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Correspondence

Monkeypox outbreak: New zoonotic alert after the COVID-19 pandemic



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Dear Editor,

After the coronavirus disease 2019 (COVID-19) pandemic, the World Health Organization (WHO) declared the monkeypox outbreak as a public health emergency of international concern (PHEIC). According to WHO, PHEIC means an extraordinary event, which constitutes a public health risk to other States through the international spread, and which potentially requires a coordinated international response (WHO, https://worldhealthorg.shinyapps.io/mpx_global). Since early May 2022, cases of monkeypox have been reported from countries where the disease is not endemic, and continue to be reported in several endemic countries. Monkeypox is a rare infectious disease, caused by the monkeypox virus (MPXV) and can occur in both humans and non-human primates. The disease often presents with flu-like symptoms such as fever, swollen lymph nodes, and rashes. Within several days, clusters of fluid-filled blisters typically appear all over the body, including on the face, and then these blisters break open and crust over [1].

The origin of the MPXV can be traced as far back as 1958 when an outbreak of a pox-like disease occurred in colonies of monkeys kept for research in the Democratic Republic of the Congo (DRC) [2,3]. It is thought that African rodents and non-human primates (including monkeys) were hosts to the virus, which gradually transmitted to humans and made them infectious. The spread was initially attributed to human contact with infected rodents, which then spread through skin-to-skin contact with an infected person. For example, in 2003, more than 70 people in the United States (U.S.) contracted monkeypox after handling prairie dogs that were kept together with infected Gambian rats and hamsters imported from Ghana.

The current 2022 global outbreak is caused by the less severe West African clade. On May 7, 2022, the world was alerted to a confirmed case of monkeypox in the United Kingdom. As of July 21, 2022, a total of 15510 confirmed cases of monkeypox have been reported in 72 countries including 5 deaths (Monkeypox, Our World in Data, <https://ourworldindata.org/monkeypox>). The MPXV cases have increased 383.94% globally within one month, which is a serious concern (see Fig. 1). In the past, most infections occurred amongst individuals who lived together or had been in contact with individuals or animals from

endemic areas [Centers for Disease Control and Prevention (CDC), <https://www.cdc.gov/poxvirus/monkeypox/about.html>], but in the current scenario, most confirmed cases of MPXV are reported in humans who have travel history and reported travel to countries in Europe and North America, rather than West or Central Africa where the MPXV is endemic [4]. Investigations are ongoing on the source and pattern of human-to-human transmission (HHT).

Despite its name, monkeys are not the main reservoir of the MPXV, the causative agent of this disease. Rather, the virus is thought to reside mainly in rodents, including squirrels and rats [1]. Although several species of rodents are suspected to be susceptible to monkeypox, the virus has only been isolated from wild animals twice, including from a chipmunk in 1985 in the DRC and from a dead baby mangabey in Côte d'Ivoire in 2012.

HHT of MPXV occurs when an individual comes into contact with an infected animal, person, or contaminated material [5]. In addition to entering the body through broken skin (including wounds invisible to the naked eye), the virus can spread largely through fluid or droplets into the mouth, nose, or eyes. Because these droplets are heavy and often unable to propagate more than a few feet, prolonged contact is required for person-to-person transmission. As a result, the ones at high risk are individuals who share a household with an infected individual, health-care workers, and veterinarians who are likely to come into immediate and prolonged contact with infected humans or species of animals susceptible to the MPXV.

In the 2022 outbreak, the majority of reported cases of monkeypox currently are in males, and most of these cases occur among males who identified themselves as gay, bisexual and other men who have sex with men (MSM), in urban areas, and are clustered in social and sexual networks. According to a recent study done by the Queen Mary University of London, 98% of infected people were gay or bisexual men, and 41% had the human immunodeficiency virus (HIV) [4]. To date, although evidence points in this direction, it is uncertain whether monkeypox can specifically be transmitted via sexual contact or spread through close physical contact. Nevertheless, this mode of transmission, coupled with the spread of monkeypox in non-endemic countries, had led many to question whether the MPXV, similar to SARS-CoV-2, has mutated to

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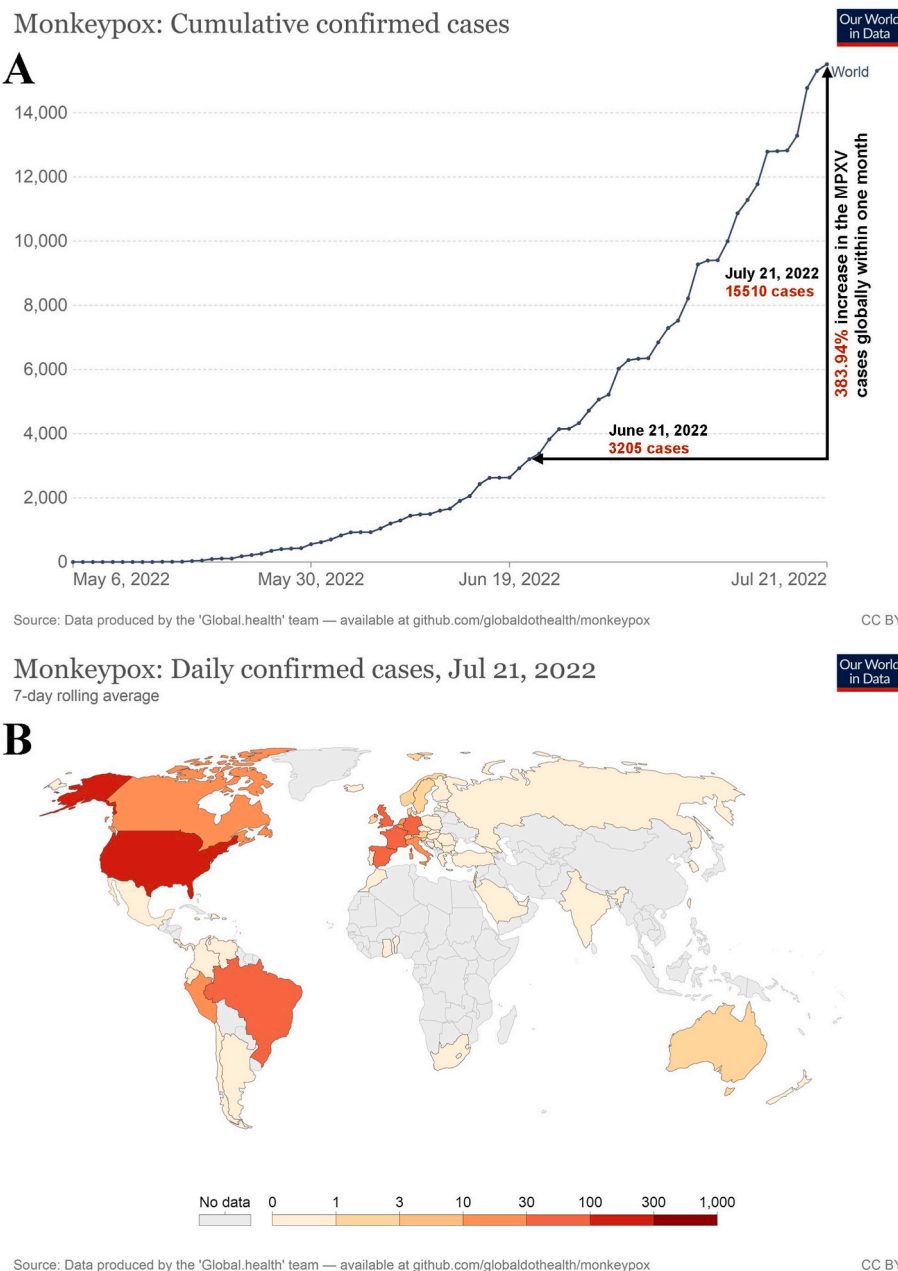


Fig. 1. Cumulative confirmed cases of monkeypox as of July 21, 2022 (A) and a map showing different countries with confirmed cases of the monkeypox globally (B). Adapted from the Our World in Data; <https://ourworldindata.org/monkeypox>.

accommodate and ease HHT [1]. Initially, it was thought that monkeypox, a type of DNA virus that detected and corrected mutations better than RNA viruses such as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), it should have been less likely to acquire rapid mutations. Yet, the virus has been circulating in countries like Europe (the epicenter of the current epidemic) for longer than originally thought possible, suggesting that it is continually acquiring mutations that counteract the human immune response [6]. More research is needed for a better understanding of the mechanisms by which the MPXV is responsible for the influx of cases.

Monkeypox is a self-limiting disease and usually resolves within 2–4 weeks. With a viral incubation period of anywhere between 5 and 21 days, there is variation in the time point at which an individual may experience symptoms. Most cases were mild and self-limited, and there were no mortalities. Although 13% of the persons were admitted to a hospital, no serious complications were reported in the majority of those

admitted [7]. In the early stages, there is nothing notable about a monkeypox infection, as it is easily comparable to many other common infections, such as the flu. Patients may experience fever, headache, muscle aches, and swollen lymph nodes, among other symptoms. (CDC, <https://www.cdc.gov/poxvirus/monkeypox/symptoms.html>). After a few days, a rash begins to form, which may form on the face and then spreads to other areas of the body, including the palms and soles. Rash lesions progress through a well-described set of stages, beginning with macules (flat lesions), progressing to pustules (raised lesions filled with yellowish fluid), and ending with scabs that eventually fall off. These symptoms mirror those of chicken pox, although less severe, and most people recover without problems. The fatality rate ranges from 1 to 10%, and a monkeypox infection can become serious and life-threatening. Infection severity depends on a variety of factors, including the infecting viral strain, access to medical care, extent of exposure, and health statuses of the individual infected. Like all other

viruses, MPXV can also be detected by polymerase chain reaction (real-time PCR, or qPCR) analysis and testing with enzyme-linked immunosorbent assay (ELISA) (performed at Laboratory Response Network (LRN) laboratories in the U.S. and globally) of material from skin lesions.

As with all infectious diseases, the key to preventing monkeypox is to limit the chances of contracting the pathogen. CDC advises people to avoid contact with animals, dead or alive, that may harbor the virus, particularly in areas where monkeypox is already a known concern. Educating people about the proper handling of potentially infected animals, such as in regions where the bush meat trade is prevalent, can also limit exposure. Conforming to routine good-hygiene practices (e.g., hand-washing) after touching an infected/potentially infected person or animal is an effective mitigation strategy. Isolating infected individuals, as is being done for confirmed cases in the current outbreak, is also essential to halting the spread.

In addition to the behavioral practices outlined above, vaccines are valuable tools for preventing and reducing the severity of viral infections. According to the WHO, the smallpox vaccine is 85% effective in preventing monkeypox. This is because the MPXV originated from the Ortho-poxvirus genus in the Poxviridae family, which also includes the viruses that cause smallpox and cowpox (CDC, <https://www.cdc.gov/poxvirus/monkeypox/about.html>). Routine smallpox vaccination is no longer performed as it ended in the aftermath of the successful eradication of smallpox. The U.S. Food and Drug Administration (FDA) has now approved a live-attenuated vaccine, trademarked as JYNNEOS, which protects against infection of smallpox and monkeypox in adults 18 years of age or older [8,9].

There is no specific treatment for monkeypox. Treatment regimens often center on deviating all symptoms and ensuring patients are as comfortable as possible. Nevertheless, several antivirals may be beneficial for monkeypox, and the CDC authorizes for controlling a monkeypox outbreak. One treatment, called tecovirimat (TPOXXTM), has been approved to treat smallpox in the U.S., Canada, and Europe. It functions by interfering with a viral protein (p37) necessary for production of mature, enveloped virions. As of May 19, 2022, TPOXXTM is approved for both oral and intravenous administration, thus expanding its potential utility [8]. Apart from the antivirals against monkeypox, international support for increased surveillance and detection of monkeypox cases are essential tools for understanding the continuously changing epidemiology of this resurging monkeypox disease [10].

Ethical approval

This article does not require any human/animal subjects to acquire such approval.

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CRediT authors contribution statement

Amit Sharma: Conceptualization, Data Curation, Writing - Original Draft, Writing - review & editing. **Priyanka:** Conceptualization, Data Curation, Writing - Original Draft, Writing - review & editing. **Mathumalar Loganathan Fahrni:** Conceptualization, Writing - Original Draft, Writing - review & editing. **Om Prakash Choudhary:** Conceptualization, Supervision, Writing - Original Draft, Writing - review & editing. All authors critically reviewed and approved the final version of the manuscript.

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References

- [1] M. Dhawan, Priyanka, O.P. Choudhary, Emergence of monkeypox: risk assessment and containment measures, *Trav. Med. Infect. Dis.* 49 (2022), 102392, <https://doi.org/10.1016/j.tmaid.2022.102392>.
- [2] M.L. Fahrni, Priyanka, A. Sharma, O.P. Choudhary, Monkeypox: prioritizing public health through early intervention and treatment, *Int. J. Surg.* 104 (2022), 106774, <https://doi.org/10.1016/j.ijisu.2022.106774>.
- [3] Petersen BW, Damon IK. Smallpox, monkeypox and other poxvirus infections". In Goldman, Lee; Schafer, Andrew I. (eds.). *Goldman-Cecil Medicine*. Vol. 26 (26th ed.). Philadelphia: Elsevier. pp. 2180-2183. ISBN 978-0-323-53266-2.
- [4] J.P. Thornhill, S. Barkati, S. Walmsley, J. Rockstroh, A. Antinori, L.B. Harrison, R. Palich, A. Nori, I. Reeves, M.S. Habibi, V. Apea, C. Boesecke, L. Vandekerckhove, M. Yakubovskiy, E. Sendagorta, J.L. Blanco, E. Florence, D. Moschese, F.M. Maltez, A. Goorhuis, V. Pourcher, P. Migaud, S. Noe, C. Pintado, F. Maggi, A.B.E. Hansen, C. Hoffmann, J.I. Lezama, C. Mussini, A.M. Cattelan, K. Makofane, D. Tan, S. Nozza, J. Nemeth, M.B. Klein, C.M. Orkin, Monkeypox virus infection in humans across 16 countries- April-June 2022, *N. Engl. J. Med.* (2022), <https://doi.org/10.1056/NEJMoa2207323>.
- [5] A.A.S. Saied, Priyanka, A.A. Metwally, O.P. Choudhary, Monkeypox: an extra burden on global health, *Int. J. Surg.* 104 (2022), 106745, <https://doi.org/10.1016/j.ijisu.2022.106745>.
- [6] A.T. Fleischauer, J.C. Kile, M. Davidson, M. Fischer, K.L. Karem, R. Teclaw, H. Hans Messersmith, P. Pontones, B.A. Beard, Z.H. Braden, J. Cono, J.J. Sejvar, A.S. Khan, I. Damon, M.J. Kuehnert, Evaluation of human-to-human transmission of monkeypox from infected patients to health care workers, *Clin. Infect. Dis.* 40 (5) (2005) 689-694, <https://doi.org/10.1086/427805>.
- [7] N. Erez, H. Achdout, E. Milrot, Y. Schwartz, Y. Wiener-Well, N. Paran, B. Politi, H. Tamir, T. Israely, S. Weiss, A. Beth-Din, O. Shifman, O. Israeli, S. Yitzhaki, S. C. Shapira, S. Melamed, E. Schwartz, Diagnosis of imported monkeypox, *Israel, 2018, Emerg. Infect. Dis.* 25 (2019) 980-983, <https://doi.org/10.3201/eid2505.190076>.
- [8] S. Sreenivas, Monkeypox: what to know. <https://www.webmd.com/a-to-z-guides/monkeypox-what-know>, 2022.
- [9] E. Petersen, A. Kantele, M. Koopmans, D. Asogun, A. Yinka-Ogunleye, C. Ihekweazu, A. Zumla, Human monkeypox: epidemiologic and clinical characteristics, diagnosis, and prevention, *Infect. Dis. Clin.* 33 (4) (2019) 1027-1043, <https://doi.org/10.1016/j.idc.2019.03.001>.
- [10] E.M. Bunge, B. Hoet, L. Chen, F. Lienert, H. Weidenthaler, L.R. Baer, R. Steffen, The changing epidemiology of human monkeypox-a potential threat? A systematic review, *PLoS Neglected Trop. Dis.* 16 (2) (2022), <https://doi.org/10.1371/journal.pntd.0010141> e0010141-e0010141.

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