

EVIDENCE OF CORRESPONDENCE

Article Title : Monkeypox Transmission Risks in Indonesia

Journal : Public Health of Indonesia, Volume 8, Issue 3, 68 – 74, July - September 2022

Authors : **Hermawan Saputra**, Nadilah Salma, Sheila Rizkia Anjari

1. Submitted to the journal “Public Health of Indonesia (PHI)” (14-08-2022)
2. First revision: Accepted with major revision (28-08-2022)
3. Revision submitted (30-08-2022)
 - Revisions and Amends
 - Revised version with highlights
4. Paper accepted (10-09-2022)
5. Final Approval Article (11-09-2022)
6. Paper published (17-09-2022)
 - Final paper

- 1. Submitted to the journal “Public Health of Indonesia (PHI)”
(14-08-2022)**

634 / Saputra et al. / Monkeypox transmission risks in Indonesia

Library

Workflow Publication

- [Submission](#)

- [Review](#)

- [Copyediting](#)

- [Production](#)

Submission Files

- [Search](#)

Name	Date	Component
Settings <input type="text" value="1686"/> Monkeypox DHS et al (1).docx	August 14, 2022	Article Text

MONKEYPOX TRANSMISSION RISKS IN INDONESIA

Hermawan Saputra¹, Nadilah Salma², Sheila Rizkia Anjari³

¹Universitas Muhammadiyah Prof.Dr. Hamka

²Universitas Indonesia

³Universitas Pembangunan Nasional Veteran Jakarta

Correspondence: hermawan.saputra@uhamka.ac.id

Abstract

After half a century as a regional disease in Central and West Africa, in 2022, Monkeypox became a reemerging disease and its spread became transnational and transcontinental. The ease of global mobilization, the risk of deviant behavior, and the possibility of virus mutations helped facilitate its spread until WHO declared it a Public Health Emergency of International Concern. Through various works of literature and secondary data, this study examines the risk of monkeypox disease in Indonesia. Considering various characteristics possessed by the Indonesian state including geographical conditions, demographics, population mobility, and virus characteristics, it is most likely that there should have been monkeypox cases in Indonesia but may not have been detected. Early vigilance needs to be owned by the community accompanied by policy support and or intervention to prevent Monkeypox transmission, especially in surveillance efforts.

Keyword: Disease, Indonesia, Monkeypox, Outbreak Risk, Transmission.

Introduction

Having not yet recovered from the COVID-19 pandemic, the world has again been made aware of the monkeypox pandemic. The World Health Organization, on 23 July 2022, declared a Public Health Emergency of International Concern (PHEIC) status because of the increasing number of cases in non-endemic areas (World Health Organization, 2022). Monkeypox is not a new disease but has been detected in monkeys since 1956 (Magnus et al., 1958). Then, in 1970, in Zaire (now Congo), Monkeypox was first identified in humans so it was established as a zoonotic pathogen (Breman et al., 1980). From that time until before May 2022, monkeypox cases were found in the Republic of Congo with virus transmission taking place from animal reservoir hosts to humans. (Heymann et al., 1998; Ulaeto et al., 2022). Although there are also few and infrequent numbers of imported cases occurring in Europe and America.

The explosion of Monkeypox cases in several countries indicates an increase in human-to-human transmission of the virus. For 8 months (1 January 2022-9 August 2022) 31,800 confirmed cases of monkeypox. Of this total, 98.8% of cases came from countries where Monkeypox had not previously been reported (Centers for Disease Control and Prevention, 2022b). A total of 89 countries have reported cases, from the previous only 7 countries. During that period, the most cases occurred in the United States (9,492), Spain (5,162), and Germany (2,982). Until August 2022, there is no data on Monkeypox cases in Indonesia which should raise a critical question, has Monkeypox really not happened in this country, or has not been detected?

This is a narrative review with the desk study method. This research aims to study the risk of Monkeypox transmission in Indonesia since WHO declared it as PHEIC. Several aspects were looked into, such as virus characteristics, geographical conditions, demographics, and population mobility.

Monkeypox at a glance:

Monkeypox is caused by a DNA virus of the genus Orthopoxvirus in the same family as the smallpox virus, namely Poxviridae. So far, two virus clades have been identified: the West African clade and the Congo Basin (Central Africa) clade(Mohapatra et al., 2022). The Congo Basin clade is more dangerous than the other clade as seen from the consistently higher case fatality rate (CFR) than the West African clade. The outbreak that occurred in 2022 is caused by West African clade.

The incubation period for this Monkeypox virus is usually 6-13 days but can range from 5 to 21 days. This disease forms skin eruption which generally begins within 1-3 days of fever. Meanwhile, symptoms can last from 2 to 4 weeks. Monkeypox can be detected when there are symptoms and at that time the transmission is highest. Unlike COVID-19, which can be transmitted even though it is asymptomatic.

Monkeypox is also known as a disease that can heal by itself (self-limited). Even so, cases of death still occur and the severity among patients can vary. The CFR varies from 1 to 11% even in children it can reach 15%(Jezek et al., 1987). Generally, Monkeypox is more severe in vulnerable groups.

Monkeypox is similar to other smallpox, one of which is caused by the Varicella Zoster Virus. For an accurate diagnosis, confirmation of the virus needs to be done using real-time polymerase chain reaction (PCR) and sequencing. This is because the antibody and antigen detection methods do not provide specific confirmation of monkeypox because orthopoxvirus is serologically cross-reactive(Mohapatra et al., 2022).

Geography:

Indonesia is a country with a strategic location and many country entrances with various routes that have many high risks of Monkeypox outbreaks. Indonesia's position which is at the crossroads of two continents, Asia and Australia, and two oceans, the Pacific and the Indian Ocean, makes Indonesia a

transportation route, especially for trade transportation. Ninety percent of world trade is transported by sea and almost half through Indonesia (Ministry of Transportation of The Republic of Indonesia, 2018). Not to mention Indonesia's export and import activities that increase the epidemiological risk of contacting disease agents with humans at ports, airports, and other transportation entrances.

Borders with other countries also increase the risk of disease transmission through the mobility of people. Indonesia shares land borders with Malaysia, Papua New Guinea, and Timor Leste. Meanwhile, its maritime areas are directly adjacent to Singapore, Malaysia, Thailand, Vietnam, the Philippines, India, Palau, Australia, Papua New Guinea, and Timor Leste. In some neighboring countries, Monkeypox cases have been reported, including Singapore (15 people), Thailand (4 people), Philippines (1 person), India (9 people), and Australia (58 people) (Centers for Disease Control and Prevention, 2022a).

The diversity of landscapes with high biodiversity also increases the potential risk of zoonoses, including monkeypox, in Indonesia. This is mainly related to the increasing population forcing the conversion of wild animal habitats into settlements, land, and other infrastructures to support human life, thereby increasing the potential for contact between humans and animals (Breithaupt, 2003).

Demographics and Population Mobility:

In the past, people who were infected with Monkeypox were children under the age of 10 years. More than 80% of the cases recorded in the 1970s to 1990s cohort were under the age of 15 while less than 50% of the population was under 15 during that period of time (Beer & Bhargavi Rao, 2019). Then the pattern of disease incidence changed to cases that commonly occur in adults 25-40 years old, including the outbreak in 2022. When viewed by gender, male cases are higher than female cases (Beer & Bhargavi Rao, 2019).

The Monkeypox case that occurred in the 2022 outbreak brought a special community to the surface with a high number of cases, called LGBTQ+. Of the several reported cases, the sufferers are men who

like men (MSM) and are bisexual(Jang et al., 2022; Thornhill et al., 2022). Most of them had sexual intercourse before being diagnosed with Monkeypox(Thornhill et al., 2022). This pattern of sexual transmission is considered unusual because there have been no previous reports of sexual transmission of the disease(Adegboye et al., 2022; Pan et al., 2022). The LGBTQ+ community, in this case, is a high-risk group. In Indonesia, the LGBTQ+ community has grown quite large, in 2013, it consisted of 2 national networks and 119 organizations in 28 provinces(Oetomo et al., 2014).

Monkeypox is not a lethal disease. However, deaths from monkeypox, which were recorded, occurred in several high-risk groups including infants, young children (less than 10 years), pregnant women, patients with complications, and immunocompromised individuals, suggesting this is a high-risk group(Beer & Bhargavi Rao, 2019). The total population of Indonesia, which is more than 270 million people, automatically calculates the proportion of these vulnerable groups bigger.

The potential import of monkeypox cases in Indonesia is related to human mobility as a risk factor for disease transmission in terms of the number of arrivals and departures of international flights to and from Indonesia. Based on data from the Indonesian Central Statistics Agency (BPS), information was obtained that international flights to and from Indonesia showed a gradual upward trend in the period 2015 to 2019(Badan Pusat Statistik, 2019, 2022). In 2020 when the COVID-19 pandemic occurred, this number decreased to approximately one-fifth of the number in 2019. The data for 2021 and 2022 have not yet been released by BPS, but based on Government of Indonesia's (GoI) statement in news articles, the number of flight passengers has increased in 2022. The increase in flight frequency has also occurred in many other countries considering that all of them have loosened restrictions due to COVID-19 cases which have gradually subsided.



Figure 1 Number of International Flight Passengers (to and from Indonesia)

Source: BPS

Flights from Monkeypox endemic areas have also increased. The number of international flight departures through Nigerian airports, for example, increased by 54.7 percent from 2021 (717,261 to 1,109,525). The number of arrivals of international passengers also increased by from 690,765 to 1,109,621(Olowookere, 2022).

Efforts to prevent transmission and treatment of Monkeypox:

Until today, there is no specific medicine for Monkeypox disease. However, to provide protection and reduce the severity, Smallpox vaccine and antiviral drugs (Tecovirimat and Brincidofovir) can be used(Centers for Disease Control and Prevention, 2022d). Smallpox vaccination is estimated to provide up to 85% cross-protection against monkeypox with unknown duration of protection(Centers for Disease Control and Prevention, 2022c). The Centers for Disease Control and Prevention (CDC) recommends vaccination within 4 days of exposure to prevent illness or up to 14 days after exposure to

reduce disease severity. Meanwhile, the use of both antivirals for the treatment of monkeypox has only been tested in vitro and in animal studies, so further clinical testing is needed.

Access to vaccines is still very limited. Currently, the United States is a country that has a large stock of vaccines. The vaccine, under the trade name JYNNEOS, will be distributed to high-risk people in the United States(The White House, 2022). The availability of this vaccine is the result of anticipating monkeypox cases after some cases occurred years ago.

The international community has begun to take steps to mitigate the outbreak amid the limitations of these clinical interventions. Efforts to detect and isolate monkeypox cases have now begun to be carried out by several countries. Belgium, for example, has implemented a mandatory 21-day quarantine for Monkeypox patients. As a detection effort, Brazil and other Latin American countries are increasing laboratory capacity by establishing skilled molecular biology and genome sequencing laboratories that routinely perform RT-PCR and phylogenetic studies(Cimerman et al., 2022).

Discussion

It is very likely that monkeypox cases in Indonesia already exist but have not been detected and reported. Given the magnitude of Indonesia's potential for disease transmission from various aspects that have been studied in this paper. From the demographic aspect, Indonesia is the 4th largest country by population (274,790,244 people). When compared with the two countries with the most reported monkeypox cases as of August, the United States and Brazil, these countries have slightly different number of the population to Indonesia, respectively, 332,975,770 and 214,962,388. If there are thousands of Monkeypox cases in both countries, how many cases should be in Indonesia?

The omission of Monkeypox cases in Indonesia and several other countries is most likely due to the ability to detect and diagnose the disease. Countries with reported Monkeypox cases in the 2022 outbreak, especially the high ones, have good health systems to deal with health emergencies. Countries

such as America, Spain, Germany and, many of those which close to Indonesia, like Singapore, Australia, and Thailand, are ranked quite well in the aspects of handling the outbreak which is summarized in the Global Health Security Index (Bell & Nuzzo, 2021). Meanwhile, Indonesia's position is still far behind in ranking compared to these countries.

The GoI needs to strengthen surveillance for Monkeypox disease. If there is a confirmed case of Monkeypox, it is necessary to immediately do tracing and treatment. Similar to the experience of dealing with the COVID-19 pandemic, the 3T concept (testing, tracing, and treatment) still applies. Things that need to be emphasized more may be related to making a diagnosis which will be a bit tricky, given the clinical overlap between monkeypox and other smallpox diseases. Beer (2019) in his research alludes to this, in which a proportion of the identified but unconfirmed monkeypox cases reported in the literature are likely to be varicella-zoster virus (VZV).

In the past, the GoI had a national vaccination program for smallpox but in 1980 it was stopped since Indonesia successfully got rid of Smallpox disease (Ministry of Health of the Republic of Indonesia, 2017). The smallpox vaccination program had been organized by the GoI starting in 1956 and the colonial government in the 19th century (Santoso et al., 2015). The implementation of smallpox vaccination may be considered by looking at the condition of public health status in this epidemic era and accompanied by appropriate strategies (e.g. targeting high-risk groups).

Despite of limited access to monkeypox vaccines and antivirals, physical distancing and the application of clean and healthy living behavior are still effective solutions to prevent monkeypox transmission. Given the transmission of monkeypox through physical contact with patient lesions. Indirect transmission with patients still needs to be further investigated. The following two cases can serve as a basis for thinking about the need for further research. First, the Atkinson study (2022) tried to examine environmental samples carried out in two adjoining rooms occupied by Monkeypox patient and his siblings. Although Monkeypox virus DNA was found in several locations in both properties (after 3 days since the last occupancy), the patient's relative did not get Monkeypox (Atkinson et al., 2022).

Another case is the transmission of Monkeypox to health workers who were infected when handling patients with full-body personal protective equipment (PPE) except respiratory PPE.

In addition all of these risk factors, the Monkeypox virus itself need to be studied further. The Swift change in virus transmission, from animal-to-human to human-to-human, brings the need to suspect the possibility of virus mutation. Regardless of Monkeypox virus type, DNA virus, which characteristics are different from RNA viruses, that are more difficult to mutate (Duffy, 2018; Peck & Lauring, 2018; Sanjuan & Domingo-Calap, 2016).

References

- Adegboye, O. A., Eugenia Castellanos, M., Alele, F. O., Pak, A., Ezechukwu, H. C., Hou, K., & Emeto, T. I. (2022). Travel-Related Monkeypox Outbreaks in the Era of COVID-19 Pandemic: Are We Prepared? *Viruses*, *14*(6), 1283. <https://doi.org/10.3390/v14061283>
- Atkinson, B., Burton, C., Pottage, T., Thompson, K.-A., Ngabo, D., Crook, A., Pitman, J., Summers, S., Lewandowski, K., Furneaux, J., Davies, K., Brooks, T., Bennett, A. M., & Richards, K. (2022). Infection-competent monkeypox virus contamination identified in domestic settings following an imported case of monkeypox into the UK. *MedRxiv*, *July*, 2022.06.27.22276202. <https://doi.org/10.1101/2022.06.27.22276202>
- Badan Pusat Statistik. (2019). *Lalu Lintas Penerbangan Luar Negeri Indonesia Tahun 2003-2018*. <https://www.bps.go.id/statictable/2009/02/21/1403/lalu-lintas-penerbangan-luar-negeri-indonesia-tahun-2003-2018.html>
- Badan Pusat Statistik. (2022). *Jumlah Penumpang Internasional berdasarkan Moda Transportasi Pesawat Terbang menurut provinsi (Orang), 2019-2020*. <https://www.bps.go.id/indicator/17/2027/1/jumlah-penumpang-internasional-berdasarkan-moda-transportasi-pesawat-terbang-menurut-provinsi.html>
- Beer, E. M., & Bhargavi Rao, V. (2019). A systematic review of the epidemiology of human

- monkeypox outbreaks and implications for outbreak strategy. *PLoS Neglected Tropical Diseases*, 13(10), 1–20. <https://doi.org/10.1371/journal.pntd.0007791>
- Bell, J. A., & Nuzzo, J. B. (2021). *Global Health Security Index: Advancing Collective Action and Accountability Amid Global Crisis*.
- Breithaupt, H. (2003). Fierce creatures. *EMBO Reports*, 4(10), 921–924. <https://doi.org/10.1038/sj.embor.embor949>
- Breman, J. G., Ruti, K., & Steniowski, M. V. (1980). Human monkeypox, 1970-79. *Bulletin of the World Health Organization*, 58(2), 165–182.
- Centers for Disease Control and Prevention. (2022a). *2020 Monkeypox Outbreak Global Map*. <https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>
- Centers for Disease Control and Prevention. (2022b). *2022 Monkeypox Outbreak Global Map*. <https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>
- Centers for Disease Control and Prevention. (2022c). *Monkeypox and Smallpox Vaccine Guidance*. <https://www.cdc.gov/poxvirus/monkeypox/clinicians/smallpox-vaccine.html>
- Centers for Disease Control and Prevention. (2022d). *Treatment Information for Healthcare Professionals*. <https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html>
- Cimerman, S., Chebabo, A., Cunha, C. A. da, Barbosa, A. N., & Rodríguez-Morales, A. J. (2022). Human monkeypox preparedness in Latin America – Are we ready for the next viral zoonotic disease outbreak after COVID-19? *The Brazilian Journal of Infectious Diseases*, 26(3), 102372. <https://doi.org/10.1016/j.bjid.2022.102372>
- Duffy, S. (2018). Why are RNA virus mutation rates so damn high? *PLoS Biology*, 16(8), 1–6. <https://doi.org/https://doi.org/10.1371/journal.pbio.3000003>
- Heymann, D. L., Szczeniowski, M., & Esteves, K. (1998). Re-emergence of monkeypox in Africa: A

- review of the past six years. *British Medical Bulletin*, 54(3), 693–702.
<https://doi.org/10.1093/oxfordjournals.bmb.a011720>
- Jang, Y. R., Lee, M., Shin, H., Kim, J.-W., Choi, M.-M., Kim, Y. M., Lee, M. J., Kim, J., Na, H. K., & Kim, J. Y. (2022). The First Case of Monkeypox in the Republic of Korea. *Journal of Korean Medical Science*, 37(27), e224. <https://doi.org/10.3346/jkms.2022.37.e224>
- Jezek, Z., Szczeniowski, M., & Paluku, K. M. (1987). *Human Monkeypox : Clinical Features of 282 Patients*. 156(2), 293–298.
- Magnus, P. von, Andersen, E. K., Petersen, K. B., & Birch-Andersen, A. (1958). *A Pox-Like Disease in Cynomolgus Monkeys*.
- Ministry of Transportation of The Republic of Indonesia. (2018). *Forty percent of the world's trade routes pass through Indonesia*. <http://dephub.go.id/post/read/empat-puluh-persen-jalur-perdagangan-dunia-melewati-indonesia>
- Ministry of Health of the Republic of Indonesia. (2017). *Vaccines in Indonesia Successfully Eradicate Smallpox and Polio and Eliminate Tetanus*. <https://sehatnegeriku.kemkes.go.id/baca/rilis-media/20170429/1420692/vaksin-indonesia-berhasil-membasmi-cacar-dan-polio-serta-mengeliminasi-tetanus/>
- Mohapatra, R. K., Tuli, H. S., Sarangi, A. K., Chakraborty, S., & Chandran, D. (2022). Unexpected sudden rise of human monkeypox cases in multiple non-endemic countries amid COVID-19 pandemic and salient counteracting strategies: Another potential global threat? *International Journal of Surgery*, 103(June), 1–4.
- Oetomo, D., Suvianita, K., Halim, K. S. S., Liang, J., Soepartha, S., & Surahman, L. (2014). *Hidup Sebagai LGBT di Asia: Laporan Nasional Indonesia*.
- Olowookere, D. (2022). *Nigeria Records 54.7% Rise in International Flight Departures*.

<https://businesspost.ng/travel/nigeria-records-54-7-rise-in-international-flight-departures/>

Pan, D., Sze, S., Nazareth, J., Martin, C. A., Al-Oraibi, A., Baggaley, R. F., Nellums, L. B., Hollingsworth, T. D., Tang, J. W., & Pareek, M. (2022). Monkeypox in the UK: arguments for a broader case definition. *The Lancet*, 399(10344), 2345–2346. [https://doi.org/10.1016/S0140-6736\(22\)01101-1](https://doi.org/10.1016/S0140-6736(22)01101-1)

Peck, K. M., & Luring, A. S. (2018). Complexities of Viral Mutation Rates. *Journal of Virology*, 92(14).

Sanjuan, R., & Domingo-Calap, P. (2016). Mechanisms of viral mutation. *Cellular and Molecular Life Sciences*, 4433–4448. <https://doi.org/10.1007/s00018-016-2299-6>

Santoso, A., Cholikh, A., Patriasari, B., Mulyaningsih, D., SP., R. S., & Sunjaya, S. (2015). *Naskah Sumber Arsip Kesehatan Masyarakat* (S. K. Yahya (ed.)). Arsip Nasional Republik Indonesia.

The White House. (2022). *FACT SHEET: Biden-Harris Administration's Monkeypox Outbreak Response*. <https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/28/fact-sheet-biden-harris-administrations-monkeypox-outbreak-response/>

Thornhill, J. P., Barkati, S., Walmsley, S., Rockstroh, J., Antinori, A., L.B.Harrison, Palich, R., Nori, A., Reeves, I., Habibi, M. S., Apea, V., Boesecke, C., Vandekerckhove, L., Yakubovsky, M., Sendagorta, E., Blanco, J. L., Florence, E., Moschese, D., Maltez, F. M., ... Mussini, C. (2022). Monkeypox Virus Infection in Humans across 16 Countries — April–June 2022. *The New England Journal of Medicine*. <https://doi.org/10.1056/NEJMoa2207323>

Ulaeto, D. O., Dunning, J., & Carroll, M. W. (2022). Comment Evolutionary implications of human transmission of monkeypox : the importance of sequencing multiple lesions. *The Lancet Microbe*, 5247(22), 1–2. [https://doi.org/10.1016/S2666-5247\(22\)00194-X](https://doi.org/10.1016/S2666-5247(22)00194-X)

World Health Organization. (2022). *WHO Director-General declares the ongoing monkeypox outbreak*

a Public Health Emergency of International Concern. <https://www.who.int/europe/news/item/23-07-2022-who-director-general-declares-the-ongoing-monkeypox-outbreak-a-public-health-event-of-international-concern>

2. First revision: Accepted with major revision (28-08-2022)

[PHI] Editor Decision

1 messages

PHI Editor <admin@stikbar.org>

Sun, Aug 28, 2022 at 10:18 AM

To: Hermawan Saputra <hermawan.saputra@uhamka.ac.id>, Nadilah Salma <nadilah.salma@ui.ac.id>, SHEILA RIZKIA ANJARI <anjarisheilarizkia@gmail.com>

Hermawan Saputra, Nadilah Salma, SHEILA RIZKIA ANJARI:

We have reached a decision regarding your submission to Public Health of Indonesia, "MONKEYPOX TRANSMISSION RISKS IN INDONESIA".

Our decision is: Revisions Required

Due for resubmission: 15 September 2022

Specifically: We need you to provide a description regarding the impacts of this review for public health practice, discipline, and healthcare policies nationally and internationally. You can use one subheading "Implications for public health policies and practices" in the discussion part.

Regards,

Editor

Public Health of Indonesia

<http://stikbar.org/ycabpublisher/index.php/PHI>

[PHI] Editor Decision External Inbox



PHI Editor <admin@stikbar.org>
to me, Nadiah, SHEILA ▾

Aug 28, 2022, 10:18 AM ☆ ↶ ⋮

Hermawan Saputra, Nadiah Salma, SHEILA RIZKIA ANJARI

We have reached a decision regarding your submission to Public Health of Indonesia: "MONKEYPOX TRANSMISSION RISKS IN INDONESIA".

Our decision is: Revisions Required
Due for resubmission: 15 September 2022

Specifically: We need you to provide a description regarding the impacts of this review for public health practice, discipline, and healthcare policies nationally and internationally. You can use one subheading "Implications for public health policies and practices" in the discussion part.

Regards,

Editor

Public Health of Indonesia

<http://stikbar.org/jcabo/publisher/index.php/PHI>

- 3. Revision submitted (30-08-2022)**
 - Revisions and Amends**
 - Revised version with highlights**

- Revisions and Amends

MATRICES OF AMENDMENTS FOR REVIEWER

Comments and Suggestions for Authors	Author's Responds
We need you to provide a description regarding the impacts of this review for public health practice, discipline, and healthcare policies nationally and internationally. You can use one subheading "Implications for public health policies and practices" in the discussion part.	Thank you very much for some inputs and points for the improvement of the paper. We will add one subheading "Implications for public health policies and practices" in the discussion part.

- Revised version with highlights

MONKEYPOX TRANSMISSION RISKS IN INDONESIA

Hermawan Saputra¹, Nadilah Salma², Sheila Rizkia Anjari³

¹Universitas Muhammadiyah Prof.Dr. Hamka

²Universitas Indonesia

³Universitas Pembangunan Nasional Veteran Jakarta

Correspondence: hermawan.saputra@uhamka.ac.id

Abstract

After half a century as a regional disease in Central and West Africa, in 2022, Monkeypox became a reemerging disease and its spread became transnational and transcontinental. The ease of global mobilization, the risk of deviant behavior, and the possibility of virus mutations helped facilitate its spread until WHO declared it a Public Health Emergency of International Concern. Through various works of literature and secondary data, this study examines the risk of Monkeypox disease in Indonesia. Considering various characteristics possessed by the Indonesian state including geographical conditions, demographics, population mobility, and virus characteristics, it is most likely that there should have been Monkeypox cases in Indonesia but may not have been detected. Early vigilance needs to be owned by the community accompanied by policy support and or intervention to prevent Monkeypox transmission, especially in surveillance efforts.

Keywords: Disease, Indonesia, Monkeypox, Outbreak Risk, Transmission.

Introduction

Having not yet recovered from the COVID-19 pandemic, the world has again been made aware of the Monkeypox pandemic. The World Health Organization, on 23 July 2022, declared a Public Health Emergency of International Concern (PHEIC) status because of the increasing number of cases in non-endemic areas (World Health Organization, 2022). Monkeypox is not a new disease but has been detected in monkeys since 1956 (Magnus et al., 1958). Then, in 1970, in Zaire (now Congo), Monkeypox was first identified in humans so it was established as a zoonotic pathogen (Breman et al., 1980). From that time until before May 2022, Monkeypox cases were found in the Republic of Congo with virus transmission taking place from animal reservoir hosts to humans (Heymann et al., 1998; Ulaeto et al., 2022). Although there are also few and infrequent numbers of imported cases occurring in Europe and America.

The explosion of Monkeypox cases in several countries indicates an increase in human-to-human transmission of the virus. For 8 months (1 January 2022 – 9 August 2022) 31,800 confirmed cases of Monkeypox. Of this total, 98.8% of cases came from countries where Monkeypox had not previously been reported (Centers for Disease Control and Prevention, 2022b). A total of 89 countries have reported cases, from the previous only 7 countries. During that period, most cases occurred in the United States (9,492), Spain (5,162), and Germany (2,982). Until August 2022, there is no data on Monkeypox cases in Indonesia which should raise a critical question, is it zero cases or is not detected?

This is a narrative review with the desk study method. This research aims to study the risk of Monkeypox transmission in Indonesia since WHO declared it as PHEIC. Several aspects were looked into, such as virus characteristics, geographical conditions, demographics, and population mobility.

Monkeypox at a glance:

Monkeypox is caused by a DNA virus of the genus Orthopoxvirus in the same family as the Smallpox virus, namely Poxviridae. So far, two virus clades have been identified: the West African clade and the Congo Basin (Central Africa) clade (Mohapatra et al., 2022). The Congo Basin clade is more dangerous than the other clade as seen from the consistently higher case fatality rate (CFR) than the West African clade. The outbreak that occurred in 2022 is caused by West African clade.

The incubation period for this Monkeypox virus is usually 6-13 days but can range from 5 to 21 days. This disease forms skin eruption which generally begins within 1-3 days of fever. Meanwhile, symptoms can last from 2 to 4 weeks. Monkeypox can be detected when there are symptoms and at that time the transmission is highest. Unlike COVID-19, which can be transmitted even though it is asymptomatic.

Monkeypox is also known as a disease that can heal by itself (self-limited). Even so, cases of death still occur and the severity among patients can vary. The CFR varies from 1 to 11% even in children it can reach 15% (Jezek et al., 1987). Generally, Monkeypox is more severe in vulnerable groups.

Monkeypox is similar to other Smallpox, one of which is caused by the Varicella Zoster Virus. For an accurate diagnosis, confirmation of the virus needs to be done using real-time polymerase chain reaction (PCR) and sequencing. This is because the antibody and antigen detection methods do not provide specific confirmation of Monkeypox because orthopoxvirus is serologically cross-reactive (Mohapatra et al., 2022).

Geography:

Indonesia is a country with a strategic location and many country entrances with various routes that have many high risks of Monkeypox outbreaks. Indonesia's position which is at the crossroads of two continents, Asia and Australia, and two oceans, the Pacific and the Indian Ocean, makes Indonesia a

transportation route, especially for trade transportation. Ninety percent of world trade is transported by sea and almost half through Indonesia (Ministry of Transportation of The Republic of Indonesia, 2018). Not to mention Indonesia's export and import activities that increase the epidemiological risk of contacting disease agents with humans at ports, airports, and other transportation entrances.

Borders with other countries also increase the risk of disease transmission through the mobility of people. Indonesia shares land borders with Malaysia, Papua New Guinea, and Timor Leste. Meanwhile, its maritime areas are directly adjacent to Singapore, Malaysia, Thailand, Vietnam, the Philippines, India, Palau, Australia, Papua New Guinea, and Timor Leste. In some neighboring countries, Monkeypox cases have been reported, including Singapore (15 people), Thailand (4 people), Philippines (1 person), India (9 people), and Australia (58 people) (Centers for Disease Control and Prevention, 2022a).

The diversity of landscapes with high biodiversity also increases the potential risk of zoonoses, including Monkeypox, in Indonesia. This is mainly related to the increasing population forcing the conversion of wild animal habitats into settlements, land, and other infrastructures to support human life, thereby increasing the potential for contact between humans and animals (Breithaupt, 2003).

Demographics and Population Mobility:

In the past, people who were infected with Monkeypox were children under the age of 10 years. More than 80% of the cases recorded in the 1970s to 1990s cohort were under the age of 15 while less than 50% of the population was under 15 during that period (Beer & Bhargavi Rao, 2019). Then the pattern of disease incidence changed to cases that commonly occur in adults 25-40 years old, including the outbreak in 2022. When viewed by gender, male cases are higher than female cases (Beer & Bhargavi Rao, 2019).

The Monkeypox case that occurred in the 2022 outbreak brought a special community to the surface with a high number of cases, called LGBTQ+. Of the several reported cases, the sufferers are men who

like men (MSM) and are bisexual (Jang et al., 2022; Thornhill et al., 2022). Most of them had sexual intercourse before being diagnosed with Monkeypox (Thornhill et al., 2022). This pattern of sexual transmission is considered unusual because there have been no previous reports of sexual transmission of the disease (Adegboye et al., 2022; Pan et al., 2022). The LGBTQ+ community, in this case, is a high-risk group. In Indonesia, the LGBTQ+ community has grown quite large, in 2013, it consisted of 2 national networks and 119 organizations in 28 provinces (Oetomo et al., 2014).

Monkeypox is not a lethal disease. However, deaths from Monkeypox, which were recorded, occurred in several high-risk groups including infants, young children (less than 10 years), pregnant women, patients with complications, and immunocompromised individuals, suggesting this is a high-risk group (Beer & Bhargavi Rao, 2019). The total population of Indonesia, which is more than 270 million people, automatically calculates the proportion of these vulnerable groups bigger.

The potential import of Monkeypox cases in Indonesia is related to human mobility as a risk factor for disease transmission in terms of the number of arrivals and departures of international flights to and from Indonesia. Based on data from the Indonesian Central Statistics Agency (BPS), information was obtained that international flights to and from Indonesia showed a gradual upward trend in the period 2015 to 2019 (Badan Pusat Statistik, 2019, 2022). In 2020 when the COVID-19 pandemic occurred, this number decreased to approximately one-fifth of the number in 2019. The data for 2021 and 2022 have not yet been released by BPS, but based on Government of Indonesia's (GoI) statement in news articles, the number of flight passengers has increased in 2022. The increase in flight frequency has also occurred in many other countries considering that all of them have loosened restrictions due to COVID-19 cases which have gradually subsided.



Figure 2 Number of International Flight Passengers (to and from Indonesia)

Source: BPS

Flights from Monkeypox endemic areas have also increased. The number of international flight departures through Nigerian airports, for example, increased by 54.7 percent from 2021 (717,261 to 1,109,525). The number of arrivals of international passengers also increased from 690,765 to 1,109,621 (Olowookere, 2022).

Efforts to prevent transmission and treatment of Monkeypox:

Until today, there is no specific medicine for Monkeypox disease. However, to provide protection and reduce the severity, Smallpox vaccine and antiviral drugs (Tecovirimat and Brincidofovir) can be used (Centers for Disease Control and Prevention, 2022d). Smallpox vaccination is estimated to provide up to 85% cross-protection against Monkeypox with unknown duration of protection (Centers for Disease Control and Prevention, 2022c). The Centers for Disease Control and Prevention (CDC) recommends vaccination within 4 days of exposure to prevent illness or up to 14 days after exposure to

reduce disease severity. Meanwhile, the use of both antivirals for the treatment of Monkeypox has only been tested in vitro and in animal studies, so further clinical testing is needed.

Access to vaccines is still very limited. Currently, the United States is a country that has a large stock of vaccines. The vaccine, under the trade name JYNNEOS, will be distributed to high-risk people in the United States (The White House, 2022). The availability of this vaccine is the result of anticipating Monkeypox cases after some cases occurred years ago.

The international community has begun to take steps to mitigate the outbreak amid the limitations of these clinical interventions. Efforts to detect and isolate Monkeypox cases have now begun to be carried out by several countries. Belgium, for example, has implemented a mandatory 21-day quarantine for Monkeypox patients. As a detection effort, Brazil and other Latin American countries are increasing laboratory capacity by establishing skilled molecular biology and genome sequencing laboratories that routinely perform RT-PCR and phylogenetic studies (Cimerman et al., 2022).

Discussion

It is very likely that Monkeypox cases in Indonesia already exist but have not been detected and reported. Given the magnitude of Indonesia's potential for disease transmission from various aspects that have been studied in this paper. From the demographic aspect, Indonesia is the 4th largest country by population (274,790,244 people). When compared with the two countries with the most reported Monkeypox cases as of August, the United States and Brazil, these countries have slight different numbers of the population to Indonesia, respectively, 332,975,770 and 214,962,388. If there are thousands of Monkeypox cases in both countries, how many cases should be in Indonesia?

The omission of Monkeypox cases in Indonesia and several other countries is most likely due to the ability to detect and diagnose the disease. Countries with reported Monkeypox cases in the 2022 outbreak, especially the high ones, have good health systems to deal with health emergencies. Countries

such as America, Spain, Germany, and many of those close to Indonesia, like Singapore, Australia, and Thailand, are ranked quite well in the aspects of handling the outbreak which is summarized in the Global Health Security Index (Bell & Nuzzo, 2021). Meanwhile, Indonesia's position is still far behind in ranking compared to these countries.

The GoI needs to strengthen surveillance for Monkeypox disease. If there is a confirmed case of Monkeypox, it is necessary to immediately do tracing and treatment. Similar to the experience of dealing with the COVID-19 pandemic, the 3T concept (testing, tracing, and treatment) still applies. Things that need to be emphasized more may be related to making a diagnosis which will be a bit tricky, given the clinical overlap between Monkeypox and other Smallpox diseases. Beer (2019) in his research alludes to this, in which a proportion of the identified but unconfirmed Monkeypox cases reported in the literature are likely to be varicella-zoster virus (VZV).

In the past, the GoI had a national vaccination program for Smallpox but in 1980 it was stopped since Indonesia successfully got rid of Smallpox disease (Ministry of Health of the Republic of Indonesia, 2017). The Smallpox vaccination program had been organized by the GoI starting in 1956 and the colonial government in the 19th century (Santoso et al., 2015). The implementation of Smallpox vaccination may be considered by looking at the condition of public health status in this epidemic era and accompanied by appropriate strategies (e.g. targeting high-risk groups).

Despite limited access to Monkeypox vaccines and antivirals, physical distancing and the application of clean and healthy living behavior are still effective solutions to prevent Monkeypox transmission. Given the transmission of Monkeypox through physical contact with patient lesions. Indirect transmission with patients still needs to be further investigated. The following two cases can serve as a basis for thinking about the need for further research. First, the Atkinson study (2022) tried to examine environmental samples carried out in two adjoining rooms occupied by a Monkeypox patient and his siblings. Although Monkeypox virus DNA was found in several locations in both properties (after 3 days since the last occupancy), the patient's relative did not get Monkeypox (Atkinson et al., 2022).

Another case is the transmission of Monkeypox to health workers who were infected when handling patients with full-body personal protective equipment (PPE) except respiratory PPE.

In addition to all of these risk factors, the Monkeypox virus itself needs to be studied further. The Swift change in virus transmission, from animal-to-human to human-to-human, brings the need to suspect the possibility of virus mutation. Regardless of Monkeypox virus type, DNA virus, which characteristics are different from RNA viruses, that are more difficult to mutate (Duffy, 2018; Peck & Luring, 2018; Sanjuan & Domingo-Calap, 2016).

Implications for public health policies and practices

This research shows that Indonesia has a high risk of Monkeypox transmission. Zero cases of Monkeypox in Indonesia so far (1970s to early August 2022) should be a big question. Therefore, this paper was written as a trigger for awareness of these risks, in relation to efforts and risk mitigation, especially by health service providers and the community. In other words, encouraging people to be aware and more vigilant in their behavior (e.g. by doing a clean and healthy lifestyle (PHBS)) and GoI to conduct testing and tracing for the disease.

Some policy recommendations would be, first, to prepare facilities for Monkeypox testing (able to run the PCR) in healthcare, particularly in the areas with international gateways, such as in North Sumatra, Bali, North Sulawesi, DKI Jakarta, and Surabaya. So the facility is not only in Ministry of Health's laboratory. Second, it is necessary to prepare epidemiological investigators for Monkeypox cases. Early preparation is a better way to anticipate the possibility of wider transmission.

This research is also relevant in encouraging sustainable efforts to anticipate other re-emerging diseases in Indonesia. As a country with large population and areas with high biodiversity, acceleration towards an "independent country" in producing medical equipment, developing drugs and vaccines, and providing high-quality treatment for any possible new disease (Saputra et al., 2022).

References

- Adegboye, O. A., Eugenia Castellanos, M., Alele, F. O., Pak, A., Ezechukwu, H. C., Hou, K., & Emeto, T. I. (2022). Travel-Related Monkeypox Outbreaks in the Era of COVID-19 Pandemic: Are We Prepared? *Viruses*, *14*(6), 1283. <https://doi.org/10.3390/v14061283>
- Atkinson, B., Burton, C., Pottage, T., Thompson, K.-A., Ngabo, D., Crook, A., Pitman, J., Summers, S., Lewandowski, K., Furneaux, J., Davies, K., Brooks, T., Bennett, A. M., & Richards, K. (2022). Infection-competent monkeypox virus contamination identified in domestic settings following an imported case of monkeypox into the UK. *MedRxiv*, July, 2022.06.27.22276202. <https://doi.org/10.1101/2022.06.27.22276202>
- Badan Pusat Statistik. (2019). *Lalu Lintas Penerbangan Luar Negeri Indonesia Tahun 2003-2018*. <https://www.bps.go.id/statictable/2009/02/21/1403/lalu-lintas-penerbangan-luar-negeri-indonesia-tahun-2003-2018.html>
- Badan Pusat Statistik. (2022). *Jumlah Penumpang Internasional berdasarkan Moda Transportasi Pesawat Terbang menurut provinsi (Orang), 2019-2020*. <https://www.bps.go.id/indicator/17/2027/1/jumlah-penumpang-internasional-berdasarkan-moda-transportasi-pesawat-terbang-menurut-provinsi.html>
- Beer, E. M., & Bhargavi Rao, V. (2019). A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. *PLoS Neglected Tropical Diseases*, *13*(10), 1–20. <https://doi.org/10.1371/journal.pntd.0007791>
- Bell, J. A., & Nuzzo, J. B. (2021). *Global Health Security Index: Advancing Collective Action and Accountability Amid Global Crisis*.
- Breithaupt, H. (2003). Fierce creatures. *EMBO Reports*, *4*(10), 921–924. <https://doi.org/10.1038/sj.embor.embor949>

Breman, J. G., Ruti, K., & Steniowski, M. V. (1980). Human monkeypox, 1970-79. *Bulletin of the World Health Organization*, 58(2), 165–182.

Centers for Disease Control and Prevention. (2022a). *2020 Monkeypox Outbreak Global Map*.
<https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>

Centers for Disease Control and Prevention. (2022b). *2022 Monkeypox Outbreak Global Map*.
<https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>

Centers for Disease Control and Prevention. (2022c). *Monkeypox and Smallpox Vaccine Guidance*.
<https://www.cdc.gov/poxvirus/monkeypox/clinicians/smallpox-vaccine.html>

Centers for Disease Control and Prevention. (2022d). *Treatment Information for Healthcare Professionals*. <https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html>

Cimerman, S., Chebabo, A., Cunha, C. A. da, Barbosa, A. N., & Rodríguez-Morales, A. J. (2022). Human monkeypox preparedness in Latin America – Are we ready for the next viral zoonotic disease outbreak after COVID-19? *The Brazilian Journal of Infectious Diseases*, 26(3), 102372.
<https://doi.org/10.1016/j.bjid.2022.102372>

Duffy, S. (2018). Why are RNA virus mutation rates so damn high? *PLoS Biology*, 16(8), 1–6.
<https://doi.org/https://doi.org/10.1371/journal.pbio.3000003>

Heymann, D. L., Szczeniowski, M., & Esteves, K. (1998). Re-emergence of monkeypox in Africa: A review of the past six years. *British Medical Bulletin*, 54(3), 693–702.
<https://doi.org/10.1093/oxfordjournals.bmb.a011720>

Jang, Y. R., Lee, M., Shin, H., Kim, J.-W., Choi, M.-M., Kim, Y. M., Lee, M. J., Kim, J., Na, H. K., & Kim, J. Y. (2022). The First Case of Monkeypox in the Republic of Korea. *Journal of Korean Medical Science*, 37(27), e224. <https://doi.org/10.3346/jkms.2022.37.e224>

Jezek, Z., Szczeniowski, M., & Paluku, K. M. (1987). *Human Monkeypox: Clinical Features of 282*

Patients. 156(2), 293–298.

Magnus, P. von, Andersen, E. K., Petersen, K. B., & Birch-Andersen, A. (1958). *A Pox-Like Disease in Cynomolgus Monkeys*.

Ministry of Transportation of The Republic of Indonesia. (2018). *Forty percent of the world's trade routes pass through Indonesia*. <http://dephub.go.id/post/read/empat-puluh-persen-jalur-perdagangan-dunia-melewati-indonesia>

Ministry of Health of the Republic of Indonesia. (2017). *Vaccines in Indonesia Successfully Eradicate Smallpox and Polio and Eliminate Tetanus*. <https://sehatnegeriku.kemkes.go.id/baca/rilis-media/20170429/1420692/vaksin-indonesia-berhasil-membasmi-cacar-dan-polio-serta-mengelimnasi-tetanus/>

Mohapatra, R. K., Tuli, H. S., Sarangi, A. K., Chakraborty, S., & Chandran, D. (2022). Unexpected sudden rise of human monkeypox cases in multiple non-endemic countries amid COVID-19 pandemic and salient counteracting strategies: Another potential global threat? *International Journal of Surgery*, 103(June), 1–4.

Oetomo, D., Suvianita, K., Halim, K. S. S., Liang, J., Soepartha, S., & Surahman, L. (2014). *Hidup Sebagai LGBT di Asia: Laporan Nasional Indonesia*.

Olowookere, D. (2022). *Nigeria Records 54.7% Rise in International Flight Departures*. <https://businesspost.ng/travel/nigeria-records-54-7-rise-in-international-flight-departures/>

Pan, D., Sze, S., Nazareth, J., Martin, C. A., Al-Oraibi, A., Baggaley, R. F., Nellums, L. B., Hollingsworth, T. D., Tang, J. W., & Pareek, M. (2022). Monkeypox in the UK: arguments for a broader case definition. *The Lancet*, 399(10344), 2345–2346. [https://doi.org/10.1016/S0140-6736\(22\)01101-1](https://doi.org/10.1016/S0140-6736(22)01101-1)

Peck, K. M., & Luring, A. S. (2018). Complexities of Viral Mutation Rates. *Journal of Virology*,

92(14).

Sanjuan, R., & Domingo-Calap, P. (2016). Mechanisms of viral mutation. *Cellular and Molecular Life Sciences*, 4433–4448. <https://doi.org/10.1007/s00018-016-2299-6>

Santoso, A., Cholikh, A., Patriasari, B., Mulyaningsih, D., SP., R. S., & Sunjaya, S. (2015). *Naskah Sumber Arsip Kesehatan Masyarakat* (S. K. Yahya (ed.)). Arsip Nasional Republik Indonesia.

Saputra, H., Saragih, H. J. R., Vitriano, O., & Salma, N. (2022). Health System Resilience in The Context of COVID-19 Vaccination Management in Indonesia. *Jurnal Medicoeticolegal Dan Manajemen Rumah Sakit (JMMR)*, 11(2).

<https://doi.org/https://doi.org/10.18196/jmmr.v11i2.12007>

The White House. (2022). *FACT SHEET: Biden-Harris Administration's Monkeypox Outbreak Response*. <https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/28/fact-sheet-biden-harris-administrations-monkeypox-outbreak-response/>

Thornhill, J. P., Barkati, S., Walmsley, S., Rockstroh, J., Antinori, A., L.B.Harrison, Palich, R., Nori, A., Reeves, I., Habibi, M. S., Apea, V., Boesecke, C., Vandekerckhove, L., Yakubovsky, M., Sendagorta, E., Blanco, J. L., Florence, E., Moschese, D., Maltez, F. M., ... Mussini, C. (2022). Monkeypox Virus Infection in Humans across 16 Countries — April–June 2022. *The New England Journal of Medicine*. <https://doi.org/10.1056/NEJMoa2207323>

Ulaeto, D. O., Dunning, J., & Carroll, M. W. (2022). Comment Evolutionary implications of human transmission of monkeypox : the importance of sequencing multiple lesions. *The Lancet Microbe*, 5247(22), 1–2. [https://doi.org/10.1016/S2666-5247\(22\)00194-X](https://doi.org/10.1016/S2666-5247(22)00194-X)

World Health Organization. (2022). *WHO Director-General declares the ongoing monkeypox outbreak a Public Health Emergency of International Concern*. <https://www.who.int/europe/news/item/23-07-2022-who-director-general-declares-the-ongoing-monkeypox-outbreak-a-public-health-event-of-international-concern>

4. Paper accepted (10-09-2022)

Notifications

×undefined

[PHI] Editor Decision

2022-09-10 03:01 AM

Hermawan Saputra, Nadilah Salma, SHEILA RIZKIA ANJARI:

We have reached a decision regarding your submission to Public Health of Indonesia, "MONKEYPOX TRANSMISSION RISKS IN INDONESIA".

Our decision is to: Accept

The post-acceptance steps are as follows:

1. You must complete the title page, and send to indonesianpublichealth@gmail.com.
2. You need to pay Article Processing Charge of your article and send the proof of payment to indonesianpublichealth@gmail.com
3. Your manuscript files will be checked, ready for the production process.
4. You will receive copyediting request which should be checked thoroughly and returned promptly.
5. You will receive final proof of your article which should be checked thoroughly and returned promptly.
6. Your article will be published open access on the journal website in the upcoming issue.

We appreciate your interest in the Journal, and we look forward to publishing your work.

Regards,

Editor

Public Health of Indonesia

<http://stikbar.org/ycabpublisher/index.php/PHI>

5. Final Approval Article (11-09-2022)

[PHI] New notification from Public Health of Indonesia

1 message

PHI Editor <admin@stikbar.org>

Sun, Sep 11, 2022 at 6:29 PM

Reply-To: PHI Editorial Office <indonesianpublichealth@gmail.com>

To: Hermawan Saputra <hermawan.saputra@uhamka.ac.id>

You have a new notification from Public Health of Indonesia:

You have been added to a discussion titled "Final Approval: Your Article" regarding the submission "Monkeypox transmission risks in Indonesia".

Link: <http://stikbar.org/ycabpublisher/index.php/PHI/authorDashboard/submission/634>

PHI Editorial Office

Public Health of Indonesia

<http://stikbar.org/ycabpublisher/index.php/PHI>

Final Approval: Your Article

×Close Panel

Participants

- PHI Editor (admin1)
- Ramadhan Tosepu, SKM, M.Kes, PhD (nurnasry)
- Hermawan Saputra (hermawansaputra)

Messages

Note

From

Dear author,

admin1

2022-09-11 11:25

Here we send the article galley for your article. Please check every detail of it, and add sticky notes for any corrections needed.

AM

Specifically: please provide statements of funding, acknowledgment, author biographies, and author contribution. You can read the current published articles for the examples. Also, please provide ORCID iD of each author if available.

We expect to have your feedback within 3 working days.

Regards,

Editor

[\[PHI\] Vol 8\(3\)-68-74.pdf](#)

Settings

hermawansaputra

2022-09-13 02:20

Kami telah menambahkan beberapa informasi yang dibutuhkan. Selain itu kami juga melakukan revisi pada teks (di stabilo) tidak mengubah substansi melainkan perbaikan tata bahasa saja.

AM

[rev_634-Article Text-1421-1711-18-20220911.pdf](#)

Berikut kita kirimkan updated articlennya. Silahkan dicek kembali. Jika ada koreksi, do not hesitate to contact us.

admin1

2022-09-13 03:22

AM

Regards

[\[PHI\] Vol 8\(3\)-68-74b.pdf](#)

Settings

hermawansaputra

2022-09-13 08:11

Berikut revisi tambahan

AM

Note	From
- Hal 68: perlu perubahan alamat - Hal 70: ada paragraf yang terpisah jadi 2 bagian (perlu disatukan) -Hal 72: ada yg belum terevisi (perlu disesuaikan dengan yg di notes) rev author 130922.pdf	
Berikut perubahannya. Silahkan dicek kembali [PHI] Vol 8(3)-68-74c.pdf	admin1 2022-09-13 08:42 AM
Settings	hermawansaputra 2022-09-13 02:44 PM
Sudah cukup. Terima kasih banyak Bapak/Ibu..	
Izin untuk bertanya, artikel untuk Vol 8(3) ini akan terbit tgl berapa? Mohon informasinya, terima kasih..	
Settings	hermawansaputra 2022-09-14 01:35 AM
Mohon izin Bapak Ibu, untuk ditambahkan ORCID ID yg blm dimasukkan.. Hermawan Saputra : https://orcid.org/0000-0002-0895-1324	
Sheila Rizkia Anjari : https://orcid.org/0000-0003-4274-3729	
Terima kasih..	
Berikut perubahannya. Kita belum tentukan tanggal berapa karena sambil menunggu yang lain. Yang jelas masih tetap di bulan September 2022. [PHI] Vol 8(3)-68-74.pdf	admin1 2022-09-14 04:08 AM
Settings	hermawansaputra 2022-09-14 06:02 AM
Ohya baik, terima kasih banyak Bapak/Ibu..	
Mohon izin, utk bagian alamat coresponding author itu tulisan RT/RW nya double	

**6. Paper published (17-09-2022)
-Final paper**

Monkeypox transmission risks in Indonesia

Hermawan Saputra^{1*}, Nadilah Salma², and Sheila Rizkia Anjari³

¹Universitas Muhammadiyah Prof.Dr. Hamka, Indonesia

²Universitas Indonesia, Indonesia

³Universitas Pembangunan Nasional Veteran Jakarta, Indonesia

Doi: <https://dx.doi.org/10.36685/phi.v8i3.634>

Received: 14 August 2022 | Revised: 30 August 2022 | Accepted: 10 September 2022

Corresponding author:

Hermawan Saputra

Jl. Warung Jati Barat, Blok Darul Muslimin No.17 RT.2/RW.5

Kalibata, Pancoran, South Jakarta City, Jakarta 12740

Email: hermawan.saputra@uhamka.ac.id

Copyright: © 2022 the Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium provided the original work is properly cited.

Abstract

After half a century as a regional disease in Central and West Africa, Monkeypox reemerged in 2022 and spread on a transnational and transcontinental scale. The World Health Organization (WHO) classified it as a Public Health Emergency of International Concern due to its rapid spread caused by the ease of global mobilization, risk deviant behaviors, and potential for virus mutations. Through literature review and other secondary data sources, this study scrutinized the risk of Monkeypox disease in Indonesia. Given the country's various characteristics, such as geographical conditions, demographics, population mobility, and virus characteristics, it is most likely that there were Monkeypox cases in Indonesia, but they might not have been detected. Therefore, early vigilance must be owned by the community and accompanied by policy support and intervention to prevent Monkeypox transmission, particularly in surveillance efforts.

Keywords: disease; Indonesia; Monkeypox; outbreak risk; transmission

Background

With the world still reeling from the COVID-19 pandemic, the Monkeypox pandemic emerges. The World Health Organization, on 23 July 2022, declared a Public Health Emergency of International Concern (PHEIC) status because of the increasing number of cases in non-endemic areas ([World Health Organization, 2022](#)). Monkeypox is not a new disease but has been detected in monkeys since 1956 ([Magnus et al., 1959](#)). Then, in 1970, in Zaire (now Congo), Monkeypox was first identified in humans, so it was established as a zoonotic pathogen ([Bremant et al., 1980](#)). From that time until before May 2022, Monkeypox cases were found in the Republic of Congo, with virus transmission from

animal reservoir hosts to humans ([Heymann et al., 1998](#); [Ulaeto et al., 2022](#)). However, there are also few and infrequent numbers of imported cases occurring in Europe and America.

The rise of Monkeypox cases in several countries indicates an increase in human-to-human transmission of the virus. For eight months (1 January 2022 – 9 August 2022), 31,800 confirmed cases of Monkeypox. Of this total, 98.8% of cases came from countries where Monkeypox had not previously been reported ([Centers for Disease Control and Prevention, 2022b](#)). Eighty nine countries have reported cases, up from just seven previously. During that period, most cases occurred in the United States (9,492), Spain (5,162), and

Germany (2,982). Until August 2022, there is no data on Monkeypox cases in Indonesia which should raise a critical question, is it zero cases, or is it not detected?

This is a narrative review with the desk study method. This research aims to study the risk of Monkeypox transmission in Indonesia since WHO declared it as PHEIC. Several aspects were looked into, such as virus characteristics, geographical conditions, demographics, and population mobility.

Monkeypox at a Glance

Monkeypox is caused by a DNA virus of the genus Orthopoxvirus in the same family as the Smallpox virus, namely Poxviridae. So far, two virus clades have been identified: the West African clade and the Congo Basin (Central Africa) clade (Mohapatra et al., 2022). The Congo Basin clade is more dangerous than the other clade, as seen from the consistently higher case fatality rate (CFR) than the West African clade. The outbreak that occurred in 2022 was caused by the West African clade.

The incubation period for this Monkeypox virus is usually 6-13 days but can range from 5 to 21 days. This disease forms skin eruption, which generally begins within 1-3 days of fever. Meanwhile, symptoms can last from 2 to 4 weeks. Therefore, Monkeypox can be detected when there are symptoms, and the transmission is highest at that time. Unlike COVID-19, which can be transmitted even though it is asymptomatic.

Monkeypox is also known as a disease that can heal by itself (self-limited). Even so, cases of death still occur, and the severity among patients can vary. The CFR varies from 1 to 11%; even in children, it can reach 15% (Jezek et al., 1987). Generally, Monkeypox is more severe in vulnerable groups.

Monkeypox is similar to other Smallpox, one of which is caused by the Varicella Zoster Virus. For an accurate diagnosis, the virus needs to be confirmed using real-time polymerase chain reaction (PCR) and sequencing. This is because the antibody and antigen detection methods do not provide specific confirmation of Monkeypox because orthopoxvirus is serologically cross-reactive (Mohapatra et al., 2022).

Geography

Indonesia is a strategically located country. It has numerous ports of entry via various routes, increasing the risk of Monkeypox outbreaks. In addition, Indonesia's position at the crossroads of two continents, Asia and Australia, and two oceans, the Pacific and the Indian Ocean, makes Indonesia a transportation route, especially for trade transportation. Ninety percent of world trade is transported by sea, and almost half through Indonesia (Ministry of Transportation of The Republic of Indonesia, 2018). Not to mention that Indonesia's export and import activities increase the epidemiological risk of disease agents being transmitted to humans at ports, airports, and other transportation hubs.

Borders with other countries also increase the risk of disease transmission through the mobility of people. Indonesia shares land borders with Malaysia, Papua New Guinea, and Timor Leste. Meanwhile, its maritime areas are directly adjacent to Singapore, Malaysia, Thailand, Vietnam, the Philippines, India, Palau, Australia, Papua New Guinea, and Timor Leste. In some neighboring countries, Monkeypox cases have been reported, including Singapore (15 people), Thailand (4 people), Philippines (1 person), India (9 people), and Australia (58 people) (Centers for Disease Control and Prevention, 2022a).

The diversity of landscapes with high biodiversity also increases the potential risk of zoonoses, including Monkeypox, in Indonesia. This is mainly related to the increasing population forcing the conversion of wild animal habitats into settlements, land, and other infrastructures to support human life, thereby increasing the potential for contact between humans and animals (Breithaupt, 2003).

Demographics and Population Mobility

In the past, people who were infected with Monkeypox were children under the age of ten. More than 80% of the cases recorded in the 1970s to 1990s cohort were under the age of 15, while less than 50% of the population was under 15 during that period (Beer & Rao, 2019). The pattern of disease incidence then started shifting to adults aged 25 to 40 cases, including the outbreak in 2022. Male

cases outnumber female cases when gender is considered (Beer & Rao, 2019).

The Monkeypox outbreak in 2022 brought the community known as LGBTQ+ to the forefront as the group with high number of cases. The sufferers in the reported cases are men who have sex with men (MSM) and bisexuals (Jang et al., 2022; Thornhill et al., 2022). Most of them had sexual intercourse before being diagnosed with Monkeypox (Thornhill et al., 2022). This pattern of sexual transmission is considered unusual because there have been no previous reports of sexual transmission of the disease (Adegboye et al., 2022; Pan et al., 2022). The LGBTQ+ community, in this case, is a high-risk group. In Indonesia, the LGBTQ+ community has grown quite large; in 2013, it consisted of 2 national networks and 119 organizations in 28 provinces (Oetomo et al., 2013).

Monkeypox is not a lethal disease. However, deaths from Monkeypox, which were recorded, occurred in several high-risk groups, including infants, young children (less than ten year old), pregnant women, patients with complications, and

immunocompromised individuals, suggesting this is a high-risk group (Beer & Rao, 2019). Indonesia's population of more than 270 million people automatically makes the proportion of these vulnerable groups bigger.

The potential import of Monkeypox cases in Indonesia is linked to human mobility as a risk factor for disease transmission in terms of the number of international flights arriving and departing from Indonesia. According to data from the Indonesian Central Statistics Agency (BPS), international flights to and from Indonesia increased gradually between 2015 and 2019 (Badan Pusat Statistik, 2019). However, in 2020 when the COVID-19 pandemic occurred, a number of international flights decreased to approximately one-fifth of a number in 2019. The data for 2021 and 2022 have not yet been released by BPS, but based on the Government of Indonesia's (GoI) statement in news articles, the number of flight passengers has increased in 2022. The increase in flight frequency has also occurred in many other countries, considering that all of them have loosened restrictions due to COVID-19 cases, which have gradually subsided.

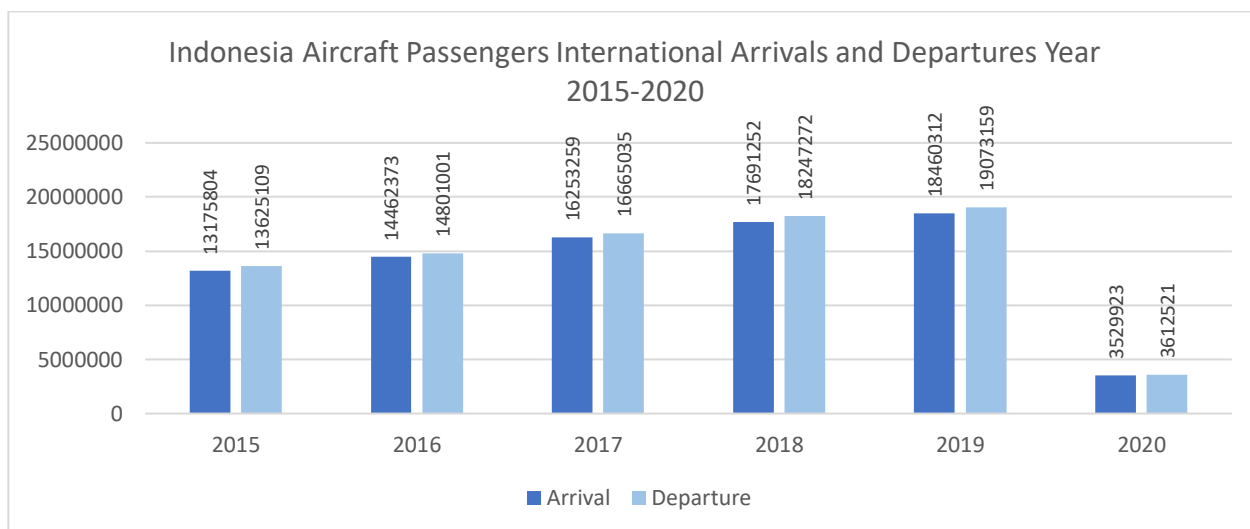


Figure 1 Number of International Flight Passengers (to and from Indonesia)
Source: Indonesian Central Statistics Agency (BPS)

Flights from Monkeypox endemic areas have also increased. For example, the number of international flight departures through Nigerian airports increased by 54.7 percent from 2021 (717,261 to 1,109,525). The number of arrivals of international passengers also rose from 690,765 to 1,109,621 (Olowookere, 2022).

Efforts to Prevent Transmission and Treatment of Monkeypox

Until today, there is no specific medicine for Monkeypox disease. However, to provide protection and reduce the severity, the Smallpox vaccine and antiviral drugs (Tecovirimat and Brincidofovir) can be used (Centers for Disease Control and

[Prevention, 2022d](#)). Smallpox vaccination is estimated to provide up to 85% cross-protection against Monkeypox with an unknown duration of protection ([Centers for Disease Control and Prevention, 2022c](#)). The Centers for Disease Control and Prevention (CDC) recommends vaccination within four days of exposure to prevent illness or up to 14 days after exposure to reduce disease severity. Meanwhile, the use of both antivirals for the treatment of Monkeypox has only been tested in vitro and animal studies, so further clinical testing is needed.

Access to vaccines is still very limited. Currently, the United States is a country that has a large stock of vaccines. The vaccine, under the trade name JYNNEOS, will be distributed to high-risk people in the United States ([The White House, 2022](#)). The availability of the vaccines is the result of early anticipation of Monkeypox disease after several cases occurred a few years ago.

Despite the limitations of such clinical interventions, the international community has begun to take steps to mitigate the outbreak. Several countries have begun to work together to detect and isolate people with Monkeypox. Belgium, for example, has implemented a mandatory 21-day quarantine for Monkeypox patients. In addition, as a detection effort, Brazil and other Latin American countries are increasing laboratory capacity by establishing skilled molecular biology and genome sequencing laboratories that routinely perform RT-PCR and phylogenetic studies ([Cimerman et al., 2022](#)).

Discussion

It is very likely that Monkeypox cases in Indonesia already exist but have not been detected and reported. Given the magnitude of Indonesia's potential for disease transmission from various aspects that have been studied in this paper. From the demographic aspect, Indonesia is the 4th largest country by population (274,790,244 people). When compared with the two countries with the most reported Monkeypox cases as of August, the United States and Brazil, these countries have slightly different number of the population to Indonesia, respectively, 332,975,770 and 214,962,388. If both countries have thousands of Monkeypox cases, how many should be in Indonesia?

The omission of Monkeypox cases in Indonesia and several other countries is most likely due to the ability to detect and diagnose the disease. Countries with reported Monkeypox cases in the 2022 outbreak, especially the high ones, have good health systems to deal with health emergencies. Countries such as America, Spain, Germany, and many of those close to Indonesia, like Singapore, Australia, and Thailand, are ranked quite well in the aspects of handling the outbreak, which is summarized in the Global Health Security Index ([Bell & Nuzzo](#)). Meanwhile, Indonesia's position is still far behind in ranking compared to these countries.

The Gol needs to strengthen surveillance for Monkeypox disease. If there is a confirmed case of Monkeypox, it is necessary to do tracing and treatment immediately. Similar to the experience of dealing with the COVID-19 pandemic, the 3T concept (testing, tracing, and treatment) still applies. Things that need to be emphasized more may be related to making a diagnosis which will be a bit tricky, given the clinical overlap between Monkeypox and other Smallpox diseases. [Beer and Rao \(2019\)](#), in their study, they mention that a portion of the identified but unconfirmed Monkeypox cases reported in the literature are likely to be Varicella-zoster virus (VZV).

In the past, the Gol had a national vaccination program for Smallpox, but in 1980 it was stopped since Indonesia successfully got rid of Smallpox disease ([Ministry of Health of the Republic of Indonesia, 2017](#)). The Smallpox vaccination program was organized by the Gol starting in 1956 and the colonial government in the 19th century ([Santoso, 2015](#)). Therefore, the implementation of Smallpox vaccination may be considered by looking at the condition of public health status in this epidemic era and accompanied by appropriate strategies (e.g., targeting high-risk groups).

Despite limited access to Monkeypox vaccines and antivirals, physical distancing and the application of clean and healthy living behavior are still effective solutions to prevent Monkeypox transmission. Given the transmission of Monkeypox through physical contact with patient lesions. Indirect transmission with patients still needs to be further investigated. The following two cases can serve as a basis for thinking about the need for further research. First, [Atkinson et al. \(2022\)](#) tried to examine

environmental samples carried out in two adjoining rooms occupied by a Monkeypox patient and his siblings. Although Monkeypox virus DNA was found in several locations in both properties (after three days since the last occupancy), the patient's relative did not get Monkeypox. Another case is the transmission of Monkeypox to health workers who were infected when handling patients with full-body personal protective equipment (PPE) except respiratory PPE.

In addition to all of these risk factors, the Monkeypox virus itself needs to be studied further. The rapid changes in virus transmission, from animal-to-human to human-to-human, raises the need to be aware of possible viral mutations. Although Monkeypox virus is a DNA virus, which is characteristically more difficult to mutate than RNA viruses, mutations can still occur (Duffy, 2018; Peck & Lauring, 2018; Sanjuán & Domingo-Calap, 2016).

Implications for Public Health Policies and Practices

According to this study, Indonesia is at high risk of Monkeypox transmission. Zero cases of monkeypox in Indonesia thus far (from the 1970s to early August 2022) should be cause for alarm. This paper was written to raise awareness of the risks, in relation to efforts and risk mitigation, particularly by healthcare providers and the community. In other words, encouraging people to be aware and more vigilant in their behavior (e.g., by doing a clean and healthy lifestyle (PHBS)) and Gol to conduct testing and tracing for the disease.

Some policy recommendations would be to, first, prepare healthcare facilities for Monkeypox testing (capable of running the PCR), particularly in areas with international gateways such as North Sumatra, Bali, North Sulawesi, DKI Jakarta, and Surabaya. As a result, the facility is not only in the Ministry of Health's laboratory. Second, epidemiological investigators must be trained to handle Monkeypox cases. Early preparation is a better way to anticipate the possibility of widespread transmission.

This research is also relevant in encouraging sustainable efforts to anticipate other re-emerging diseases in Indonesia. As a country with a large population and areas with high biodiversity,

acceleration towards an "independent country" in producing medical equipment, developing drugs and vaccines and providing high-quality treatment for any possible new disease (Saputra et al., 2022)

Declaration of Conflicting Interest

The author declares no conflict of interest in this study.

Funding

None.

Acknowledgment

None.

Author Contribution

All authors contributed to the whole research process. Each of them had particular main duties: HS, research team leader, study conception and design, analysis and interpretation of the results, approve the final manuscript; NS, data collection (literature review), analysis and interpretation of the results, writes the paper; SRA, research administration management.

Author Biographies

Hermawan Saputra is a Public Health Lecturer at Graduate School of Universitas Muhammadiyah Prof. Dr. Hamka. He is also a member of the Expert Board of Indonesian Public Health Association (IAKMI) and a health communications and leadership practitioner.

Nadilah Salma is a Public Health Professional who is passionate about social development and policy. She is a part-time research assistant at Department of Health Policy and Administration, Faculty of Public Health, Universitas Indonesia and a national board member of Indonesian Public Health Association.

Sheila Rizkia Anjari is a Research Assistant at Department of Public Health, Faculty of Health Sciences, Universitas Pembangunan Nasional Veteran Jakarta and a staff of Bogor City Health Office (Division of Health Human Resources).

References

- Adegboye, O. A., Eugenia Castellanos, M., Alele, F. O., Pak, A., Ezechukwu, H. C., Hou, K., & Emeto, T. I. (2022). Travel-related monkeypox outbreaks in the era of COVID-19 pandemic: Are we prepared? *Viruses*, 14(6), 1283. <https://doi.org/10.3390/v14061283>
- Atkinson, B., Burton, C., Pottage, T., Thompson, K. A., Ngabo, D., Crook, A., Pitman, J., Summers, S., Lewandowski, K., & Furneaux, J. (2022). Infection-competent monkeypox virus contamination identified in domestic settings following an imported case of Monkeypox into the UK. *Environmental Microbiology*. <https://doi.org/10.1111/1462-2920.16129>
- Badan Pusat Statistik. (2019). Lalu lintas penerbangan luar negeri Indonesia tahun 2003-2018. <https://www.bps.go.id/statictable/2009/02/21/1403/lal>

[u-lintas-penerbangan-luar-negeri-indonesia-tahun-2003-2018.html](#)

- Beer, E. M., & Rao, V. B. (2019). A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. *PLoS Neglected Tropical Diseases*, 13(10), e0007791. <https://doi.org/10.1371/journal.pntd.0007791>
- Bell, J., & Nuzzo, J. B. Global health security index: Advancing collective action and accountability amid global crisis.(2021). www.ghsindex.org
- Breithaupt, H. (2003). Fierce creatures: Zoonoses, diseases that jump from animals to humans, are a growing health problem around the world. Understanding their causes and their effects on humans have therefore become an important topic for global public health. *EMBO Reports*, 4(10), 921-924. <https://doi.org/10.1038/sj.embor.embor949>
- Breman, J. G., Steniowski, M., Zanotto, E., Gromyko, A., & Arita, I. (1980). Human Monkeypox, 1970-79. *Bulletin of the World Health Organization*, 58(2), 165.
- Centers for Disease Control and Prevention. (2022a). 2020 Monkeypox outbreak global map. <https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>
- Centers for Disease Control and Prevention. (2022b). 2022 Monkeypox outbreak global map. <https://www.cdc.gov/poxvirus/monkeypox/response/2022/world-map.html>
- Centers for Disease Control and Prevention. (2022c). Monkeypox and smallpox vaccine guidance. <https://www.cdc.gov/poxvirus/monkeypox/clinicians/smallpox-vaccine.html>
- Centers for Disease Control and Prevention. (2022d). Treatment Information for healthcare professionals. <https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html>
- Cimerman, S., Chebabo, A., Cunha, C. A. d., Barbosa, A. N., & Rodríguez-Morales, A. J. (2022). Human monkeypox preparedness in Latin America—Are we ready for the next viral zoonotic disease outbreak after COVID-19? *The Brazilian Journal of Infectious Diseases*, 26(3), 102372.
- Duffy, S. (2018). Why are RNA virus mutation rates so damn high? *PLoS Biology*, 16(8), e3000003. <https://doi.org/https://doi.org/10.1371/journal.pbio.3000003>
- Heymann, D. L., Szczeniowski, M., & Esteves, K. (1998). Re-emergence of Monkeypox in Africa: A review of the past six years. *British Medical Bulletin*, 54(3), 693-702. <https://doi.org/10.1093/oxfordjournals.bmb.a011720>
- Jang, Y. R., Lee, M., Shin, H., Kim, J.-W., Choi, M.-m., Kim, Y. M., Lee, M. J., Kim, J., Na, H. K., & Kim, J. Y. (2022). The first case of Monkeypox in the Republic of Korea. *Journal of Korean Medical Science*, 37(27). <https://doi.org/10.3346/jkms.2022.37.e224>
- Jezek, Z., Szczeniowski, M., Paluku, K. M., & Mutombo, M. (1987). Human Monkeypox: Clinical features of 282 patients. *Journal of Infectious Diseases*, 156(2), 293-298. <https://doi.org/10.1093/infdis/156.2.293>
- Magnus, P. v., Andersen, E. K., Petersen, K. B., & Birch-Andersen, A. (1959). A pox-like disease in cynomolgus monkeys. *Acta Pathologica Microbiologica Scandinavica*, 46(2), 156-176.
- Ministry of Health of the Republic of Indonesia. (2017). Vaccines in Indonesia Successfully eradicate smallpox and polio and eliminate tetanus. <https://sehatnegeriku.kemkes.go.id/baca/rilis-media/20170429/1420692/vaksin-indonesia-berhasil-membasmi-cacar-dan-polio-serta-mengelimnisi-tetanus/>
- Ministry of Transportation of The Republic of Indonesia. (2018). Forty percent of the world's trade routes pass through Indonesia. <http://dephub.go.id/post/read/empat-puluh-persen-jalur-perdagangan-dunia-melewati-indonesia>
- Mohapatra, R. K., Tuli, H. S., Sarangi, A. K., Chakraborty, S., Chandran, D., Chakraborty, C., & Dhama, K. (2022). Unexpected sudden rise of human monkeypox cases in multiple non-endemic countries amid COVID-19 pandemic and salient counteracting strategies: Another potential global threat? *International Journal of Surgery (London, England)*, 103, 106705. <https://doi.org/10.1016/j.ijso.2022.106705>
- Oetomo, D., Suvianita, K., Halim, K., Liang, J., Soeparana, S., & Surahman, L. (2013). Hidup sebagai LGBT di asia: Laporan nasional Indonesia. https://www.usaid.gov/sites/default/files/documents/2496/Being_LGBT_in_Asia_Indonesia_Country_Report_Bahasa_language.pdf
- Olowookere. (2022). Nigeria records 54.7% rise in International flight departures. <https://businesspost.ng/travel/nigeria-records-54-7-rise-in-international-flight-departures/>
- Pan, D., Sze, S., Nazareth, J., Martin, C. A., Al-Oraibi, A., Baggaley, R. F., Nellums, L. B., Hollingsworth, T. D., Tang, J. W., & Pareek, M. (2022). Monkeypox in the UK: arguments for a broader case definition. *The Lancet*, 399(10344), 2345-2346. [https://doi.org/10.1016/S0140-6736\(22\)01101-1](https://doi.org/10.1016/S0140-6736(22)01101-1)
- Peck, K. M., & Luring, A. S. (2018). Complexities of viral mutation rates. *Journal of Virology*, 92(14), e01031-01017. <https://doi.org/10.1128/JVI.01031-17>
- Sanjuán, R., & Domingo-Calap, P. (2016). Mechanisms of viral mutation. *Cellular and Molecular Life Sciences*, 73(23), 4433-4448. <https://doi.org/10.1007/s00018-016-2299-6>
- Santoso, A., Cholikh, A., Patriasari, B., Mulyaningsih, D., SP., R. S., & Sunjaya, . (2015). Naskah sumber arsip kesehatan masyarakat (S. K. Yahya (ed.)). Arsip Nasional Republik Indonesia.
- Saputra, H., Saragih, H. J., Vitriano, O., & Salma, N. (2022). Health system resilience in the context of COVID-19 Vaccination Management in Indonesia. *Jurnal Medicoeticolegal Dan Manajemen Rumah Sakit (JMMR)*, 11(2). <https://doi.org/10.18196/jmmr.v11i2.12007>

The White House. (2022). Fact sheet: Biden-Harris administration advances cleaner industrial sector to reduce emissions and reinvigorate american manufacturing. <https://www.whitehouse.gov/briefing-room/statements-releases/2022/02/15/fact-sheet-biden-harris-administration-advances-cleaner-industrial-sector-to-reduce-emissions-and-reinvigorate-american-manufacturing/>

Thornhill, J. P., Barkati, S., Walmsley, S., Rockstroh, J., Antinori, A., Harrison, L. B., Palich, R., Nori, A., Reeves, I., & Habibi, M. S. (2022). Monkeypox virus infection in humans across 16 countries—April–June 2022. *New England Journal of Medicine*. <https://doi.org/10.1056/NEJMoa2207323>

Ulaeto, D. O., Dunning, J., & Carroll, M. W. (2022). Evolutionary implications of human transmission of Monkeypox: the importance of sequencing multiple lesions. *The Lancet Microbe*, 5247(22), 1–2. [https://doi.org/10.1016/S2666-5247\(22\)00194-X](https://doi.org/10.1016/S2666-5247(22)00194-X)

World Health Organization. (2022). WHO Director-General declares the ongoing monkeypox outbreak a Public Health Emergency of International Concern. <https://www.who.int/europe/news/item/23-07-2022-who-director-general-declares-the-ongoing-monkeypox-outbreak-a-public-health-event-of-international-concern>

Cite this article as: Saputra, H., Salma, N., & Anjari, S. R. (2022). Monkeypox transmission risks in Indonesia. *Public Health of Indonesia*, 8(3), 68-74. <https://dx.doi.org/10.36685/phi.v8i3.634>