

Epidemiological characteristics and diagnostic methods of 2022 monkeypox outbreak

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Abstract. Since the outbreak of the monkeypox epidemic in May 2022, cases of monkeypox have occurred in various regions of the world, and the spread of the disease has gradually shifted from endemic to non-endemic areas, posing a major threat to public health and safety. In order to better understand and effectively manage the monkeypox epidemic, this paper will summarise the epidemiological situation of monkeypox through the use of the database PubMed/ Medline and further summarise the statistics from the WHO and CDC website.

Keywords: Monkeypox, Examination method, Prevention and control measure.

1. Introduction

Monkeypox is a zoonotic disease. Monkeypox virus, the double-stranded DNA (dsDNA) virus, belongs to chordopox virinae orthopox virus. It has a brick-shaped or elliptical structure with a size of 200-400 nm. The first human case of monkeypox infection was documented in the Republic of Congo in 1970 [1] after its first discovery in Copenhagen in 1958. Primarily endemic for monkeypox are tropical nations in Central and East Africa. The World Health Organization, which designated the monkeypox outbreak as “Public Health Emergency of International Concern” on July 23, 2022, is extremely concerned about the outbreak of monkeypox in several countries because in 2022 the geographic pattern of monkeypox transmission is rapidly shifting from endemic to non-endemic areas.

Monkeypox can be divided into spread between human and animals as well as between humans. Sneezing, coughing, and other near respiratory droplets are the primary means of human-to-human transfer. The main methods of transmission include prolonged face-to-face contact, direct contact with virus lesions and bodily fluids, and indirect contact with infected items via clothes or contaminated bedding [2]. Monkeypox typically has an incubation period of 5 to 21 days, which is broken down into three phases: the fever phase, the skin rash phase, and the crusting phase according to information released by World Health Organization (WHO). Acute fever of 38.5°C or higher, a headache, lymphadenopathy, bodily pains, and weakness are all signs of the fever phase, which typically lasts 1 to 3 days. From macules or papules through pustules and blisters, ulcers, and finally to the crusting phase [3]. In the current monkeypox outbreak, however, some cases were discovered to have typical clinical symptoms like oral ulcers, fever, lymphadenopathy, and pain when swallowing. Additionally, other genital organ and perianal diseases that occasionally appear first but do not spread to other parts of the body, like a localized genital rash with blistering, pustular, or ulcerative lesions in the anus [4]. Contrarily, human-to-animal transmission is often brought on by direct contact with the blood, bodily fluids, or epidermal or mucosal sores of infected animals. Rats are the most plausible suspects given there is no known natural reservoir for monkeypox [5].

Monkeypox, smallpox, cowpox, and vaccinia virus all are orthopox virus [6], having similar genetic and antigenic properties, hence immunization against one of these viruses offers significant protection against other viruses in the orthopox genus. Due to cross-immunity, a protective immune response against a condition brought on by any orthopox virus will lessen the risk of contracting a different orthopox virus. Based on years of study, smallpox immunization has been proved to prevent monkeypox [7]. The smallpox vaccination, however, has been stopped since since smallpox was proclaimed extinct in the 1990s. As a result, the smallpox vaccine’s ability to offer cross-immunity against other orthopox viruses has started to wane [8].

2. Epidemiology

As of 20 September 2022, the cumulative number of confirmed monkeypox cases and deaths reported to the WHO between 1 January 2022 and 4 July 2022, as released by the organization on July 6, as well as between 1 January 2022 and 7 August 2022, as released by the organization on August 7, and between 1 January 2022 and 5 September 2022, as released by the organization on September 7, were calculated. The data was tabulated and plotted for each month on different continents with a stacked bar chart of the percentage increase in the total for each month and a stacked bar chart of the number of deaths. The data on the cumulative number of confirmed monkeypox cases and deaths reported to WHO from 1 January 2022 to 5 September 2022 were released on 7 September.

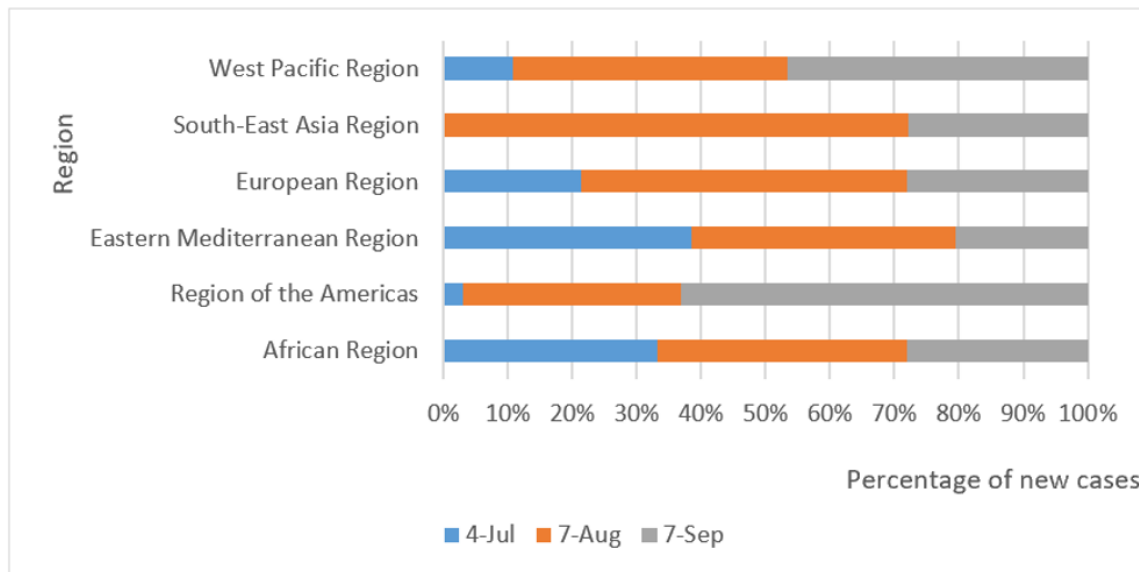


Figure 1. Percentage increase in monkeypox per month

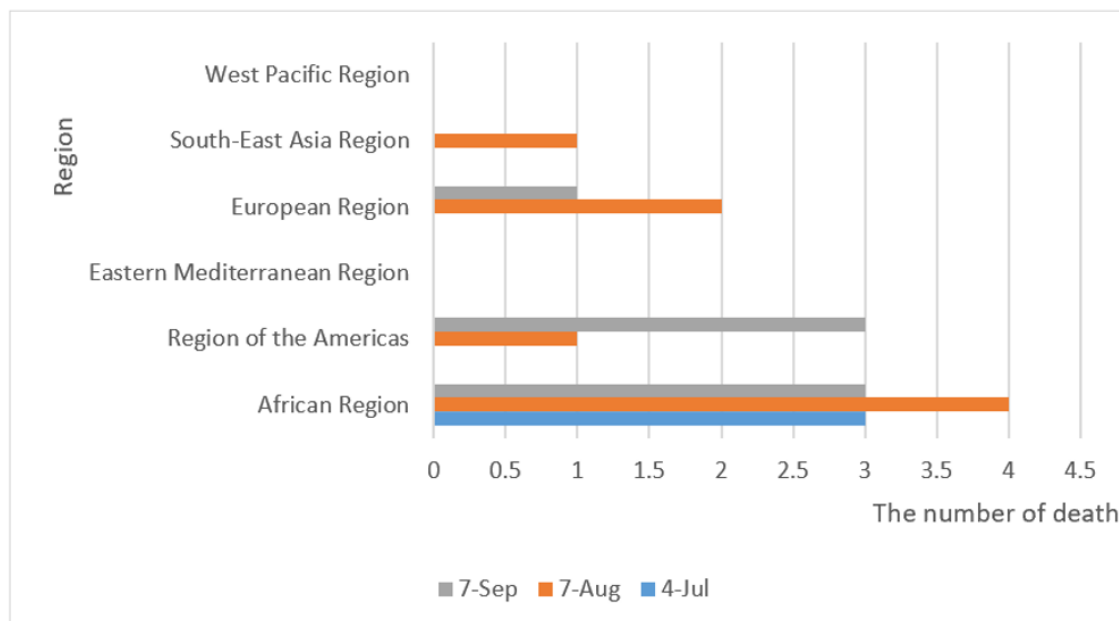


Figure 2. Number of deaths from monkeypox

The growth of monkeypox cases was more rapid in July and August, as shown by Graph 1. In addition, monkeypox cases have been reported in the Western Pacific, American, Eastern Mediterranean, and European regions, which were originally non-endemic monkeypox.

It can be found that the number of deaths caused by monkeypox in the African region as shown by in Graph 2. It was significantly higher than other monkeypox non-endemic areas as it was the primary monkeypox virus endemic area.

Combining the two graphs reveals that while there are many cases of the monkeypox virus in both the European and American regions, the lethality is not severe and there are not many deaths.

52,996 laboratory-tested confirmed cases of monkeypox had been reported to WHO as of 4 September, 2022, from 102 different countries and regions. Other significant epidemiological findings can be found by reading the relevant WHO information:

1. Monkeypox predominantly affects young males, with 98.2% (26,953/27,449) of the available case data being in males around mid-36 years of age.

2. 95.2% (11 923/12 530) of the reported cases were identified as homosexual, bisexual and other men who would have sex with men. Of all reported types of transmission, transmission through skin and mucosal contact during sexual activity was the most common.

3. The majority of cases were likely to be contacts exposed in a sexually active party setting [11].

The observation and identification of four cases of classic monkeypox virus were finished by Andrea Antinori et al. The fact that all cases had been sexually active and all initially presented with lesions mainly in the anal. Furthermore, genital regions suggest that close contact during sexual intercourse is an important part of the transmission of the virus. Further studies are needed to assess the persistence and transmission of monkeypox virus in different body fluids [12].

3. Diagnostic methods

The clinical examination for the diagnosis of monkeypox can be broadly divided into two types of laboratory tests as well as a physical examination.

3.1. Laboratory inspection

According to the UK Health and Safety Executive (UKHSA), a positive monkeypox virus polymerase chain reaction (PCR) assay in a sample from any anatomical site constitutes laboratory confirmation of monkeypox virus infection [12].

For the purpose of diagnosing the monkeypox virus, laboratory testing can be carried out serological analysis methods including virus culture/isolation, polymerase chain reaction (PCR, real-time PCR), electron microscope, immunohistochemistry, and specific antibody (IgG and IgM-based). Techniques including culture/isolation of the virus, polymerase chain reaction (PCR, real-time PCR), electron microscopy, immunohistochemistry, and serological detection of specific antibodies can all be used to diagnose the monkeypox virus (IgG and IgM based).

It is generally advised to carry out [13, 14] in a biosafety level III laboratory [13]. The ideal clinical samples for testing are exudates, crusts, or swabs from blister lesions that have been maintained cool, dry, and sterile. The top of intact skin blister lesions or skin biopsies of blistering pustules are of higher interest for examination. [15]

RT-PCR was used to target the genes for the B6R, DNA polymerase gene、E9L, DNA-dependent RNA polymerase subunit 18, rpo18 [17] and F3L gene [18]. Additionally, MPXV DNA has been found using PCR amplification genes or gene fragments with RFLP restriction fragment length polymorphism (RFLP) [19, 20, 21]. However, RFLP is time-consuming, does require viral culture, and enzymatic digestion of PCR products is necessary prior to gel electrophoresis. As a result, RFLP may not be suitable in clinical settings where high requirements for speed, sensitivity, and technique specificity are needed. [13]

3.2. Physical examination

During a physical examination for monkeypox, it's important to look for changes like body-wide blisters and pustules, a noticeable rise in body temperature, and palpable lymph node enlargement. Lesions are monomorphic, pea-sized, and hard in monkeypox patients, resembling smallpox, but they

have a crop-like look and lack significant centrifugal spread. The most notable clinical symptom of monkeypox virus is lymphadenopathy [22, 23].

4. Prevention and treatment

Controlling the source of infection, blocking the transmission pathway, and safeguarding vulnerable people are the three basic components of infectious diseases prevention and treatment. According to the most recent studies, monkeys that live in tropical rainforests, infected rodents or other species, and monkeypox-infected individuals are the main routes of infection for monkeypox. Given that, it's critical to tighten restrictions on tropical rainforest areas and to increase precautions against coming into close contact with any animals that might be infected with the monkeypox virus while the disease is prevalent.

In non-endemic regions or nations, it's critical to raise knowledge about monkeypox prevention and regularly clean or wash public spaces with disinfectant or alcohol to improve self-cleaning in order to block the transmission channel. People should be aware of the monkeypox pandemic in the neighborhood, promptly isolate any suspected cases, get medical assistance if one experience monkeypox-related symptoms. Under this situation, people should limit sexual activity during this time to prevent the spread of the disease from sexual fluids. Before eating, all animal gems should be completely cooked.

The monkeypox vaccine is also available for persons at risk who may have had intimate contact with monkeypox patients in order to protect susceptible populations, however mass vaccination is not currently advised. Currently, the JYNNEOS vaccine and the ACAM2000 vaccine have both been authorized for use in the treatment and prevention of monkeypox. The CDC recommends two doses of the JYNNEOS vaccine, and those who have previously experienced allergic reactions to the antibiotic's gentamicin or ciprofloxacin, or to chicken or egg proteins, should take the suggestions from a doctor or have a vigorous injection. ACAM2000 is a live virus with the capacity to multiply and a cowpox virus within that can spread to other people. As the cowpox virus is related to the viruses that cause monkeypox or smallpox, it acts as a preventative medicine, with lesions or ulcers developing at the injection site following administration (named "blood sampling"). Healing of the lesions could take weeks or longer. If vaccinated with ACM2000, special attention needs to be paid to the lesion site to avoid transmission of cowpox virus to others or to other parts of one's body during the healing period. It is generally recommended to avoid ACAM2000 in immunosuppressed individuals (such as HIV-infected), so it is reasonable to avoid ACAM2000 in populations at increased risk for unrecognized HIV, in populations with most current non-African cases, and in populations where monkeypox may be more widely transmitted (such as sex workers) [24, 25, 26].

If one is unlucky enough to have been in close contact with someone who has monkeypox (close contact is defined as having sex with a person who has monkeypox, touching or being in close contact with the rash of a person with monkeypox, engaging in prolonged skin contact, or having used other personal items and materials used by a person with monkeypox), the following actions should be taken immediately. Finally, get urgent medical attention to receive skilled treatment if you experience a new or unexplained rash or other monkeypox symptoms. In order to prevent and treat them, get in touch with the CDC and let those who have lately had close contact with them know. [25].

There isn't currently a specific medication for monkeypox. The US Food and Drug Administration (FDA) has licensed the antiviral medication ticloplimide (thermoplastic) for the treatment of smallpox in adults and children, however several smallpox preventative medications can also be used to treat monkeypox. Additionally, a crucial component of treating monkeypox is attempting to manage the illness' symptoms. Ibuprofen and acetaminophen (Tylenol) are two drugs that can be used to treat the disease's symptoms.

5. Conclusion

Monkeypox has been discovered to be gradually expanding to locations where it is not already circulating, according to research and statistics on the rise in monkeypox cases in various regions over the previous three months. Because this is the only method to better protect the public health, conducting social work training for different populations has become more crucial.

CDCs worldwide are currently creating and improving interim recommendations for treating monkeypox. The prognosis and treatment of monkeypox may also depend on a number of factors, including prior vaccination status, one's own health status, and even the presence of complications after the disease. Although there is no specific treatment for monkeypox, many infected individuals have a mild self-limiting disease course. Individualized treatment therefore appears to be the most sensible coping mechanism at this time. It's also critical to stress that anyone can contract monkeypox and that we should all work together to eradicate this "shared enemy" of humanity.

Healthcare professionals have a responsibility to treat patients with monkeypox while maintaining their own safety. They also have a responsibility to inform the public about public health issues, such as the prevention and treatment of monkeypox, with a focus on prevention techniques, symptom recognition, and the treatability of monkeypox to reduce social anxiety. Using sterile synthetic swabs, collecting two swabs from each lesion, preferably from different places on the body or from lesions with different appearances, and swabs of lesion surfaces, exudates, or lesion crusts are the recommended types of specimens for laboratory testing of monkeypox virus are other crucial aspects of implementing diagnostic procedures for the disease. When treating monkeypox patients, it is important to read the literature, pay attention to the most recent prevention and treatment measures and guidelines from the CDC, WHO, as well as other countries. It is needed to pay attention to the patients' health status, adjust the treatment medication and related dosage as needed, and simultaneously relieve the negative reactions that monkeypox patients experience after contracting the virus.

General people we should accept the risk of monkeypox, avoid being overly fearful or indifferent, regularly wash our hands after contact with public facilities, be aware of monkeypox outbreaks, and report any clinical symptoms of monkeypox to local health and disease control agencies as soon as possible if we have a history of high exposure. To spread awareness, defend ourselves against monkeypox in endemic places, and keep an eye out for outbreaks of monkeypox in non-endemic areas to learn more about them in case of emergency. Additionally, even though a significant number (though not all) of the confirmed cases are currently among men who have sex with men (MSM), many of these instances are discovered in STI clinics. [28] Nevertheless, the general people shouldn't be excessively alarmed by incidents of infection brought on by homosexual and bisexual males because doing so could unintentionally stigmatize, undermine, and put a lot of psychological strain on this group.

Since there is a ready-made vaccine for monkeypox and a better understanding of the pathogen, there is currently no way to predict whether it will become the next pandemic infectious disease. However, because the new crown epidemic is still widespread throughout the world, many nations have tightened quarantine regulations, strengthened customs inspection, and other preventive measures. However, there is still a need for caution in non-endemic areas, health care systems in some developing and resource-poor countries are already under a lot of stress from the COVID-19 pandemic, and some resource-poor countries and regions still need to be ready for monkeypox emergency outbreaks due to inadequate testing resources and limited access to monkeypox vaccines. Emergency response to epidemics of monkeypox is still required. No region or nation can be shielded from zoonotic infections like the monkeypox virus in today's interconnected and globalized globe unless prompt preventive action is done. Therefore, considering the severity of the coexistence of pandemics (COVID-19), it has become especially vital for governments globally to adopt comprehensive and evidence-based scientific programs at all levels to restrict the spread of MPX diseases. [29]

In today's globalized world, nations and national health organizations should work together to conduct more research on the epidemiology, ecology, and biology of the virus in a multifaceted manner. A thorough analysis of the epidemiological features of the monkeypox virus is essential for timely public health interventions and for healthcare providers to provide timely treatment.[30] In order to better comprehend the disease's principles and contribute to the prevention of human infection, it is also crucial to better grasp the disease's scope and mode of transmission. With the combined efforts of nations around the world, it is anticipated that this wave of monkeypox epidemics will gradually subside and offer crucial real-world experience for nations to handle public health challenges.

References

- [1] J. Louten, Virus Structure and Classification, Essential Human Virology, 2016, pp. 19 – 29.
- [2] Kumar N, Acharya A, Gendelman HE, Byrareddy SN. The 2022 outbreak and the pathobiology of the monkeypox virus. *J Autoimmune*. 2022 Jul; 131: 102855.
- [3] Meo SA, Klonoff DC. Human monkeypox outbreak: global prevalence and biological, epidemiological and clinical characteristics - observational analysis between 1970-2022. *Eur Rev Med Pharmacol Sci*. 2022 Aug; 26 (15): 5624 - 5632.
- [4] Public Health Agencies Issue Monkeypox Guidance to Control Transmission, UK Health Security Agency, 2022.
- [5] Kugelman JR, Johnston SC, Mulembakani PM, et al. Genomic variability of monkeypox virus among humans, Democratic Republic of the Congo. *Emerg Infect Dis*. 2014; 20 (2): 232 - 239.
- [6] G. Pauli, J. Blümel, R. Burger, et al. Orthopox viruses: infections in humans *Transfus Med Hemother*, 37 (2010), pp. 351 - 364.
- [7] Monkeypox. [Jun; 2022]; <https://www.who.int/news-room/fact-sheets/detail/monkeypox> 2022.
- [8] Appendix2. Monkeypoxvirus. [Jun; 2022]<https://www.aabb.org/docs/default-source/default-document-library/regulatory/eid/130s.pdf> 2009.
- [9] Multi-country outbreak of monkeypox, External Situation Report 5, published 7 September 2022, Data as received by WHO national authorities by 17:00 CEST, 5 September 2022.
- [10] Antinori A, Mazzotta V, Vita S, Carletti F, Tacconi D, Lapini LE, D'Abramo A, Cicalini S, Lapa D, Pittalis S, Puro V, Rivano Capparuccia M, Giombini E, Gruber CEM, Garbuglia AR, Marani A, Vairo F, Girardi E, Vaia F, Nicastri E; INMI Monkeypox Group. Epidemiological, clinical and virological characteristics of four cases of monkeypox support transmission through sexual contact, Italy, May 2022. *Euro Surveill*. 2022 Jun; 27 (22): 2200421.
- [11] Fowotade A., Fasuyi T.O., Bakare R.A. Re-emergence of monkeypox in Nigeria: A cause for concern and public enlightenment. *Afr. J. Clin. Exp. Microbiol*. 2018; 19: 307.
- [12] Monkeypox: case definitions. UK Health Security Agency, 2022.
- [13] Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox Virus in Nigeria: Infection Biology, Epidemiology, and Evolution. *Viruses*. 2020 Nov 5; 12 (11): 1257.
- [14] Saxena SK, Ansari S, Maurya VK, Kumar S, Jain A, Paweska JT, Tripathi AK, Abdel-Moneim AS. Re-emerging human monkeypox: A major public-health debacle. *J Med Virol*. 2022 Jun 1.
- [15] Petersen E, Kantele A, Koopmans M, Asogun D, Yinka-Ogunleye A, Ihekweazu C, Zumla A. Human Monkeypox: Epidemiologic and Clinical Characteristics, Diagnosis, and Prevention. *Infect Dis Clin North Am*. 2019 Dec; 33 (4): 1027 - 1043.
- [16] Li Y., Olson V. A., Laue T., Laker M.T., Damon I.K. Detection of monkeypox virus with real-time PCR assays. *J. Clin. Virol*. 2006; 36: 194 – 203.
- [17] Reynolds M.G., Carroll D.S., Olson V. A., Hughes C., Galley J., Likos A., Montgomery J.M., Suu-ire R., Kwasi M.O., Root J.J., et al. A Silent Zoonotic of an Orthopoxvirus in Ghana, West Africa: Evidence for Multi-Species Involvement in the Absence of Widespread Human Disease. *Am. J. Trop. Med. Hyg*. 2010; 82: 746 – 754.

- [18] Orba Y., Sasaki M., Yamaguchi H., Ishii A., Thomas Y., Ogawa H., Hang B. M., Mweene S., Morikawa S., Saijo M., et al. Orthopoxvirus infection among wildlife in Zambia. *Gen. Virol.* 2015; 96: 390 – 394.
- [19] Ropp S. L., Jin Q.I., Knight J. C., Massung R.F., Esposito J.J. PCR Strategy for Identification and Differentiation of Smallpox and Other Orth poxviruses. *Clin. Microbiol.* 1995; 33: 2069 – 2076.
- [20] Meyer H., Pfeffer M., Rziha H.-J. Sequence alterations within and downstream of the A-type inclusion protein genes allow differentiation of Orthopoxvirus species by polymerase chain reaction. *Gen. Virol.* 1994; 75: 1975 – 1981.
- [21] Kulesh D.A., Loveless B.M., Norwood D., Garrison J., Whitehouse C.A., Hartmann C., Mucker E., Miller D., Wasieloski L.P., Huggins J., et al. Monkeypox virus detection in rodents using real-time 3'-minor groove binder TaqMan® assays on the Roche LightCycler. *Lab. Investig.* 2004; 84: 1200 – 1208.
- [22] Kabuga A.I., El Zowalaty M.E. A review of the monkeypox virus and a recent outbreak of skin rash disease in Nigeria. *J. Med. Virol.* 2019; 91: 533 – 540.
- [23] Fowotade A., Fasuyi T.O., Bakare R.A. Re-emergence of monkeypox in Nigeria: A cause for concern and public enlightenment. *Afr. J. Clin. Exp. Microbiol.* 2018; 19: 307.
- [24] Rizk JG, Lippi G, Henry BM, Forthal DN, Rizk Y. Prevention and Treatment of Monkeypox. *Drugs.* 2022 Jun; 82 (9): 957 - 963.
- [25] <https://www.cdc.gov/index.htm>
- [26] Crum-Cianflone NF, Sullivan E. Vaccinations for the HIV-infected adult: a review of the current recommendations, part II. *Infect Dis Ther.* 2017.
- [27] Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox Virus in Nigeria: Infection Biology, Epidemiology, and Evolution. *Viruses.* 2020 Nov 5; 12 (11): 1257.
- [28] Adalja A, Inglesby T. A Novel International Monkeypox Outbreak. *Ann Intern Med.* 2022 May 24.
- [29] Khan S, Akbar SMF, Yahiro T, Al Mahtab M, Kimitsuki K, Nishizono A. Unprecedented rise of monkeypox in Europe and America: Are Asian countries ready for a new outbreak during the ongoing COVID-19 pandemic? *J Glob Health.* 2022 Aug 31; 12: 03066.
- [30] Zhu F, Li L, Che D. Monkeypox virus under COVID-19: Caution for sexual transmission - Correspondence. *Int J Surg.* 2022 Aug; 104: 106768.