

# Mpox in the Modern Era: Epidemiological Trends, Public Health Challenges, and Global Response Strategies – A narrative review

Bindu Dhanapal<sup>1\*</sup>, Saramma Mini Jacob<sup>2</sup> and Palaniyandi Velusamy<sup>3</sup>

<sup>1</sup>Department of Microbiology, Sree Balaji Medical College and Hospital, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>2</sup>Department of Research and Development, Sree Balaji Medical College and Hospital, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

<sup>3</sup>Department of Research and Development, Sree Balaji Medical College and Hospital, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

\*Corresponding author Email: mail2bindhu@rediffmail.com

<https://dx.doi.org/10.13005/bpj/3425>

(Received: 17 June 2025; accepted: 16 February 2026)

Mpox, previously known as monkeypox, is a zoonotic viral disease historically restricted to Central and West Africa but has recently drawn global attention due to its spread into non-endemic regions, including India. Of the two major clades, Clade I is associated with more severe disease, higher transmissibility and higher fatality than Clade II. The 2022 outbreak showed a distinct epidemiological shift with most cases affecting homosexual men, many of whom had concurrent HIV or other sexually transmitted infections, whereas past outbreaks primarily involved children. This outbreak was also characterized by a shorter incubation period and a higher frequency of genital and perianal lesions. Across all outbreaks, common clinical features include fever, headache, myalgia, lymphadenopathy, and vesiculopustular skin lesions. Diagnosis is confirmed using PCR, and antivirals such as Tecovirimat may be used in severe cases. Three vaccines—ACAM2000, MVA-BN, and LC16—are currently approved in various jurisdictions for prevention and post-exposure prophylaxis in high-risk groups. The evolving epidemiology emphasises the need for robust surveillance, early case detection, effective clinical management, ongoing research, and coordinated global public health action. Policymakers and researchers increasingly endorse a One Health approach to strengthen prevention and control strategies for Mpox.

**Keywords:** Clade, Mpox, One Health, Orthopoxvirus, Tecovirimat.

Mpox, previously called Monkeypox was first identified in 1958 in monkeys, and the first human case was reported in 1970 in the Democratic Republic of the Congo (DRC). Initially, it was considered a zoonotic virus primarily confined to Central and West Africa. It has recently gained attention due to its global spread outside endemic regions.<sup>1</sup> The World Health Organization (WHO) endorsed the name change from monkeypox to

Mpox to reduce stigma.<sup>2</sup> Mpox is a zoonotic disease caused by the monkeypox virus (MPXV), which belongs to the *Orthopoxvirus* family.<sup>1</sup>

The recent increase in Mpox cases in non-endemic locations has raised significant public health issues, and a thorough study is needed to guide worldwide response plans. In 2022, the World Health Organization declared it a Public Health Emergency of International Concern

(PHEIC) after unprecedented outbreaks were recorded in several non-African nations. A new outbreak in the Democratic Republic of Congo in 2024 revealed a novel Clade I sub-lineage of the virus, which may evade detection by commonly used PCR tests.<sup>3</sup> This ongoing situation highlighted the need for continued surveillance, research, and a coordinated global response to contain the spread of Mpox. Recently, again WHO declared it a PHEIC on August 14<sup>th</sup>, 2024, where clade I had spread to 15 countries. It is therefore necessary to update the current knowledge in epidemiology, diagnosis, clinical management, and public health responses while identifying critical research gaps that require further analysis to enhance global preparedness and response efforts.

## MATERIALS AND METHODS

This narrative review was conducted by a comprehensive web-based literature search using PubMed, Google Scholar, Medline, and Scopus. Original research articles, case reports, case series, systematic reviews, meta-analyses, and WHO/CDC reports with terms such as “Epidemiology”, “transmission”, “clinical manifestations”, “diagnosis”, “treatment”, “vaccine”, and “tecovirimat” were included and conference abstracts, non-scientific and non-English articles were excluded. Boolean operators such as OR and AND were applied to refine the search. A total of 125 papers published between 2016 and 2024 were screened based on these criteria.

### Epidemiology of Mpox

Mpox has emerged as a global health concern with rapidly changing epidemiology. Mpox has expanded globally, with the 2022-2023 outbreak marking the first sustained transmission outside Africa.<sup>4</sup> The virus is genetically structured into two major clades (clades 1 and 2/3) that diverged from 560-860 years ago, possibly due to ecological changes in West and Central Africa.<sup>4</sup> While previously zoonotic, human-to-human transmission now dominates in 110 countries, particularly in regions of Europe and North America.<sup>5</sup> Phylogenetic analysis of 175 MPXV genomes from 38 countries revealed that the global outbreak was caused by multiple sub-clades within the clade IIb lineage, suggesting a single infection source.<sup>5</sup> However, a growing outbreak of clade I

in the Democratic Republic of Congo indicated the potential for sexual transmission and global spread.<sup>4</sup> Clade I is considered to cause more severe symptoms and is more contagious.<sup>5</sup>

The first worldwide epidemic spread occurred in 2022, predominantly affecting men aged 30-40, particularly homosexual men.<sup>6</sup> The reemergence of the disease is associated with environmental changes, population movements, and cessation of smallpox vaccination.<sup>1</sup> As per WHO, over 120 countries have reported Mpox between Jan 2022 to Aug 2024, with over 100,000 laboratory-confirmed cases reported and over 220 deaths among confirmed cases. The changing epidemiology of Mpox, including its geographic expansion and novel transmission routes, underscores the need for strengthened outbreak response systems and further research into its pathophysiology and transmission dynamics.<sup>6</sup>

### Transmission Dynamics

Monkeypox virus (MPXV) has the potential for animal-to-human transmission and spillover events. While African rodents (Gambian giant rats) and squirrels are considered possible reservoirs, many mammalian species can be infected.<sup>7</sup> The virus's ability to infect various animals raises concerns about its maintenance in natural reservoirs and potential spillback into new animal populations.<sup>7</sup> Transmission from animals to humans can occur through close contact with infected animals, contaminated bushmeat, and exposure to body fluids.<sup>7</sup> Recent outbreaks underscore the need to better understand MPXV ecology, reservoir dynamics and the conservation impacts on wildlife.<sup>7</sup> Animal model research continues to provide insight into MPXV pathogenesis, virulence factors, and transmission, guiding vaccine development and preventive strategies.

Mpox spreads from animals to humans and between humans through direct contact, respiratory droplets, and fomites.<sup>1</sup> The 2022 outbreak demonstrated high transmissibility among men who have sex with men (MSM), with sexual contact being the predominant mode of spread, particularly among individuals living with HIV.<sup>8</sup> Risk factors for mortality include younger age, co-infections, and chronic infections.<sup>8</sup> The virus can persist on surfaces for up to 15 days and remain viable in bodily fluids for prolonged periods.<sup>8</sup>

**Table 1.** Diagnostic Tests for Mpox

| S. No | Method                                              | Application                                                                      | Advantages                                                 | Disadvantages                                                                      | References |
|-------|-----------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------------|------------|
| 1     | Real-time PCR (qPCR)                                | Detects MPXV DNA. Gold-standard.                                                 | High sensitivity and specificity; rapid turnaround         | Requires laboratory infrastructure; limited availability in resource-poor settings | 18, 19     |
| 2     | Whole Genome Sequencing (WGS)                       | Sequencing of the full MPXV genome to track variants and evolution               | Identifies new clades/lineages; essential for surveillance | Expensive, time-consuming; requires advanced facilities                            | 18         |
| 3     | Electron Microscopy (EM)                            | Visualization of <i>Orthopoxvirus</i> particles                                  | Rapid identification of poxvirus morphology                | Low specificity; cannot distinguish MPXV from other Orthopoxviruses                | 18         |
| 4     | Virus Isolation / Cell Culture                      | Growth of live virus in cell lines                                               | Confirms viable virus; useful for research                 | Slow; requires high-containment BSL-3 labs; not for routine diagnosis              | 18         |
| 5     | Serological Tests (ELISA)                           | Detects IgM and IgG antibodies against MPXV                                      | Useful for surveillance and late-stage infection           | Cross-reactivity with other Orthopoxviruses; not useful for early detection        | 19         |
| 6     | Rapid Point-of-Care Tests (ABICAP immunofiltration) | Antibody-based immunofiltration assay detecting viral antigens                   | Results in ~45 minutes; portable                           | Requires further validation; moderate sensitivity                                  | 20         |
| 7     | Isothermal Amplification (RPA/RAA) + CRISPR-Cas12a  | Nucleic acid amplification without thermal cycling coupled with CRISPR detection | Fast (20–30 min); sensitive; suitable for field settings   | Limited availability, needs optimization for large-scale use                       | 21         |

Population vulnerabilities are amplified by waning immunity following the cessation of smallpox vaccination and increased globalization.<sup>6</sup>

The incidence of Mpox infection has risen steadily since the 1970s, accompanied by a shift from animal-to-human transmission to predominantly human-to-human transmission, especially through sexual contact.<sup>9</sup> The median age of patients has increased from 4 to 21 years, with recent cases occurring among young adults.<sup>9</sup> Urban areas have consistently reported a higher incidence than rural areas.<sup>10</sup> Gender disparities have been observed, with a higher incidence in males, except for the 20-29 age group, where females show higher rates.<sup>11</sup> Racial disparities are also evident, with a higher incidence among Black and Hispanic populations in both urban and rural areas.<sup>10</sup> These evolving epidemiological patterns are thought to be driven, in part, by declining population immunity following the end of routine smallpox vaccination.<sup>9,11</sup>

### **Clinical Manifestations and Complications**

The clinical presentation of Mpox has evolved considerably, with the 2022 global outbreak showing distinct features compared with the classical disease. Traditionally, Mpox presents with fever, lethargy, lymphadenopathy, and vesiculopustular rash.<sup>12</sup> However, recent outbreaks have demonstrated a predominance of anogenital and mucosal lesions, anorectal pain, and proctitis,<sup>12</sup> particularly among MSM, many of whom also had concurrent sexually transmitted infections.<sup>6</sup> A shorter incubation period has also been observed.<sup>8</sup> Dermoscopic signs as the “rising sun” pattern, may assist diagnosis. Disease severity varies by viral Clade, and host factors, with advanced HIV infection, young children, and pregnant women at higher risk for severe disease.

Atypical presentations included neurological, dermatological, and respiratory symptoms, complicating diagnosis and management.<sup>13</sup> Emerging evidence suggests additional transmission pathways, including airborne droplets and feco-oral routes, with cases reported in healthcare facilities and following consumption of contaminated meat.<sup>14</sup> Individuals with HIV, particularly MSM, and children under 8 years, are more susceptible to complicated disease courses.<sup>14</sup>

HIV co-infection is a significant risk

factor, with HIV-positive individuals more likely to contract Mpox and face higher mortality rates.<sup>15</sup> Advanced HIV disease, characterized by CD4+ cell count less than 100 cells/ $\mu$ l, absence of antiretroviral therapy, and extensive skin lesions (macules, papules, vesicles, pustules, ulceronecrotic lesions) are strongly associated with increased mortality.<sup>15</sup> The disease can affect multiple physiological systems, including cardiovascular, gastrointestinal, and ocular.<sup>16</sup> Severe complications such as encephalitis and septicemia have also been reported.<sup>17</sup> While the overall mortality rate ranges from 0% to 23%, rates remain highest among infants, children, pregnant women, and severely immunocompromised individuals.<sup>17</sup> Prompt recognition of complications is crucial for reducing morbidity and mortality.<sup>16</sup>

### **Diagnosis of Mpox**

Laboratory diagnosis of Mpox relies primarily on real-time PCR as the gold standard for detecting the MPXV genome.<sup>18</sup> Proper specimen collection, including swabbing lesions from multiple sites, and timing is essential for accurate diagnosis.<sup>19</sup> Whole genome sequencing is crucial for identifying new variants and understanding virus evolution.<sup>18</sup> PCR remains the primary diagnostic tool, while diagnostic methods such as electron microscopy, virus isolation, and serological tests are valuable for comprehensive virus characterization and epidemiological studies.<sup>18</sup> (Table 1) Rapid methods like Antibody Immuno Column for Analytical Processes (ABICAP) immunofiltration assay,<sup>20</sup> and Recombinase-based Isothermal Amplification Assays (RPA/RAA) with CRISPR-Cas12a mediated assay<sup>21</sup> (Table 1) are developed to provide quick, precise and easy detection of MPXV, demonstrating their potential for outbreak and prevention control.

### **Research on Mpox Emerging Virology**

Advances in genomics have enhanced our understanding of viral evolution and adaptation. MPXV, exhibits clade-specific differences in virulence and transmission.<sup>22</sup> The virus's evolution involves recombination, gene loss, and gain.<sup>23</sup> Analyses of MPXV genomes revealed core and variable regions, with the latter being more susceptible to mutations, gene loss/gain, and recombination.<sup>23</sup> The 2022 outbreak lineage (B.1) has shown rapid diversification from the ancestral lineage (A.1), and has unique mutations in genes

that are indicative of viral adaptation, perhaps by genome editing by APOBEC3A.<sup>22</sup> Comparative genomic analysis across different clades found only a small percentage of conserved proteins, suggesting potential correlations between lineage/clade and variations in virulence and disease pathology.<sup>24</sup> These studies highlight the importance of ongoing genomic surveillance in understanding MPXV's evolutionary trajectory and its impact on public health.

Guan *et al.* (2023) estimated an evolutionary rate of  $7.75 \times 10^{-5}$  substitutions/site/year for MPXV and identified amino acids under positive selection in key proteins. And suggested that the virus's ability to evade host immune responses is partly due to its interferon-binding protein.<sup>24</sup> Delamonica *et al.* investigated the role of human APOBEC3 enzymes in MPXV evolution, finding that the virus genome shows an over-representation of TC hotspots and an under-representation of GC hotspots.<sup>25</sup> This suggests MPXV may have evolved in a host with specific APOBEC preferences and has the potential for rapid evolution in human populations. The researchers also noted that inverted terminal repeat regions and longer genes in MPXV will likely evolve faster. These findings have implications for vaccine development and underscore the urgency of containing MPXV transmission. The Mpox virus has circulated in humans since at least 2016, as evidenced by APOBEC3-induced mutations indicating human transmission.

### **Treatment Options**

At present, there is no specific treatment available for Mpox except for supportive care for pain, fever, skin care, and general antiviral medications. However, recent research on antiviral therapies for Mpox has focused on three main drugs: tecovirimat, cidofovir, and brincidofovir. Tecovirimat inhibits the VP37 envelope-wrapping protein, preventing virus formation.<sup>26</sup> Cidofovir and Brincidofovir interfere with DNA synthesis through DNA polymerase inhibition.<sup>26</sup> While no FDA-approved treatment exists, tecovirimat is considered the first-line therapy due to its efficacy and safety profile.<sup>27</sup> Research is ongoing to verify the efficacy and applicability of these antivirals, particularly in vulnerable populations such as HIV-positive individuals.<sup>26</sup> Further studies are needed to address safety concerns and improve treatment

recommendations for immunocompromised patients.<sup>26, 27</sup>

### **Current Vaccines**

The recent Mpox outbreak has prompted global efforts to control its spread, with vaccination playing a crucial role. The third generation live vaccine containing the modified vaccinia Ankara strain (MVA), known commercially as JYNNEOS® (developed by Bavarian Nordic), has shown high effectiveness against Mpox.<sup>28</sup> Other approved vaccines are ACAM2000 developed by Pasteur Biologics Company, and LC-16.<sup>29</sup> These vaccines are available for prevention and post-exposure prophylaxis in high-risk populations. However, challenges remain in vaccine availability, production, and distribution, particularly in Mpox-endemic countries in Africa.<sup>28</sup> The discontinuation of routine smallpox vaccination since the 1980s has led to decreased immunity in previously vaccinated populations.<sup>30</sup> While vaccination is an effective preventive measure, there is a need for the development of safer and more effective Mpox-specific vaccines to address safety concerns and limitations of current options.<sup>30</sup>

### **Public Health Campaigns**

The 2022-2023 Mpox outbreak primarily prompted public health responses worldwide. Education campaigns and vaccination efforts were key to controlling the spread.<sup>31</sup> Local public health units played a crucial role in tailoring responses to community needs, including capacity building, contact tracing, and vaccine delivery.<sup>32</sup> While most affected gay, bisexual, and MSM were well-informed and willing to adhere to public health measures, barriers existed for those marginalized from their networks.<sup>31</sup> Despite these efforts, racial disparities in vaccination rates were observed, highlighting the need to address hidden biases in healthcare access.

### **Global Response and Policy Implications**

The outbreak in 2022-2023 highlighted the importance of international cooperation and rapid response frameworks. The WHO declared it PHEIC, prompting coordinated efforts worldwide.<sup>33</sup> Key strategies included enhancing surveillance systems, improving diagnostic capabilities, and implementing effective control measures.<sup>33</sup> The outbreak also revealed challenges in public health preparedness, including the need for robust diagnostics, clinical management plans,

and addressing stigma against vulnerable groups. Despite these challenges, the global response demonstrated the value of preparedness efforts, as existing smallpox vaccines and therapeutics were repurposed for Mpox.<sup>34</sup> This coordinated international response provided valuable lessons for future outbreak management. Other key policies include prioritizing treatment, vaccination, and post-exposure prophylaxis for gay, bisexual, and MSM, who are disproportionately affected.<sup>35</sup> Destigmatization efforts and community-based consultation are crucial for effective prevention.<sup>35</sup> Awareness programs should be conducted for healthcare workers for proper treatment, management, and implementation of strict infection control measures. The possibility of reverse zoonosis necessitates screening both humans and animals, emphasizing a One Health approach.<sup>35</sup> Early recognition, management, and preventive vaccination are critical for controlling the spread of Mpox.

The 2022 Mpox outbreak highlighted the importance of cross-border collaboration and information sharing. The implementation of Mpox surveillance revealed the importance of clear communication, standardized terminology, and adaptable informatics platforms. Improvements in laboratory reporting completeness and timeliness were identified as crucial for effective public health responses. These experiences underscore the need for standardized, flexible surveillance approaches and closer collaboration among partners across jurisdictions and agencies.

#### **Gaps in Current Knowledge**

Misconceptions about Mpox vaccines, treatments, and transmission were prevalent among healthcare professionals.<sup>36</sup> Strategies to address vaccine hesitancy and improve uptake included tailored outreach campaigns, partnerships with community organizations, and improving vaccine accessibility.<sup>37</sup> The Health Belief Model identified cues to action and perceived susceptibility as key factors in predicting Mpox vaccine acceptance.<sup>36</sup>

Key areas of uncertainty include the true disease burden in endemic regions, the diversity of animal reservoirs, and transmission dynamics.<sup>38</sup> There is a need for better biosafety evidence, particularly regarding viral spread, infectious dose, and decontamination strategies.<sup>39</sup>

AI-based systems like EPIWATCH can scan open-source data to detect early signals of rash and fever illnesses, potentially indicating Mpox cases.<sup>40</sup> Knowledge gaps exist in understanding the pathogenicity and virulence of Mpox at the human-animal-ecology interface. Addressing these gaps requires international collaboration and a One Health approach, integrating human, animal, and environmental health to improve prevention and control strategies.<sup>38</sup> A One Health approach is proposed as an effective strategy for preventing current and future epidemics.

This narrative review has limitations. The search was restricted to English-language, which may have excluded relevant evidence from Mpox-endemic regions. As a narrative rather than systematic review, no formal quality appraisal of included studies was undertaken, and heterogeneity across study designs limits comparability. Given the rapidly evolving nature of Mpox epidemiology, diagnostics, and viral genomics, recent data may not be reflected. In addition, underreporting and limited surveillance capacity in endemic settings may affect the completeness and generalizability of the findings.

#### **CONCLUSION**

The 2022-2024 global outbreaks demonstrated the potential for Mpox to become endemic outside its original geographical area. The surge of Mpox in Africa, particularly the Clade I outbreak in the Democratic Republic of Congo, raises concerns about novel transmission routes and geographic expansion. Researchers emphasized the importance of addressing poverty-related factors and implementing a One Health approach to combat Mpox and other emerging epidemics. Closing the knowledge gaps and improving preparedness efforts for this previously neglected disease are crucial for effective threat reduction. Recommendations for future emerging infectious disease surveillance include standardized approaches, clear communication, and improved collaboration among informatics, laboratory, and clinical partners to enhance system flexibility and reporting timeliness. These efforts are essential for early detection and effective control of Mpox outbreaks.

## ACKNOWLEDGMENT

The authors wish to thank the authorities of Sree Balaji Medical College and Hospital for their support.

### Funding sources

The author(s) received no financial support for the research, authorship, and/or publication of this article

### Conflict of Interest

The author(s) do not have any conflict of interest

### Data availability

This statement does not apply to this article.

### Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval

### Informed consent statement

This study did not involve human participants, and therefore, informed consent was not required

### Clinical Trial Registration

This research does not involve any clinical trial

### Permission to reproduce material from other sources

Not applicable.

### Author contributions

Bindu D: Conceptualization, Methodology, Writing – Original Draft; Saramma Mini Jacob: Data Collection, Analysis, Writing – Review & Editing; Palaniyandi Velusamy: Visualization, Supervision.

## REFERENCES

1. Martini M, Behzadifar M, Bragazzi NL, Orsini D. Pox (Pox), a term for various infectious diseases in the history of public health and epidemiology: the dreaded Smallpox, the almost unknown Alastrim and the Mpox. *J. prev. med. Hyg.* 2023, 64, E209- E214. <https://doi.org/10.15167/2421-4248/jpmh2023.64.2.3011>.
2. Ulaeto D, Agafonov A, Burchfield J, et al. New nomenclature for Mpox (monkeypox) and monkeypox virus clades. *Lancet Infect Dis.* 2023, 23, 273 - 275. [https://doi.org/10.1016/S1473-3099\(23\)00055-5](https://doi.org/10.1016/S1473-3099(23)00055-5).
3. Masirika LM, Udahemuka JC, Schuele L, et al. Ongoing Mpox outbreak in Kamituga, South Kivu province, associated with monkeypox virus of a novel Clade I sub-lineage, Democratic Republic of the Congo. *Euro Surveill.* 2024, 29(11), 2400106. <https://doi.org/10.2807/1560-7917.ES.2024.29.11.2400106>.
4. Nachega JB, Sam-Agudu NA, Ogoina D, et al. The surge of Mpox in Africa: a call for action. *Lancet Glob Health* 2024, 12(7), e1086-e1088. [https://doi.org/10.1016/S2214-109X\(24\)00187-6](https://doi.org/10.1016/S2214-109X(24)00187-6).
5. Gao L, Shi Q, Dong X, Wang M, Liu Z and Li Z. Mpox, Caused by the MPXV of the Clade IIb Lineage, Goes Global. *Trop. Med. Infect. Dis.* 2023, 8, 76. <https://doi.org/10.3390/tropicalmed8020076>.
6. Dijck CV, Hoff NA, Mbala-Kingebeni P, et al. Emergence of Mpox in the post-smallpox era-a narrative review on Mpox epidemiology. *Clin Microbiol Infect.* 2023, 29(12), 1487-1492. <https://doi.org/10.1016/j.cmi.2023.08.008>.
7. Falendysz EA, Lopera JG, Rocke TE, Osorio JE. Monkeypox Virus in Animals: Current Knowledge of Viral Transmission and Pathogenesis in Wild Animal Reservoirs and Captive Animal Models. *Viruses* 2023,15(4), 905. <https://doi.org/10.3390/v15040905>.
8. Pan D, Nazareth J, Sze S, et al. Transmission of monkeypox/Mpox virus: A narrative review of environmental, viral, host, and population factors in relation to the 2022 international outbreak. *J Med Virol.* 2023, 95(2), e28534. <https://doi.org/10.1002/jmv.28534>.
9. Bunge EM, Hoet B, Chen L, et al. The changing epidemiology of human monkeypox-A potential threat? A systematic review. *PLoS Negl Trop Dis.* 2022, 16(2), e0010141. <https://doi.org/10.1371/journal.pntd.0010141>.
10. Zelaya CE, Smith BP, Riser AP, et al. Urban and Rural Mpox Incidence Among Persons Aged 15–64 Years — United States, May 10–December 31, 2022. *MMWR Morb Mortal Wkly Rep.* 2023, 72, 574-578. <https://doi.org/10.15585/mmwr.mm7221a2>.
11. Whitehouse ER, Bonwitt J, Hughes CM, et al. Clinical and Epidemiologic Findings from Enhanced Monkeypox Surveillance in Tshuapa Province, Democratic Republic of the Congo During 2011–2015. *J Infect Dis.* 2021, 223(11), 1870-1878. <https://doi.org/10.1093/infdis/jiab133>.
12. Thornhill JP, Gandhi M, Orkin C. Mpox: The Reemergence of an Old Disease and Inequities. *Annu Rev Med.* 2024, 75, 159-175. <https://doi.org/10.1146/annurev-med-080122-030714>.
13. Sokunbi AE, Adeyemi O. Exploring atypical manifestations of Mpox: Anarrative review. *Res*

- J Health Sci.* 2024, 12(1), 71-81. <http://dx.doi.org/10.4314/rejhs-0001-6010-3034.v12i1.9>
14. Sydorhuk A, Horbachova O. Emergent infection: atypical clinical cases of monkeypox (updated review). *The Journal of V. N. Karazin Kharkiv National University* 2023, 46, 101-110. <https://doi.org/10.26565/2313-6693-2023-46-11>
15. Triana-González S, Roman-Lopez C, Mauss S, et al. Risk factors for mortality and clinical presentation of monkeypox. *AIDS* 2023, 37(13), 1979-1985. <https://doi.org/10.1097/QAD.0000000000003623>
16. Ajmera K, Shah H, Chourasia P, Chitturi S. Current Evidence and Practice Guidelines of Systemic Complications of 2022 Mpox Outbreak: A Scoping Review. *Cureus* 2023, 15(9), e45754. <https://doi.org/10.7759/cureus.45754>
17. Seyed AS, Afsahi A, Afzalian A, et al. A Systematic Review of Epidemiology, Pathogenesis, Manifestations, And Outcomes. *Russ. J. Infect. Immun.* 2023, 13, 1169-118. <https://doi.org/10.15789/2220-7619-MAS-15632>
18. Rus KR, Zakotnik S, Sagadin M, et al. Review of virological methods for laboratory diagnosis and characterization of monkeypox virus (MPXV): lessons learned from the 2022 Mpox outbreak. *Acta Dermatovenereol Alp Pannonica Adriat.* 2024, 33(1), 23-35.
19. Jain N, Umar TP, Sayad R, et al. Monkeypox Diagnosis in Clinical Settings: A Comprehensive Review of Best Laboratory Practices. *Adv Exp Med Biol.* 2024, 1451, 253-271. [https://doi.org/doi:10.1007/978-3-031-57165-7\\_16](https://doi.org/doi:10.1007/978-3-031-57165-7_16)
20. Stern D, Olson VA, Smith SK, et al. Rapid and sensitive point-of-care detection of Orthopoxviruses by ABICAP immunofiltration. *Virol J.* 2016, 13, 207. <https://doi.org/10.1186/s12985-016-0665-5>
21. Mao L, Ying J, Selekon B, et al. Development and Characterization of Recombinase-Based Isothermal Amplification Assays (RPA/RAA) for the Rapid Detection of Monkeypox Virus. *Viruses* 2022, 14(10), 2112. <https://doi.org/10.3390/v14102112>
22. Lim CK, Roberts J, Moso M, et al. Mpox diagnostics: Review of current and emerging technologies. *J Med Virol.* 2023, 95(1), e28429. <https://doi.org/10.1002/jmv.28429>
23. Yu Z, Zou X, Deng Z, et al. Genome analysis of the Mpox (formerly monkeypox) virus and characterization of core/variable. *Genomics* 2023, 116(1), 110763. <https://doi.org/10.1016/j.ygeno.2023.110763>
24. Guan H, Gul I, Xiao C, et al. Emergence, phylogeography, and adaptive evolution of Mpox virus. *New Microbes New Infect.* 2023, 52, 101102. <https://doi.org/10.1016/j.nmni.2023.101102>
25. Delamonica B, Davalos L, Larijani M, Anthony SJ, Liu J, MacCarthy T. Evolutionary potential of the monkeypox genome arising from interactions with human APOBEC3 enzymes. *Virus Evol.* 2023, 06(27), 546779. <https://doi.org/10.1093/ve/vead047>
26. Ivanov DT, Slabakova YA, Argirova RM, Valkov TK. Antivirals for the treatment of Monkeypox: utilization in the general and HIV-positive population and gaps for research. A short narrative review. *Infez Med.* 2023, 31(2), 186-194. <https://doi.org/10.53854/liim-3102-6>
27. Pourkarim F, Entezari-Maleki T. Clinical considerations on monkeypox antiviral medications: An overview. *Pharmacol Res Perspect* 2024, 12(1), e01164. <https://doi.org/10.1002/prp2.1164>
28. Titanji BK, Marconi VC. Vaxxing to elimination: smallpox vaccines as tools to fight Mpox. *J Clin Invest.* 2023, 133(2), e167632. <https://doi.org/10.1172/JCI167632>
29. Rana J, Patel SK, Agrawal A, et al. Mpox vaccination in global perspective: priorities and challenges. *Ann Med Surg (Lond).* 2023, 85, 2243-2246. <https://doi.org/10.1097/MS9.0000000000000550>
30. Wang X, Gu Z, Sheng S, Song R, Jin R. The Current State and Progress of Mpox Vaccine Research. *China CDC Wkly* 2024, 6(7), 118-125. <https://doi.org/10.46234/ccdcw2024.025>
31. May T, Towler L, Smith LE, et al. Mpox knowledge, behaviours and barriers to public health measures among gay, bisexual and other men who have sex with men in the UK: a qualitative study to inform public health guidance and messaging. *BMC Public Health* 2023, 23(1), 2265. <https://doi.org/10.1186/s12889-023-17196-0>
32. Crouch S, Jalil E, Pierce AB, Baptista M, Wong E, Stuart R. Mpox Management: A Holistic Local Response to a Global Threat. *J Public Health Manag Pract.* 2024, 30(2), 204-207. <https://doi.org/10.1097/PHH.0000000000001870>
33. McQuiston JH, Braden CR, Bowen MD, et al. The CDC Domestic Mpox Response — United States, 2022–2023. *MMWR Morb Mortal Wkly Rep.* 2023, 72, 547-552. <https://doi.org/10.15585/mmwr.mm7220a2>
34. Goldstein RH. Never Let a Good Outbreak Go to Waste. *NEJM Evid.* 2024, 33, EVIDE2300357. <https://doi.org/10.1016/j.chest.2020.10.018>
35. Manirambona E, Khan SH, Siddiq A, et al. Intriguing insight into unanswered questions



- about Mpox: exploring health policy implications and considerations. *Health Res Policy Sys.* 2024, 22(1), 37. [https://doi.org/ 10.1186/s12961-024-01123-9](https://doi.org/10.1186/s12961-024-01123-9)
36. Riad A, Drobov A, Rozmarinova J, et al. Monkeypox Knowledge and Vaccine Hesitancy of Czech Healthcare Workers: A Health Belief Model (HBM)-Based Study. *Vaccines* 2022, 10(12), 2022. [https://doi.org/ 10.3390/vaccines10122022](https://doi.org/10.3390/vaccines10122022).
37. Agroia H, Smith E, Vaidya A, Rudman S, Roy M. Monkeypox (Mpox) Vaccine Hesitancy Among Mpox Cases: A Qualitative Study. *Health Promot Pract.* 2023, 15, 15248399231215054. [https://doi.org/ 10.1177/15248399231215054](https://doi.org/10.1177/15248399231215054).
38. Haider N, Guitian J, Simons D, et al. Increased outbreaks of monkeypox highlight gaps in actual disease burden in Sub-Saharan Africa and in animal reservoirs. *Int J Infect Dis.* 2022, 122, 107-111. [https://doi.org/ 10.1016/j.ijid.2022.05.058](https://doi.org/10.1016/j.ijid.2022.05.058).
39. Blacksell SD, Dhawan S, Kusumoto M, et al. The Biosafety Research Road Map: The Search for Evidence to Support Practices in the Laboratory—Mpox/Monkeypox Virus. *Appl Biosaf.* 2023, 28, 152-161. [https://doi.org/ 10.1089/apb.2022.0045](https://doi.org/10.1089/apb.2022.0045).
40. Hutchinson D, Kunasekaran M, Quigley A, Moa A, MacIntyre CR. Could it be monkeypox? Use of an AI-based epidemic early warning system to monitor rash and fever illness. *Public Health* 2023, 220, 142-147. [https://doi.org/ 10.1016/j.puhe.2023.05.010](https://doi.org/10.1016/j.puhe.2023.05.010).