

Review Article

Re-emergence of human monkeypox 2022: its ecology and public health significance-short review article

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ABSTRACT

Monkeypox virus (MPXV) is one of *Orthopoxvirus* subfamily, it's refers to a zoonotic disease caused by MPXV. Human monkeypox, on the other hand, has a much lower morbidity and fatality rate than smallpox. Reference to the current resurgence, monkeypox outbreaks have been reported over the past 5 decades, 10 countries in Africa was initially discovered to be affected by the outbreak and subsequently 4 countries apart from Africa. Additionally, re-emergence of monkeypox in African countries, especially Nigeria about forty 40 years of the initial outbreak, midst 2010-2019. Climate change, deforestation, lack of proper health and research advance infrastructure among the society and uncontrol intake of bush meat in the African countries could have been the reason for the recent re-emergence of monkeypox within the communities. Public health significance of monkeypox outbreak could be the factors related to the vulnerability of the population towards MPXV when smallpox vaccination was stopped. Due to the rapid global outreach of monkeypox endemic, it should be therefore considered as a very serious re-surging pathogen in the world. However, detail and proper observational research could bring more light on the influence of MPXV on overall human population, together with the advancement in qualitative and quantitative of outbreak data collection, research in the current situation is crucial and need an emergency treat in order to encourage the researchers to improve more findings on the monkeypox outbreak, which will subsequently enhances appropriate case management and public health response.

Keywords: Human monkeypox, Re-emergence, Ecology, Public health

INTRODUCTION

Monkeypox virus (MPV) remains to hide in the equatorial rainforests of Central and West Africa over forty years after smallpox was eradicated.¹ And Monkeypox is however, a common zoonotic viral infection that occur as a consequence of MPXV, which belongs to the *Orthopoxvirus* genus, which also included smallpox, cowpox, and vaccinia viruses. The illness was firstly discovered in science laboratory monkeys in 1958, were as the very first human case was detected in a boy child of 9-month of age in the Democratic Republic of

Congo in 1970. (DRC). Human monkeypox (MPV) is a smallpox-like disease distinguished by a prodromal phase of pyrexia and exhaustion followed by vesiculopustular skin eruption that develop. Human monkeypox, on the other hand, has a much lower morbidity and fatality rate than smallpox.²

When a person contacted the virus from an animal, a human, or any infected object, the disease can be transmitted. The virus route of transmission is through broken skin, the respiratory system, or mucosal membranes (despite being not apparent) (eyes, nose, or mouth). Bites or scratches, wild meat preparation, coming

in direct contact with bodily fluids or erupted material, or indirect contact with lesion material, like through contaminated bedding, can all result in animal-to-human transmission.³ More than 90% of monkeypox illnesses are found and recording the highest number of cases in the Congo Basin, with the DRC. Cases of monkeypox were only recorded on a sporadic basis in the bordering Republic of the Congo, mostly in the rural, highly wooded regions close to the DRC border, where humans are regularly in touch with wild animals. In 2003, 2007, and 2010, monkeypox epidemic transpired in the Likouala department, in the Northern portion of the Republic of Congo, during which the factor was closely interconnected to MPXV reported in the DRC.⁴

The significance of MPXV in terms of public health, there are 3 factors that condition the chances of transmission of MPXV to human.¹ Food concoction methods: The importance of food concoction methods in the infection of human. The dietary habits of the Bumba and Ikela zones different from those of the Tshela zone. In the farmer, rats, that are collected by youngsters as young as 5-6 years old, account for 60 to 85% of all wild beast caught by the bucolic people which are often eaten raw. After the age of nine or ten years, youngsters follow their parents and prepare meats. Children in Bas-Zaïre, on the contrary, begin trapping animals in the wild around the ages of between 12-13, and tiny mammals are

uncommon target. Furthermore, raw meat intake is uncommon, owing to improved general education.² The secondary factor related to the vulnerability of the population as a whole towards the MPXV and vaccination against the smallpox disease, when smallpox vaccination was stopped.³ Human-to-human transmission. The transmissibility of the MPXV among humans counts to the third factor that is affecting the human monkeypox incidence.⁵ Approximately 200-250 nanometer in size via electron microscope. Pox viruses are coated with lipoprotein envelope containing linear double stranded DNA, various complications like pneumonia, encephalitis, sepsis, permanent skin and corneal scarring and eventually death can result from monkey pox infection.⁵

OUTBREAKS OF MONKEYPOX IN HUMANS

Table 1 and 2; the distribution of confirmed cases country wise is shown in Figure 1.⁶

From 21 May, 13:00, 92 science laboratories confirmed cases, and 28 doubted cases of monkeypox with ongoing investigations, have been reported to WHO from 12 Member States that are not endemic for MPXV, across three WHO locations (Table 2, Figure 1). There was no associated mortality reported to date.⁷

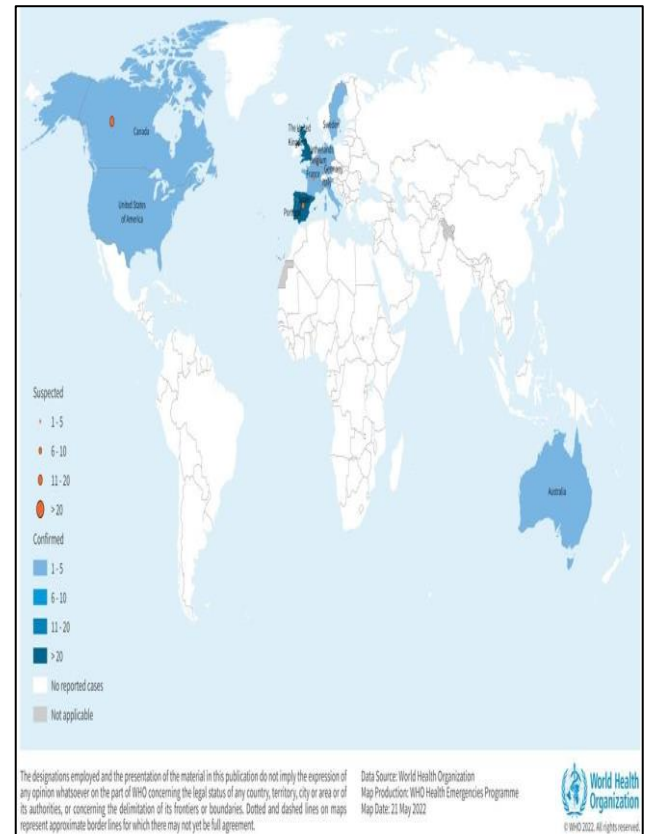


Figure 1: The geographical distribution showing the confirmed and suspected cases of monkeypox in non-endemic regions between 13th to 21st May 2022, as at 13:00.⁷

Table 1: The cases of human monkeypox reported in the world between 1970 till 2018.⁶

Country	1970-1990	1991-1999	2000-2009	2010-2018
DRC (former Zaire)	386 (confirmed) (27) + 2-5	511	Not fully enumerable	Not fully enumerable
Republic of Central Africa	6 cases (confirmed)	N/A	4	At least 68 (at least 29 confirmed)
Cameroon	2 cases (confirmed)	4 (1 confirmed)	N/A	16 cases (1 confirmed case)
Nigeria	10 cases (3 confirmed cases)	N/A	N/A	244 (101 confirmed)
Ivory Coast	2 (confirmed)	N/A	N/A	N/A
Liberia	4 cases (confirmed)	N/A	N/A	2 cases (confirmed)
Sierra Leone	1 case (confirmed)	N/A	N/A	At least 2 cases (2 confirmed cases)

Continued.

Country	1970-1990	1991-1999	2000-2009	2010-2018
Gabon	1-10 (one confirmed)	N/A	N/A	N/A
USA	N/A	N/A	47 cases (37 confirmed cases, 10 probable cases)	N/A
Republic of Congo	N/A	N/A	12 cases (3 confirmed cases, 8 probable)	98 (9 confirmed)
South Sudan	N/A	N/A	49 cases (10 confirmed cases, 9 probable)	N/A

LITERATURE REVIEW

The data presented in this study was abstracted from a popular search engines accomplished in the month of May 2022. Search engines such as Google Scholar and PubMed Central. In PubMed Central 86 articles returned 9 were abstracted with reference to keywords similarities those published within the last 5 years and Google Scholar 144 articles returned, using keywords related to reemergence of human monkeypox its public health significance 11 articles were returned for inclusion. That included 21 studies collectively. All included papers were done within 2017 to 2022 and published in English to response the research question of this study. Original articles, text books and review works are the articles included in this paper. These articles were compiled, transmission mode, and further tabulated and grouped into symptoms, risk factors or behaviors and treatment in

Table 3. Study result revealed several modes of transmission ranging from human-to-human and animal-to-human (zoonotic transmission). Fever onset and lymphadenopathy were shown to be initial symptoms of monkeypox which however, distinguishes it from that of smallpox. Sharing dish with infected patient and sleeping together were revealed to be risk behaviors that will lead one to get infected with disease. Similarly, comparing this with zoonotic transmission, sleeping, touching and living near forest also identified as some risk factors of contracting the disease. Vaccination and antivirals

reported in many studies to have impact in prevention against any form of orthopoxviral. Furthermore, importance of this antivirals further discussed about how it proved to be effective among individuals.

MONKEYPOX: TRANSMISSION MODE

There are typically 2 common and possible means of MPXV mode of transmission; animals-to-human transmission and human-to-human transmission. Human-to-human transmission; consists of respiratory droplets and exposure with infected person body liquids, meeting infected person's accessories/environment, inter-human transmission has been found to have contact association with infected patient's skin lesion. This is evidence-based report on Central Africa clade were inter-human spread reported to be more, this is however, in contrast to West African clade.^{8,9}

Animal-to-human transmission; (zoonotic transmission), the viral hosts are classified based on their model hosts, "the rope squirrels, tree squirrels, followed by Gambian pouched rats, non-human primates as well as the dormice".¹⁰ Animal to human transmission transpires through direct contact with the company of any of previously mentioned natural viral hosts of MPXV/by anyways consumption of any of hosts. However, animal-to-human transmission might happen via unmediated contact with infected animal body fluids, blood, and injection of mucocutaneous lesion of an infected zoonotic host.^{9,11}

Table 2: The cases of monkeypox upsurge in non-endemic countries reported to WHO between 13 to 21 May 2022 as at 13:00.

Country	Confirmed	Suspected
Australia	1 to 5	None
Belgium	1 to 5	1 to 5
Canada	1 to 5	11-20
France	1 to 5	1 to 5
Germany	1 to 5	None
Italy	1 to 5	None
Netherlands	1 to 5	None
Portugal	21 to 30	None
Spain	21 to 30	6 to 10
Sweden	1-5	None
United Kingdom	21 to 30	None
United States of America	1 to 5	None
Total	92	28

Table 3: Symptoms.

Symptoms	Risk factor	Treatment
Some clinical features of monkeypox bear a resemblance to that of smallpox, the following symptoms are the major differences that distinguish monkeypox from smallpox	Human-to-human: the risk behaviors suspected for contracting MPXV are; living in the same house, sharing the same bed or room with the infected person. ¹³ eating or drinking from the same meal with the MPV confirmed person. ¹⁴	Vaccination: it was reported in many studies that smallpox vaccination imparts cross protection against other form of orthopoxviral sort including MPXV. ¹⁸
Onset of fever, rash appearance usually occurs 1st to 3rd days following the onset of fever, enlargement of lymph node accompanied by simultaneous lesion appearance progressing at a similar size mainly in the peripheral limbs but can wrap the whole body in case of severe illness.¹²	Animal-to-human: sleeping on the ground surface, or outside household, or going to/living near the jungle were revealed as some risk factors that increase the chances of exposure for animal-to-human transmission. ^{15,16}	As reported in some published studies, any individual that is already vaccinated earlier against smallpox were seen to be protected up to 85% against MPXV. ^{18,19}
the infection last-up to the period of 4 weeks until the skin lesion peels off.¹²	Daily vulnerability to sick animals, bedding and washing their cages. touching, or getting a scratch by an infected animal that cause a skin bleed were also identified as risk behaviors that can lead one to acquire MPXV. ¹⁷	Antivirals: the food and drug administration (FDA) has approved 4-trifluoromethylphenol or tecovirimat derivative to be effective on the infected animals by obstructing the release of intracellular virus from the cell, observed following a clinical trial, using animal as a model. ^{19,20}
		However, Cidofovir and Brincidofovir, were proved to be effective antivirals. ²¹ Iseni and Delaune were proved to have potential antiviral activity against orthopoxviruses following series of clinical trials. ²²

DISCUSSION

The initial monkeypox outbreak that involved human beings in the United States of America in the year 2003, might aid in structuring response to the essential query presented in this paper.^{23,24} There are ascending worries relating to the geographical escalate and greater upburst of monkeypox worldwide. Reference to the current situation, monkeypox outbreaks have been reported over the past 5 decades, the initial outbreak was recovered in 10 African countries and subsequently 4 countries apart from Africa. Additionally, the resurgence of MPXV in African countries, especially Nigeria about 40 years of the initial outbreak, around 2010-2019 there was a report for the disease re-emergence in Sierra Leone and Liberia that is about 4 decades after the outbreak. It was revealed that, the first outbreaks of monkeypox emerged inside the Republic of Congo in the year 2000 to 2009 while in South Sudan the outbreak emerged in 2005 respectively.²⁵

Ultimately, in the year 2003, the first case of monkeypox imported to the United State of America was via rodents from Ghana, which was counted as first zoonotic transmission that subsequently led to animal-to-human

transmission, and about 47 cases were confirmed.²⁵ In the year 2018-2021, adults proceeding to Israel, the United Kingdom, Singapore, and the United States from Nigeria, was diagnosed with MPXV.²⁶⁻³¹ These mentioned cases were skeptical to be the result of zoonotic transmission (animal-to-human transmission). During the rampant flow of smallpox, at that time no cases of monkeypox were announced. One of the reasons for that could have been the indistinguishable features of the two diseases (smallpox and monkeypox), or simply because the world put more priority over the smallpox or ultimately could have been due to deficiency of science laboratory corroboration of the etiologic factor that guides to supposition of smallpox.³² As shown in some documented data, vaccination of smallpox was found to be nearly protective against monkeypox up to 85%.³³

According to the study model of modelling human-to-human transmission of the monkeypox, it was reported that since about 85% of the population were immunized against monkeypox, the monkeypox outbreak could not have commenced in the Republic of Congo between the year 1980 and 1984 respectively. In sequence to these years, monkeypox was noticed as an infrequent disease in

the population, transpiring only occasionally. However, afterwards, the DRC has announced the rapid expansion of monkeypox human-to-human transmission.³⁴ A notable challenge faced by the health care workers, those working in the rural Republic of Congo and additional poor resource settings is how to supply proper and basic care for patients with monkeypox with a recommended evidence-based treatment protocol, including the basic supportive therapies were a concern.³⁵

Current evidence supporting the rapid rise of monkeypox over time was most persistent in the Republic of Congo where other diseases remain at constant, while the monkeypox incidence rises over time.³⁶ The current outbreak of monkeypox is among the reported increased resurgence outside the Republic of Congo, this therefore suggest that the incidence has arisen over a broader geographical extend. With the lack of surveillance prior, presently there have been a few remarkable advances in the scrutiny systems, this is succeeding a joint external evaluation assessment by the global health security agenda, as well as some developments in laboratory capacity, it is however improbable supportive cause for the changes observed in the epidemiology of monkeypox.³⁶ Being MPXV an orthopoxviral family, it is however evident to have a risk to the general populations especially the endemic areas, and of course in children as it is evidently seen during the recent pandemic of coronavirus, how the disease produces a prospective health risk on overall children development, health intervention for further research and betterment of informed information, education and counseling of the parent about their children's health is highly magnificent.^{37,38} Therefore, a significant developments in qualitative and quantitative of outbreak data collection is crucial and need an emergency treat in order to encourage the researchers to improve more findings on the monkeypox outbreak, which will subsequently enhances appropriate case management and public health reaction.

Limitations

the finding presented in this paper may not be generalized globally due to its short review nature. Study bias was observed as more priority in terms of health care support was shown to the endemic areas in lieu to general population. In addition, lack of qualitative and quantitative data source is observed during the initial endemic in the republic of congo which could had been tackle as well as improve for the betterment of preventing the population as a whole. The up to date data could have aid within the advancement of a standard rules for prophylaxis as well as management/treatment of the monkeypox disease in an infected patient. However, clear focus and proper discussion about importance of qualitative and quantitative research aspect on monkeypox should be put into consideration, as there is currently a very limited details on the outcome of monkeypox disease on gravid women and their unborn children. Eventually, this could therefore aid in promoting

people's knowledge on the necessary preventive measures against the monkeypox disease. In a nutshell, nothing was mentioned about comparison of monkey pox infection among various age groups. There was also no citation or situation in which monkeypox was co-management with any other disease simultaneously.

CONCLUSION

The recent monkeypox reemergence could be due to climate change, deforestation, lack of proper health and research advance infrastructure among the society and uncontrol intake of bush meat in the African countries that may have produced an ecological and immunological recess for MPXV to resurge in the African countries. The MPX reemergence has proved that the virus cannot be confined to the upsurge geographical locations, as cases of travelers from Ghana and Nigeria have reported positive to the United States, United Kingdom, Singapore and Israel in recent years. It is recommended that epidemiological surveillance of MPXV in humans should be performed on a frequent basis and not just for the seek of response to an outbreak. However, due to the rapid global outreach of monkeypox endemic, it should be therefore considered as a very serious re-surfing pathogen in the world. One of the major concerns among the health care professionals is human-to-human monkeypox transmission, and it is also a worry between the household members.

Proper observational research could bring more light on the influence of MPXV on overall human health, it should also shed light on detail route of transmission in both human-to-human and zoonotic transmission, the clinical features, the rate of re-emergence, the health consequences, the chances of secondary viral infections, the rate of mortality and prevalence of potential complications. This could aid in treatment or supportive care, optimizing the nature of the disease and curative measures of either the monkeypox or smallpox emergency.

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REFERENCES

1. Guagliardo SA, Reynolds MG, Kabamba J, Nguete B, Shongo Lushima R, Wemakoy OE et al. Sounding the alarm: Defining thresholds to trigger a public health response to monkeypox. *PLoS Neglected Trop Dis*. 2018;12(12):e0007034.
2. Ogoina D, Izibewule JH, Ogunleye A, Ederiane E, Anebonam U, Neni A et al. The 2017 human monkeypox outbreak in Nigeria-report of outbreak experience and response in the Niger Delta University Teaching Hospital, Bayelsa State, Nigeria. *PLoS One*. 2019;14(4):e0214229.

3. Tumewu J, Wardiana M, Ervianty E, Anggraeni S, Widia Y, Amin M et al. An adult patient with suspected of monkeypox infection differential diagnosed to chickenpox. *Infectious Dis Rep*. 2020;12(S1):33-5.
4. Doshi RH, Guagliardo SA, Doty JB, Babeaux AD, Matheny A, Burgado J et al. Epidemiologic and ecologic investigations of monkeypox, Likouala Department, Republic of the Congo, 2017. *Emerging Infect Dis*. 2019;25(2):273.
5. Khodakevich L, Ježek Z, Messinger D. Monkeypox virus: ecology and public health significance. *Bull World Heal Organiz*. 1988;66(6):747.
6. Moore MJ, Rathish B, Zahra F. Mpox (monkeypox). *Treasure Island (FL): StatPearls Publishing*; 2022. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK574519/>. Accessed on 10 January, 2023.
7. Sklenovska N, Van Ranst M. Emergence of monkeypox as the most important orthopoxvirus infection in humans. *Frontiers Publ Heal*. 2018;6:241.
8. Multi-country monkeypox outbreak in non-endemic countries. Available at: <https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON385>. Accessed on 10 January, 2023.
9. Jenewari FO. Monkey Pox in Nigeria: Epidemiology and Prevention. In *Proceedings of the Problems and Prospects for the Development of Modern Medicine*, GomSMU, Kharkiv, Ukrainian. 2019;194-5.
10. Brown K, Leggat PA. Human monkeypox: Current state of knowledge and implications for the future. *Trop Med Infect Dis*. 2016;1-8.
11. Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox Virus in Nigeria: Infection Biology, Epidemiology, and Evolution. *Viruses*. 2020;12(11):1257.
12. Ugorji CV, Nworuh Ibe SNO, Iwuoha G, Abanobi OC. Factors associated with the practice of monkey pox preventive behaviors among health workers in Yenagoa LGA, Bayelsa state, Nigeria. *IOSR J. Nurs Health Sci*. 2019;8:75-85.
13. Sklenovská N, Van Ranst M. Emergence of Monkeypox as the Most Important Orthopoxvirus Infection in Humans. *Frontiers Publ Heal*. 2018;6:241.
14. Jezek Z, Grab B, Szczeniowski MV, Paluku KM, Mutombo M. Human monkeypox: secondary attack rates. *Bull World Health Organ*. 1988;66(4):465-70.
15. Nolen LD, Osadebe L, Katomba J, Likofata J, Mukadi D, Monroe B et al. Introduction of monkeypox into a community and household: Risk factors and zoonotic reservoirs in the Democratic Republic of the Congo. *Am J Trop Med Hyg*. 2015;93(2):410-5.
16. Fuller T, Thomassen HA, Mulembakani PM, Johnston SC, Lloyd-Smith JO, Kisalu NK et al. Using remote sensing to map the risk of human monkeypox virus in the Congo Basin. *Ecohealth*. 2011;8(1):14-25.
17. Guagliardo SAJ, Doshi RH, Reynolds MG, Dzabatou-Babeaux A, Ndakala N, Moses C et al. Do monkeypox exposures vary by ethnicity? Comparison of Aka and Bantu suspected monkeypox cases. *Am J Trop Med Hyg*. 2020;102(1):202-5.
18. Reynolds MG, Davidson WB, Curns AT, Conover CS, Huhn G, Davis JP et al. Spectrum of infection and risk factors for human monkeypox, United States, 2003. *Emerg Infect Dis*. 2007;13(9):1332-9.
19. Brown K, Leggat PA. Human monkeypox: Current state of knowledge and implications for the future. *Trop. Med. Infect. Dis*. 2016;1:8.
20. Nasir IA, Dangana A, Ojeamiren I, Emeribe AU. Reminiscing the recent incidence of monkeypox in Nigeria: Its ecologic-epidemiology and literature review. *Port Harcourt Med J*. 2018;11:1-9.
21. Fowotade A, Fasuyi TO, Bakare RA. Re-emergence of monkeypox in Nigeria: A cause for concern and public enlightenment. *Afr J Clin Exp Microbiol*. 2018;19:307.
22. Wilson ME, Hughes JM, McCollum AM, Damon IK. Human monkeypox. *Clin Infect Dis*. 2014;58:260-7.
23. Delaune D, Iseni F. Drug development against small pox: Present and future. *Antimicrob. Agents Chemother*. 2020;64:1-22.
24. Centers for Disease Control and Prevention. Update: multistate outbreak of monkeypox-Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin, 2003. *MMWR Morb Mortal Wkly Rep*. 2003;52:642-6.
25. Reed KD, Melski JW, Graham MB. The detection of monkeypox in humans in the Western Hemisphere. *N Engl J Med*. 2004;350:342-50.
26. Centers for Disease Control and Prevention. Monkeypox. Available at: <https://www.cdc.gov/poxvirus/monkeypox/index.html>. Accessed on 10 January, 2023.
27. Erez N, Achdout H, Milrot E, Schwartz Y, Wiener-Well Y, Paran N et al. Diagnosis of imported monkeypox, Israel, 2018. *Emerg Infect Dis*. 2019;25(5):980-3.
28. Public Health England. Monkeypox case confirmed in England 2019. Available at: <https://www.gov.uk/government/news/monkeypox-case-confirmed-in-england>. Accessed on 10 January, 2023.
29. Public Health England. Monkeypox case confirmed in England 2019. Available from: <https://www.gov.uk/government/news/monkeypox-case-confirmed-in-england>. Accessed on 10 January, 2023.
30. Monkeypox-United Kingdom of Great Britain and Northern Ireland (Nigeria). 2021. Available at: <https://www.who.int/emergencies/disease-outbreak-news/item/monkeypox-united-kingdom-of-great-britain-and-northern-ireland-ex-nigeria>. Accessed on 10 January, 2023.

31. Yong SEF, Ng OT, Ho ZJM, Mak TM, Marimuthu K, Vasoo S et al. Imported monkeypox, Singapore. *Emerg Infect Dis*. 2020;26(8):1826-30.
32. CDC Newsroom. CDC and Texas Confirm Monkeypox In U.S. Traveler. 2021. Available at: <https://www.cdc.gov/media/releases/2021/s0716-confirm-monkeypox.html>. Accessed on 10 January, 2023.
33. Reynolds MG, Carroll DS, Karem KL. Factors affecting the likelihood of monkeypox's emergence and spread in the post-smallpox era. *Curr Opin Virol*. 2012;2(3):335-43.
34. Fine PE, Jezek Z, Grab B, Dixon H. The transmission potential of monkeypox virus in human populations. *Int J Epidemiol*. 1988;17(3):643-50.
35. Rimoin AW, Mulembakani PM, Johnston SC, Lloyd Smith JO, Kisalu NK, Kinkela TL et al. Major increase in human monkeypox incidence 30 years after smallpox vaccination campaigns cease in the Democratic Republic of Congo. *Proc Natl Acad Sci USA*. 2010;107(37):16262-7.
36. Rimoin AW, Kisalu N, Kebela-Ilunga B, Mukaba T, Wright LL, Formenty P et al. Endemic human monkeypox, Democratic Republic of Congo, 2001-2004. *Emerg Infect Dis*. 2007;13:934-7.
37. Durski KN, McCollum AM, Nakazawa Y, Petersen BW, Reynolds MG, Briand S et al. Emergence of Monkeypox - West and Central Africa, 1970-2017. *Morbidity Mortality Weekly Rep*. 2018;67(10):306-10.
38. Karama RS, Simon NH, Chatterjee A, Aswasthi S, Akinola A, Acharya S et al. Effectiveness of video-based teaching program to assess the knowledge of young mothers in identifying developmental milestones in Delhi NCR, India. *Int J Heal Sci*. 2022;6(S1):12194-04.
39. Akinola A, Karama R, Rajput M. Awareness of natural breastfeeding milk among mothers and the importance of colostrum within the first hour of birth in India. *Int J Community Med Publ Heal*. 2022;9(7):2992-7.

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