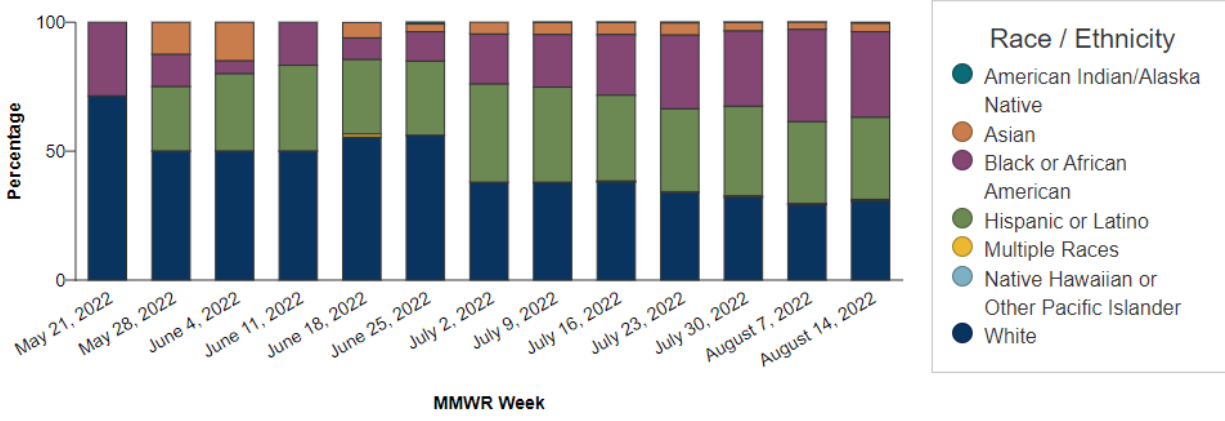
Monkeypox cases reported to CDC: Race/Ethnicity



Viral survivability on surfaces

- Poxviruses can survive in linens, clothing and on surfaces
  - particularly when in dark, cool, and low humidity environments
- In one study, investigators found live virus 15 days after a patient's home was left unoccupied
- Porous materials (bedding, clothing, etc.) may harbor live virus for longer periods of time than non-porous (plastic, glass, metal) surfaces
- Orthopoxviruses are very sensitive to UV light and many disinfectants

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Prevention of transmission

- **In hospital**
  - Contact + airborne + eye protection
  - Private room
  - Decontamination
- **At home**
  - Keep lesions covered, wear gloves when changing bandages
  - Avoid close contact with humans and pets, mask as needed
  - Limit exposure to others as much as possible
  - Do not share potentially contaminated items, e.g., sheets, toothbrushes
  - Hand hygiene
  - Waste disposal – don't let dogs/cats/mammals get into contaminated waste
  - Routinely clean and disinfect commonly touched surfaces

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Environmental Cleaning

- Disinfectant: EPA-registered product*
- Clean and disinfect household in following order**
  1. General waste containment
  2. Laundry
  3. Hard surfaces and household items
  4. Upholstered furniture and other soft furnishings
  5. Carpet and flooring
  6. Waste disposal

*https://www.epa.gov/pesticide-registration/disinfectants-emerging-viral-pathogens-evps-list-q
**https://www.cdc.gov/poxvirus/monkeypox/specific-settings/home-disinfection.html

High-Contact Object and Surface Contamination in a Household of Persons with *Monkeypox Virus* Infection — Utah, June 2022

Weekly / August 26, 2022 / 71(34);1092-1094

On August 19, 2022, this report was posted online as an MMWR *Early Release.*

Jack A. Pfeiffer[1,2]; Abigail Collingwood[2]; Linda E. Rider[2]; Faisal S. Minhaj[1,3]; Audrey M. Matheny[3]; Chantal Kling[3]; Andrea M. McCollum[3]; Leisha D. Nolen[2]; Clint N. Morgan[3]
(View author affiliations)

View suggested citation

In May 2022, the Salt Lake County Health Department reported two real-time polymerase chain reaction (PCR)–confirmed travel-associated cases of monkeypox to the Utah Department of Health and Human Services (UDHHS). The two persons with monkeypox (patients A and B) lived together without other housemates. Both persons experienced prodromal symptoms (e.g., fatigue and body aches). Eight days after symptom onset, patient A experienced penile lesions; lesions spread to the lips, hands, legs, chest, and scalp by day 10. Patient B experienced prodromal symptoms 8 days after illness onset of patient A; patient B experienced a lesion on the foot which spread to the leg and finger by day 11. Although both patients had lesions in multiple anatomic areas, the overall number of lesions was small, and lesions varied in presentation from "pimple-like" or ulcerated, to characteristically well-circumscribed and centrally umbilicated. Both patients had mild illness. The time from symptom onset to resolution was approximately 30 days for patient A and approximately 22 days for patient B.

https://www.cdc.gov/mmwr/volumes/71/wr/mm7134e1.htm

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- **No viral cultures yielded live virus**
- **Most samples (70%) yielded evidence of viral DNA via PCR**
- **Residents were conscientious cleaners**

https://www.cdc.gov/mmwr/volumes/71/wr/mm7134e1.htm

Testing, home isolation, treatment, and contact tracing will be coordinated by OSDH Communicable Disease Epidemiologist-on-Call: **405-426-8710**

Collecting specimen for PUI Monkeypox

Contact OSDH Epidemiologist on-call prior to collecting specimens for detailed instructions

- Don appropriate PPE
- Sample more than one lesion from different locations of body or lesions with differing appearances
- Vigorously swab or brush lesion with 2 separate sterile dry polyester/Dacron swabs
- Break off end of applicator of each swab into an empty 15ml blue-capped virology tube
- Any scab or extra biological specimen can be put in a separate sterile container and transported to lab
- **Do not** add or store in viral or universal transport media
- Specimen label must have at least two primary identifiers
  - Needs big Meditech label- Order as: *Miscellaneous Micro CDC Pox*
- Give to micro staff trained in sending testing to OSDH
  - Likely pass through OSDH to go to CDC
  - Call to confirm transport instructions with OSDH Lab
  - CDC only accepts specimens on weekdays

CDC test 10515-Poxvirus Molecular Detection i.e.: *Monkeypox* virus, *Variola* virus, *Vaccinia* virus, smallpox, sore mouth: turnaround time is 5 days.

Thank you!

- Questions and Discussions

Extra slides