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Emergence of Monkeypox in India: A Current Scenario and Future Directions

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Abstract: **The emergence of monkeypox virus (MPXV) in India highlights new public health concern, especially with the COVID-19 pandemic still fresh in mind. With the first case reported in July 2022, largely linked to international travel, India's dense population, high mobility, and urbanization create a conducive environment for potential transmission. Although MPXV was historically confined to Central and West Africa, its spread to non-endemic regions like India underscores the need for heightened vigilance. India's healthcare system, already strained by the pandemic, faces challenges in addressing emerging infections like monkeypox due to gaps in access, diagnostics, and public health infrastructure. However, experience gained during COVID-19 has enhanced rapid diagnostics, public awareness, and vaccine preparedness. While India has effectively contained initial monkeypox cases through isolation and testing protocols, sustained vigilance remains essential. Enhancing diagnostic capacity, expanding public education, and investing in treatment and vaccine research are crucial to preventing future outbreaks. This comprehensive review highlights MPXV's epidemiology, clinical features, transmission dynamics, socio-economic impact, public health responses, while offering recommendations for treatment, vaccine development, and outlining future directions for improved disease control.**

Index Terms: **Monkeypox (Mpox), MPXV, Orthopoxvirus.**

I. Introduction

Monkeypox (Mpox) is a viral zoonosis which is caused by the monkeypox virus which belongs to the Orthopoxvirus genus, which also includes the smallpox virus (Forni et al, 2022). The World Health Organization (WHO) began using the abbreviation "MPXV" for Mpox virus in 2022 as part of a global effort to standardize virus names and avoid potential stigmatization. This updated nomenclature aligns with modern naming conventions and better reflects the virus's broader animal reservoirs and transmission dynamics (Diatta et al, 2023). MPXV has emerged as a significant public health concern in recent years, particularly in non-endemic regions (Farahat et al, 2022). First identified in 1958 in laboratory monkeys, the virus was later found to cause human disease, with the first case reported in the Democratic Republic of Congo in 1970 (Fenollar et al, 2018). The disease mainly occurs in tropical rainforest region of Central and West Africa, where the virus is maintained in a complex cycle involving rodents and other wildlife (Mitja et al, 2023). Recent global outbreaks have shown MPXV's spread beyond its traditional regions, reaching countries in Africa, Europe, the Americas, and Asia, including India (Ilic et al, 2022). Mpox shares some clinical similarities with smallpox, a disease eradicated in 1980, but generally presents with a milder clinical course (Sukhdeo et al, 2022). The disease begins with a prodrome of fever, headache, muscle aches, and lymphadenopathy, followed by the appearance of a characteristic rash (Altindis et al, 2022). Despite the availability of a smallpox vaccine that offers some protection against Mpox, the virus's increasing incidence in previously unaffected regions has raised concerns about its potential for wider dissemination and the need for effective public health interventions (Quarleri et al, 2022).

The re-emergence of Mpox in various parts of the world, including cases linked to international travel, underscores the importance of understanding its epidemiology, transmission dynamics, and clinical features. This knowledge is critical for developing appropriate diagnostic, therapeutic, and preventive measures. This review article aims to provide a comprehensive overview of the (MPXV), focusing on its pathogenesis, epidemiology, clinical manifestations, transmission, diagnosis, treatment, public health response, socio-economic impact, challenges and recommendations with the One Health approach

as a guiding principle to ensure a comprehensive and integrated strategy. By doing so, it seeks to contribute to the growing body of knowledge necessary for the effective management and control of Mpox, particularly in regions where the virus poses an emerging threat.

II. Global Epidemiology

MPXV has historically been endemic to Central and West Africa, with sporadic outbreaks occurring in countries like the Democratic Republic of Congo, Nigeria, and Cameroon (Kabuga and Zowalaty, 2019). In these regions, the virus is maintained in wild animals, particularly rodents, and occasionally transmitted to humans, often through direct contact with infected animals or their body fluids. Since the first human case was identified in 1970, Mpox has primarily affected rural, forested areas where people have close contact with wildlife (Farahat et al, 2022).However, the global epidemiology of Mpox has changed significantly in recent years. Beginning in the 2000s, cases started to appear outside Africa, often linked to international travel or the importation of animals (Bunge et al, 2022). The 2003 outbreak in the United States, traced back to imported Gambian pouched rats, marked the first significant occurrence of Mpox in a non-endemic region (Sun et al, 2023). The most notable shift occurred in 2022 when Mpox cases surged globally, with outbreaks reported in multiple countries across Europe, North America, Asia, and beyond (Gomez, 2022). Unlike previous outbreaks, the 2022 surge involved significant human-to-human transmission, particularly among populations with close physical contact, such as men who have sex with men (MSM) (Pan et al, 2023). This shift in transmission dynamics highlighted the virus's potential to spread in urban settings and underscored the need for robust global surveillance and response strategies (Alakunle et al, 2020).

As of 2024, Mpox remains a significant public health challenge, with cases emerging in both endemic and non-endemic regions. The global response has been robust, including enhanced surveillance systems, extensive public awareness campaigns, and the deployment of vaccines like the smallpox vaccine, which offers cross-protection against Mpox (William, 2023). The WHO has played a pivotal role by issuing guidance, coordinating international efforts, and declaring Mpox a Public Health Emergency of International Concern. Despite these efforts, the ongoing spread of the virus in non-endemic areas underscores the need for continued vigilance and international cooperation in addressing this emerging threat (Figure-1).

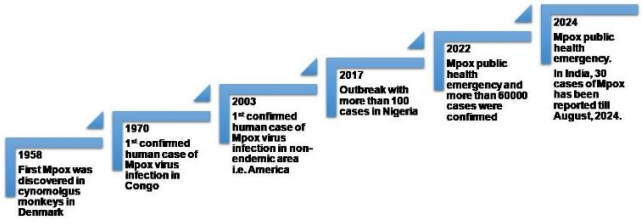

Fig. 1: The periodic details of the historical major MPXV outbreaks.

III. Indian Epidemiology

India's encounter with MPXV began in July 2022 when the first confirmed case was reported in Kerala. The individual was a traveller who had returned from the Middle East, marking India's entry into the global Mpox outbreak that was escalating at the time. Since then, multiple cases were documented in different parts of the country, particularly in states like Kerala, which saw additional cases, and Delhi, where community transmission started to raise concerns. Several other states also reported sporadic cases, although the outbreak did not reach the same intensity in India as it did in parts of Europe and North America. India has reported a total of 27 confirmed cases and 1 death related to Mpox from July 2022 to June 2024, according to WHO and national sources. Most cases have been recorded in Kerala and New Delhi, with many linked to international travel, particularly from the UAE and Nigeria (WHO, 2024). Table 1 provides an overview of Mpox cases, offering insights into regional and demographic distributions in India.[16] Most of these cases have been linked to international travel, with limited evidence of local transmission (Begum et al, 2023; Relhan et al, 2022; Singh et al, 2012). The Indian epidemiological landscape for Mpox is characterized by sporadic cases rather than widespread outbreaks. However, the potential for broader transmission exists, given India's dense population, high mobility, and urbanization (Araf et al, 2024). India's healthcare system, already strengthened by its response to the COVID-19 pandemic, played a pivotal role in managing Mpox cases through effective surveillance, diagnostic testing, and stringent isolation protocols.

Table 1: Mpox Cases: Regional and Demographic Insights in India

Year	Date of Diagnosis	Number of Cases	Place	History of Travel (last 21 days)	Reference
2022	July – December 2022	15	Kerala (Thiruvananthapuram, Kollam), New Delhi	UAE, Nigeria	61; https://worldhealthorg.shinyapps.io/mpx_global/
2023	January-December 2023	12	Kerala, New Delhi	International travel	https://worldhealthorg.shinyapps.io/mpx_global/

Despite the low number of Mpox cases in India, the government acted promptly, issuing public health guidelines, tightening surveillance at airports and other entry points, and launching public education campaigns about the virus's symptoms and transmission. In collaboration with the National Centre for Disease Control (NCDC) and the Indian Council of Medical Research (ICMR), health authorities implemented early detection protocols, isolation measures, and comprehensive contact tracing. Quarantine measures were enforced to prevent the virus from spreading further. Additionally, public health

efforts included raising awareness about vaccination (though limited in availability), releasing clinical management guidelines, and launching extensive educational campaigns to inform the public about the virus and how to prevent it. These coordinated measures reflected India's commitment to controlling the outbreak and ensuring public safety (Khadka et al, 2023).

IV. Virus Morphology and Genome

MPXV is an enclosed, double-stranded DNA virus from the Orthopoxvirus genus of the poxviridae family. Other noteworthy viruses in this genus include the variola virus (which causes smallpox), the vaccinia virus (which is used in smallpox vaccinations), and the cowpox virus, all of which are known to have an impact on human and animal health. Electron microscopy of MPXV infected cells shows a brick- shaped or oval morphology ranging from 200 nm to 250 nm similar to variola or vaccinia viruses. Genome is large a length ranging from 197 kb-200kb and encoding about 180-190 proteins (Condit et al, 2006;Li et al, 2022; Mitja et al, 2023; Shchelkunov et al, 2002) (Figure-2). The structure of the genome has a central core that is consistent and shares 90% sequence homology in open reading frame located between C10L and A24R with other Orthopoxviruses. Virus also has variable regions at each end, and it includes repeated segments at the terminals that are arranged in an inverted fashion (Lu et al, 2023). Variable regions at the ends of genome can differentiate between species and strains of Orthopoxviruses. The pathogenesis, host preference, and immune response of these viruses are determined by their open reading frames (ORFs) (Kumar et al, 2023). Historically, two distinct clades of Mpox have been identified: the Central African (Congo Basin) clade and the West African clade. These clades differ by about 0.5% in their genomic sequences, with the Congo Basin clade being more virulent, transmissible with fatality rate of 10% (Mitja et al, 2023). The WHO has renamed them as Clade I (for the Congo Basin) and Clade II (for the West African clade), with Clade II further divided into Clade IIa and Clade IIb. All the cases in the global outbreak were linked to Clade IIb, however this year; there has been a rise in cases and deaths from Mpox (Clade Ib) in Africa. This new outbreak is due to a variant known as Clade Ib, which is a branch of Clade I, endemic to the Congo region. The evolving virus shows a range of minor genetic modifications, including small gene variants and the deletion of certain genes (Karagoz et al, 2023; Alert CD,2022).

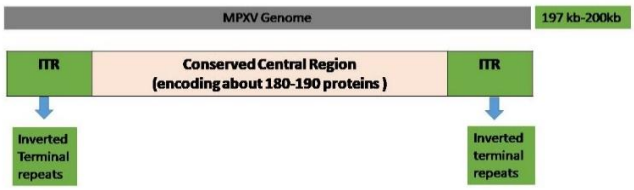

Fig. 2. Overview of the genomic structure of MPXV

V. Clinical Presentation

MPXV infection typically presents with symptoms similar to those of smallpox, though generally less severe (Altindis et al, 2022). The clinical presentation of Mpox in Indian patients has been consistent with global observations. After an incubation period of 5 to 21 days, the disease begins with a prodromal phase characterized by fever, intense headache, muscle aches (myalgia), back pain, and profound fatigue. Within 1 to 3 days after the onset of fever, a distinctive rash appears, starting with macules, which are flat, discolored spots. This rash progresses to papules, then vesicles, and finally pustules. Typically beginning on the face, the rash spreads to other areas of the body, including the palms and soles. The lesions are usually painful and undergo a progression that leads to scabbing and eventual healing (Bayer et al, 2005; Khattak et al, 2023; Bryer et al, 2022). Lymphadenopathy, or swollen lymph nodes, is a distinguishing feature of Mpox, helping to differentiate it from smallpox and other similar illnesses. Table 2 gives a comprehensive comparison of clinical features and diagnostic characteristics of Monkeypox, Smallpox, and Chickenpox (Varicella) (Breman et al, 2002;Collum et al, 2013;Giulio et al, 2004). The severity of Mpox can vary. While many patients experience a mild, self-limiting illness, severe cases can occur, particularly in children, pregnant women, and immunocompromised individuals. Complications may include secondary bacterial infections, respiratory distress, and, in some cases, encephalitis (inflammation of the brain) (Gaeta et al, 2022; Saied et al, 2022). The overall case fatality rate of Mpox has historically ranged from 1% to 10% in endemic regions, with higher rates observed in children and those with weakened immune systems (Petersen et al, 2019). However, the case fatality rate in recent outbreaks outside of Africa has been lower, likely due to better access to medical care and supportive treatment. Early recognition of the clinical signs of Mpox is crucial for timely diagnosis, isolation, and management of cases, helping to prevent further spread of the virus (Zumla et al, 2022). In most cases reported in India, the disease has been mild, with patients recovering within 2-4 weeks. Complications of Mpox can include haemorrhage, tissue necrosis, obstruction, and severe inflammation, potentially leading to conditions such as sepsis. As of September 2024, the latest data indicates that the mortality rate for Mpox in non-endemic regions is approximately 0.06%. This figure 3 is based on the most recent updates from public health authorities, including the WHO, Centers for Disease Control and Prevention (CDC), and European Centre for Disease Prevention and Control (ECDC). These agencies continually monitor and analyze global health data to provide accurate and up-to-date information on emerging diseases (https://worldhealthorg.shinyapps.io/mpx_global/). However, severe cases, though rare, have been documented, particularly in immunocompromised individuals (Candela et al, 2023;Cabanillas et al, 2023; Maqbool et al, 2023).

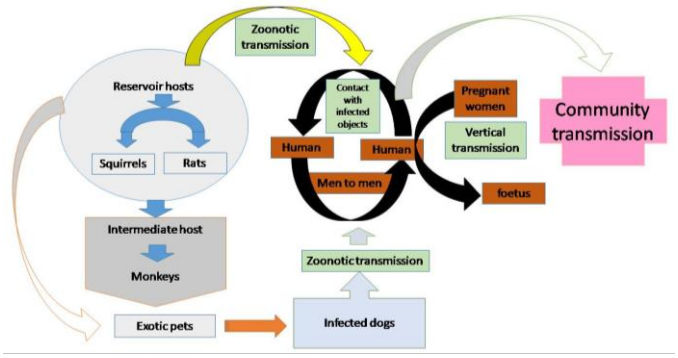

Fig. 3. Different routes of transmission in the MPXV

Table 2: Comparative Overview of Clinical and Diagnostic Features of Monkeypox, Smallpox, and Chickenpox (33, 34, 35).

Disease characteristic	**Monkeypox**	**Smallpox**	**Chickenpox/varicella**
History			
Recent contact with exotic animal	Yes	No	No
Recent exposure to patient with vesicular rash	Possible	Yes	Yes
Previous vaccination against smallpox	10-15%	Rare	Yes
Time period			
Incubation period	7-17 days	10-14 days	10-21 days
Prodromal period	1-3 days	2-4 days	0-2 days
Rash period (from lesions to desquamation)	14-28 days	14-28 days	10-21 days
Symptoms			
Prodromal fever	Yes	Yes	Uncommon, mild fever if present
Fever	Yes, 38.5-40.5°C	Yes, often >40°C	Yes, up to 38.8°C
Malaise	Yes	Yes	Yes
Headache	Yes	Yes	Yes
Lymphadenopathy	Yes	No	No
Lesions on palms and soles	Yes, common	Yes, common	Rare
Lesion distribution	Centrifugal (80%) or centripetal (5%)	Centrifugal	Centripetal
Lesion depth	Superficial	Deep	Superficial
Evolution of skin lesions	Monomorphic (80%) or pleomorphic (20%)	Monomorphic	Pleomorphic
Lesion appearance	Hard, deep, well-circumscribed, umbilicated	Hard, deep, well-circumscribed, umbilicated	Superficial, irregular borders, “dew drop on rose petal”
Lesion progression	Often in one stage; slow progression (1–2 days)	Often in one stage; slow progression (1–2 days)	Often in multiple stages, fast progression
Desquamation (days after onset)	22–24	14–21	6–14
Extracutaneous manifestations			
Secondary skin/soft-tissue infection	19%	Possible	Possible
Pneumonitis	12%	Possible	3–16%
Ocular complications	4-5%	5-9%	No
Encephalitis	<1%	<1%	<1%
Laboratory diagnosis			
DNA detection (e.g., PCR)	MPXV	*Variola* virus	VZV
Electron microscopy	*Poxvirus* particles	*Poxvirus* particles	*Herpesvirus*
Culture on chick chorioallantois	Characteristic pocks	Characteristic pocks	No growth
Serology	Orthopoxvirus and MPXV antibodies	*Orthopoxvirus* and MPXV antibodies	*Varicella* antibodies

VI. Transmission

MPXV transmission involves multiple pathways, including zoonotic, intermediate host, and vertical transmission (Falendysz et al, 2023). In central Africa, rodents and primates are thought to be natural hosts for the MPXV. Early human illnesses are associated with wildlife, where contact with or consumption of diseased animals can result in human infection (Harris, 2022). Zoonotic transmission occurs when humans come into direct contact with these infected animals, typically through bites, scratches, or handling contaminated materials. An intermediate host, such as non-human primates, can also harbor the virus, potentially facilitating its spread to humans. Person- to-Person transmission is due to direct contact with skin, saliva, upper respiratory secretion, body fluid from infected individuals. In addition to direct contact, virus can also spread through contact with objects, fabrics and surface which is used by infected individual (Iqbal &Jaffri, 2022; Walter &Malani, 2022; Beeson et al, 2023; Upadhayay et al, 2022). Furthermore, vertical transmission can occur during pregnancy or childbirth, potentially leading to complications such as stillbirth (Dashraath et al, 2022) (Figure-3).

VII. Diagnosis

Diagnosing MPXV is crucial for effective management and containment of the disease, particularly due to its similarity to other rash-causing illnesses such as smallpox, chickenpox, and other viral infections (Selvaraj et al, 2023). The diagnosis typically involves a combination of clinical evaluation and laboratory testing.

1. Clinical Evaluation: The initial step in diagnosis is the clinical assessment of symptoms, including the characteristic rash, fever, and lymphadenopathy. However, due to the overlap of symptoms with other diseases, clinical evaluation alone is insufficient for a definitive diagnosis (Soheili et al, 2022).
2. Laboratory Testing: The gold standard for confirming MPXV is polymerase chain reaction (PCR) testing, which detects viral DNA by targeting specific genes in samples from skin lesions, including vesicles or pustules. The gene commonly targeted in PCR testing for MPXVis the A29L gene, which is a conserved gene specific to the Orthopoxvirus genus (Nakhaie et al, 2023). Various studies have shown that some other common gene targets for real-time PCR are include A4L (CP), A27L (ATI), A29L (14kDa protein), B2R (HA), B6R (EEV), B7R, C3L/D14L, E9L (DNA polymerase), and J2R (TNFR)53-58 (Lee et al, 2023; Kuo and Wang, 2013; Saijo et al, 2008; Li et al, 2006; Shchelkunov et al, 2011; Li et al, 2010), in conventional PCR, includes A27L (ATI) and B2R (HA) (Lee et al, 2023; Neubaueret al, 1998) for Loop-mediated isothermal amplification (LAMP), includes A27L (ATI) and C3L/D14L genes (Lee et al, 2023; Neubaueret al, 1998) and J2R (TNFR) is the key target in recombinase polymerase amplification (RPA) (Davi et al, 2019). The PCR test for MPXV exhibits high sensitivity and specificity, with sensitivity reported at approximately 97% to 100% and specificity at 98% to 100%, making it the preferred method for confirming cases (Peris et al, 2023). In some instances, blood or throat swabs may also be used for testing, but skin lesion samples generally provide the most reliable results (Goia et al, 2024). Additional diagnostic methods for MPXV include electron microscopy and serological tests. Electron microscopy, which visually identifies the virus by its distinctive structure, requires sophisticated equipment such as an electron microscope and specialized expertise, making it less commonly used. Serological tests, which detect antibodies against the virus, are less frequently employed due to their lower specificity and potential for false positives or negatives, especially in the early stages of infection when antibody levels may be insufficient (Chauhan et al, 2023).
3. Diagnosis status in India: In India, the National Institute of Virology (NIV), Pune, has been at the forefront of testing and confirming Mpox cases using RT-PCR to detect viral DNA which is the gold standard for accurate diagnosis (https://mohfw.gov.in/?q=diseasealerts-0) (Dubey, 2022).

In addition to NIV, other key agencies involved in Mpox diagnostics in India include: The ICMR which coordinates and supports diagnostic efforts by providing guidelines and quality control for RT-PCR testing across various laboratories. The NCDC is responsible for surveillance and outbreak response, working closely with other agencies to monitor and manage Mpox cases. Also, State Public Health Laboratories conduct RT-PCR testing and play a crucial role in local diagnostics and reporting of Mpox cases. Together, these agencies ensure a comprehensive diagnostic approach, including confirming cases, managing outbreaks, and maintaining public health safety through standardized and accurate testing procedures.

VIII. Management and Treatment

Several antiviral compounds have demonstrated potential in treating infections caused by Orthopoxvirus species, including Mpox. Cidofovir, known for its broad-spectrum antiviral activity, inhibits viral DNA polymerase but is limited by nephrotoxic effects. Brincidofovir (CMX-001), a lipid conjugate of cidofovir, offers a safer alternative with reduced kidney toxicity while maintaining strong antiviral efficacy. Tecovirimat (ST-246)targets the p37 envelope protein, inhibiting viral release from infected cells, and has shown efficacy against various Orthopoxvirus species, including variola virus. For severe cases, these antivirals may be used in combination with Vaccinia immune globulin (VIG) to manage adverse events related to vaccination.16, 35 For first-line treatment, BMJ Best Practice recommends Tecovirimat or Brincidofovir, both FDA-approved, combined with supportive care such as oxygenation, antipyretics, and fluid management. If secondary bacterial infections or coinfections like varicella-zoster are suspected,

acyclovir or empirical broad-spectrum antibiotics might be used.16, 53

In India, the current management of confirmed Mpox cases, as advised by the National Centre for Disease Control Directorate General of Health Services, Government of India focuses primarily on supportive care and isolation.29 This includes protecting compromised skin and mucous membranes, managing symptoms like fever, pruritus, and nausea with antipyretics and antiemetics, and maintaining hydration through oral rehydration. Close monitoring is essential to prevent complications such as blurred vision, dyspnea, seizures, and lethargy. Antipyretics, analgesics, and hydration therapy are typically used, with severe cases requiring hospitalization and intensive care, particularly for secondary bacterial infections.66-69

IX. Vaccine

Smallpox vaccines like ACAM2000 are not commonly used in Mpox-endemic regions, including India, due to their risk of severe side effects, such as myocarditis, pericarditis, and severe skin infections, which limit their use, particularly in immunocompromised individuals. Although an ideal vaccine would be safe for both children and those with weakened immunity, current options do not fully meet these criteria. Newer vaccines show promise: Modified Vaccinia Ankara (MVA) is an attenuated vaccine that does not replicate in mammalian cells and has provided protection in primates but is less effective in individuals with reduced T-cell function. LC16m8, another promising option, is a live attenuated vaccine derived from the vaccinia virus that has proven effective in preventing severe Mpox in nonhuman primates and has been safely administered to over 50,000 children in Japan (William et al, 2023; McCollum and Daman, 2013). Globally, ACAM2000 and MVA-BN are used for high-risk populations, including healthcare workers, lab personnel, close contacts of infected individuals, travelers to outbreak areas, and military personnel, particularly in countries such as the UK, US, and Canada (Lee et al, 2023). ACAM2000 is FDA-approved for pre- and post-exposure use but carries some risk of cardiac issues, while MVA-BN (Modified Vaccinia Ankara-Bavarian Nordic), developed by Bavarian Nordic, is approved for both Mpox and smallpox prevention in the US and Europe (https://www.who.int/news-room/fact-sheets/detail/monkeypox). Despite these options, widespread vaccination has not been implemented due to limited vaccine availability and the relatively low incidence of cases (Liu et al, 2024). In India, the ICMR has encouraged pharmaceutical companies to develop vaccines and diagnostics for Mpox, while current management strategies focus on supportive care and isolation rather than widespread vaccination.

X. Public Health Response

India's public health response to Mpox has been proactive and comprehensive, drawing lessons from the COVID-19 pandemic. The Ministry of Health and Family Welfare (MoHFW) quickly issued guidelines for surveillance, case management, and isolation (https://mohfw.gov.in/?q=diseasealerts-0). Airports and ports were placed on high alert, focusing on travellers from regions with known Mpox outbreaks. Contact tracing and quarantine measures have been implemented to limit the virus's spread. The ICMR developed diagnostic protocols, expanded testing capacity, and initiated research on transmission dynamics, vaccine efficacy, and potential treatments. Public awareness campaigns were launched to educate the population about symptoms, transmission routes, and preventive measures for Mpox (Jindal et al, 2022). While the smallpox vaccine (ACAM2000) has been considered for high-risk groups due to its cross-protection against Mpox, widespread vaccination has not been deemed necessary because of the virus's lower transmission rate compared to COVID-19 (Hasan and saeed, 2022; Saadh et al, 2023).

XI. Socio-economic impact

Mpox outbreaks can severely impact socio-economic stability, especially in LMICs like India. Economic disruptions include labor shortages, reduced productivity, and increased healthcare spending, which can strain public finances. Vulnerable populations, particularly immunocompromised and women as they often take on care giving roles and are more vulnerable to economic instability, face heightened risks, leading to deepened gender inequality and social instability. Healthcare systems may become overwhelmed, while disruptions in supply chains and trade further hinder economic recovery. Addressing these challenges requires targeted public health interventions, equitable healthcare access, and robust social protection programs (Sah et al, 2022; Jamil et al, 2023).

XII. Challenges and Recommendations

Despite the proactive response, India faces several challenges in controlling Mpox. The risk of misdiagnosis is high, particularly in regions where healthcare infrastructure is limited, and where skin conditions like chickenpox or scabies are common (Hussain et al, 2022). There is also the potential for stigmatization of affected individuals, which may hinder reporting and prevention efforts. Furthermore, the possibility of the MPXV becoming endemic in India cannot be ruled out. Factors such as population density, climate, and the presence of animal reservoirs could contribute to sustained transmission. This underscores the need for ongoing surveillance, research, and preparedness (Dubey et al, 2023).

1. Surveillance and Reporting: Enhancing surveillance and ensuring timely reporting of cases are critical. This includes expanding diagnostic capabilities to cover more areas, especially in rural regions.

2. Public Awareness: Increasing public awareness about Mpox symptoms and prevention measures is essential to reduce stigma and encourage early detection.
3. Healthcare Infrastructure: Strengthening healthcare infrastructure, particularly in rural areas, will be vital for managing potential outbreaks.
4. International Collaboration: Continued collaboration with international health organizations and sharing of data will help India stay prepared for any potential escalation in cases.
5. Research and Development: Investing in research for better diagnostic tools, treatments, and vaccines specific to Mpox will be crucial in the long term.

XIII. One Health as a Guiding Principle for Recommendations

The One Health approach, introduced in the 1800s, addresses health crises at the human-animal-environment interface. It gained prominence in the 20th century due to pandemics like SARS, and its multidisciplinary collaboration has become crucial in optimizing health across humans, animals, and ecosystems. Mpox, a viral zoonotic disease occurring at the intersection of human, animal, and environmental health, demands a One Health approach to effectively address the ongoing crisis and prevent future outbreaks. First, there is an urgent need to develop unified, global zoonotic disease surveillance systems to gather critical data for evidence-based responses, minimizing the risk of cross-border transmission. Second, multidisciplinary collaboration among scientists, including epidemiologists, microbiologists, veterinarians, and public health experts, must be prioritized to better understand Mpox's origin, transmission patterns, and risk factors. This effort requires adequate research funding from governments and international donors. Third, laboratories in endemic regions should be equipped with molecular diagnostic tools for rapid viral DNA sequencing, enabling early detection and containment of cases. Currently, only a few labs in these areas have the necessary diagnostic capabilities. Fourth, since wildlife trade significantly contributes to Mpox transmission, a targeted ban on trading wildlife that poses public health risks should be enforced. Fifth, under the One Health framework, an international expert committee should be formed to review public health measures, treatment options, safety protocols, and containment strategies for Mpox. Sixth, community healthcare systems in endemic regions must be strengthened, with resources allocated to improve response and control efforts. Seventh, community-based research is essential to understand local perceptions, risky behaviors, and health-seeking practices regarding Mpox. Finally, ongoing public awareness campaigns are necessary to educate people, especially in rural areas with limited media access, about Mpox transmission and preventive measures. These strategies are crucial for controlling the spread of Mpox and preventing future outbreaks (Killewo et al, 2017; Tajudeen et al, 2023).

Conclusion

The MPXV, while not as devastating as some other infectious diseases, presents a significant public health challenge for India. India's encounter with the MPXV in 2022 highlighted the interconnected nature of global health and the need for robust public health systems. While the country's response has been effective in containing the initial spread, continued vigilance is essential to prevent future outbreaks. Strengthening diagnostic capacity, public awareness, and research into vaccines and treatments will be crucial in managing Mpox and other emerging infectious diseases in the future.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

There is no ethical issue.

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