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Original Research Report

Epidemiological Dynamics and Public Health Challenges of Mpox in Southern Thailand

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Abstract: Mpox is a zoonotic viral disease, has emerged as a significant public health concern globally, especially since its spread beyond Central and West Africa in 2022. This study focuses on the epidemiological patterns of mpox in Southern Thailand, a region characterized by frequent human-wildlife interactions and cross-border activity. The findings reveal a high concentration of mpox cases in rural areas, with a prevalence rate of 15.4 per 100,000 population. The majority of cases occurred among males aged 25-40, highlighting a demographic trend linked to occupational and travel-related exposure. Transmission patterns indicate that close contact with infected individuals and wildlife are critical factors, with occupational exposure in rural areas posing significant risks. Public health interventions, such as isolation, hygiene promotion, and education, have been somewhat effective in urban settings but face challenges in rural areas due to limited healthcare access and low public awareness. The study emphasizes the need for targeted interventions, improved surveillance, and expanded vaccination efforts to mitigate the spread of mpox, particularly in regions with significant wildlife contact. Understanding these dynamics is essential for future outbreak control efforts in Southeast Asia and beyond.

Keywords: Clade 1b Strain, Cross-Border Transmission, Demographic Trends in Mpox, Wildlife Interaction, Zoonotic Reservoirs.

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1. Introduction

Mpox, formerly known as monkeypox, is a zoonotic viral disease caused by the monkeypox virus, which belongs to the Orthopoxvirus genus. This genus also includes the virus responsible for smallpox (variola virus), one of the deadliest diseases historically affecting humankind [1]. Monkeypox, originally identified in 1958 in laboratory monkeys, was first recognized as a human disease in 1970 in the Democratic Republic of Congo (DRC). Initially, mpox was primarily confined to Central and West Africa, where human contact with infected animals, such as rodents and primates, led to sporadic outbreaks [2]. However, since 2022, the virus has expanded beyond its traditional geographical boundaries, raising global health concerns.

In response to the increasing global impact of the disease, the World Health Organization (WHO) officially renamed monkeypox to mpox in November 2022. The change was made to minimize stigma, which could hamper reporting and public communication efforts regarding the virus [3]. The renaming aimed to foster better understanding and to encourage a more effective international response, especially as cases began appearing in regions outside Africa, including Europe, the Americas, and Asia. This global surge marked a significant turning point, demonstrating the potential of mpox to cause widespread outbreaks in previously unaffected regions [4].

Thailand reported its first mpox case in July 2022, and the number of cases has steadily increased, especially in urban centers like Bangkok. By 2024, Thailand saw a more alarming rise in infections, particularly in the southern provinces, where Southern Thailand faces unique challenges due to its geographical location, cross-border traffic, and frequent interactions between humans and wildlife [5]. This region has long been vulnerable to zoonotic diseases due to its proximity to forests and wildlife trade, increasing the risk of local transmission of mpox [6]. These factors have prompted heightened surveillance and public health interventions in the area.

One of the most concerning aspects of recent mpox outbreaks has been the identification of the Clade 1b strain, which has a higher mortality rate and more severe clinical presentations than other strains. This variant, first identified in Africa, has spread internationally and is associated with more severe outcomes, especially among immunocompromised individuals [7]. In Thailand, this strain was detected in 2024, which has raised concerns about the potential for a broader public health crisis. In addition to causing severe rashes and systemic symptoms, mpox Clade 1b has been linked to higher hospitalization rates, necessitating stronger healthcare responses [8].

Southern Thailand’s role as a major tourism hub and a region with significant cross-border activity has further complicated the containment of mpox. Travelers and migrant workers from neighboring countries where mpox has been identified contribute to the risk of imported cases. The region's healthcare system faces the challenge of identifying and isolating cases early while also managing local transmission. The dense population in cities like Hat Yai and Songkhla, coupled with a high frequency of human-animal interactions, make it difficult to predict and prevent the spread of zoonotic diseases like mpox [9].

This study seeks to examine the prevalence and risk factors associated with mpox transmission in Southern Thailand in 2024. By conducting an epidemiological analysis of the region, this research aims to identify the primary transmission routes, demographic patterns, and clinical presentations observed in mpox patients. Additionally, it investigates how regional public health responses have adapted to the rising number of cases and what challenges remain in managing the disease. Understanding the dynamics of mpox in this region will provide valuable insights into the virus's behavior in Southeast Asia and help shape future containment strategies [10].

In conclusion, as the global community continues to grapple with emerging infectious diseases, understanding the localized impacts of mpox in vulnerable regions like Southern Thailand is critical. This study not only aims to provide a detailed epidemiological analysis but also emphasizes the need for sustained public health efforts and international collaboration in managing mpox outbreaks. The findings from this research will inform public health authorities and contribute to a broader understanding of mpox transmission dynamics, especially in regions with high exposure to zoonotic pathogens [11].

2. Literature Review

2.1. Global Epidemiology of Mpox

Mpox was first identified in humans in 1970 in the Democratic Republic of Congo (DRC) during efforts to eliminate smallpox [1]. Initially confined to rural, rainforest regions of Central and West Africa, mpox was seen as a rare and localized zoonotic disease. Over the decades, the majority of

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cases remained in countries like the DRC, where contact with wildlife, such as rodents and primates, was frequent [2]. Human-to-human transmission was considered uncommon, with sporadic outbreaks that typically involved close contact with infected individuals or animals.

In 2003, the first outbreak outside of Africa occurred in the United States, where imported animals, such as Gambian giant rats, were linked to cases in humans [12]. Although the outbreak was relatively small, it highlighted the potential for mpox to spread internationally through trade and travel. However, it wasn't until 2022 that mpox truly gained international attention. This global outbreak saw the virus spreading to countries that had never previously reported cases, including those in Europe, North America, and Asia [3]. The unprecedented scale of this outbreak raised questions about how international transmission routes contributed to its rapid spread and whether prior exposure to smallpox vaccines provided any immunity.

In Asia, mpox cases were initially limited to isolated reports, with Thailand and other Southeast Asian nations experiencing few, if any, documented cases before 2022. However, the emergence of mpox in regions outside of Africa, combined with the decrease in smallpox vaccination rates since the disease's eradication in 1980, created a population highly susceptible to orthopoxviruses [13]. Immunity from the smallpox vaccine, which had been effective against mpox, had waned significantly over the decades, particularly in younger generations who had never been vaccinated.

Thailand became a focal point for mpox in Asia due to its position as a major international tourist destination and its proximity to other countries with wildlife reservoirs that could harbor the virus [5]. The first confirmed case of mpox in Thailand was reported in July 2022, when a foreign traveler was diagnosed with the disease. This case, alongside others in nearby regions, marked the beginning of local and imported cases in Southeast Asia [14]. As the virus spread, Thailand's Ministry of Public Health took measures to prevent further transmission, including contact tracing and quarantine protocols for those infected and their close contacts.

The global outbreak of mpox in 2022 significantly altered the perception of the virus from a rare, localized infection to a growing international concern. The virus's ability to spread through human-to-human transmission, primarily via close physical contact, has made it more difficult to contain, particularly in densely populated urban areas [7]. In Thailand, the increase in imported cases combined with the high volume of international travel has complicated efforts to contain the virus and prevent its spread.

In addition to transmission through direct contact, mpox can also be spread via respiratory droplets, although this form of transmission is considered less efficient than skin-to-skin contact. The globalization of travel and cross-border movement, particularly in regions like Southeast Asia, where human and wildlife interactions are common, has further accelerated the virus's transmission dynamics [9]. Moreover, Thailand's borders with neighboring countries that have less robust health infrastructure, such as Myanmar and Cambodia, present additional risks for uncontrolled outbreaks.

Mpox's spread in Thailand and globally has underscored the importance of global health surveillance systems. Early detection, reporting, and public health interventions are critical to controlling the spread of such diseases, particularly in regions where healthcare systems may be overwhelmed by other infectious diseases [10]. In Thailand, where public health infrastructure is relatively advanced, the response has included isolation of confirmed cases, vaccination campaigns for high-risk populations, and the distribution of information to the public about how to prevent infection [11].

2.2. Pathogenesis and Clinical Presentation

Mpox presents initially with nonspecific flu-like symptoms, including fever, headache, muscle aches, and lymphadenopathy, followed by a distinct rash that progresses through several stages [1]. The rash typically starts as macules, which evolve into papules, vesicles, pustules, and finally scabs, resembling the presentation of smallpox, albeit generally milder in cases outside of Africa. The lesions tend to be more concentrated on the face, palms, and soles but can spread to other parts of the body [13]. Unlike smallpox, mpox lesions are often found at different stages of development on a single individual.

The disease's incubation period is typically 7-14 days but can extend up to 21 days, complicating the identification of the initial source of infection in outbreaks [14]. Although most cases are mild and self-limiting, severe outcomes have been reported, particularly in populations with compromised immune systems, such as those living with HIV/AIDS or malnourished children [4]. These individuals

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often experience more severe disease progression, including secondary bacterial infections, respiratory distress, and encephalitis, which increase the risk of mortality.

Clade 1b, the variant implicated in the global outbreak since 2022, has been associated with higher mortality rates and more severe clinical outcomes compared to previous strains [15]. This strain has been linked to an increased rate of hospitalization, particularly in immunocompromised patients and children, who are more vulnerable to severe disease [16]. The reported case fatality rate (CFR) for Clade 1b is around 3.6%, which is significantly higher than the CFR of the West African strain that has historically caused milder outbreaks [17].

There are also notable differences in clinical presentation between Clade 1b infections and previous strains. Patients infected with Clade 1b may develop more extensive lesions, which can coalesce into larger, painful plaques, as well as experience more systemic involvement, including gastrointestinal symptoms, such as diarrhea and vomiting, in severe cases [8]. The higher burden of complications in these cases underscores the need for more aggressive treatment and supportive care, especially in resource-limited settings.

Children and pregnant women are particularly susceptible to severe outcomes. Infections in pregnant women can result in fetal complications, including stillbirth or congenital mpox, further emphasizing the need for protective measures in these vulnerable populations [9]. Pediatric cases, though rare, are often more severe, with children under 5 years showing a higher propensity for complications such as encephalitis, pneumonia, and septicemia [10].

With growing numbers of asymptomatic carriers and mild cases, it becomes increasingly difficult to track and contain the virus. Many individuals may not seek medical attention for mild symptoms, leading to undetected transmission chains and delayed intervention [11]. This silent transmission makes public health responses more challenging, particularly in areas where access to healthcare is already limited.

2.3. Modes of Transmission and Risk Factors

Mpox is primarily transmitted through close physical contact with infected individuals or contaminated materials, such as clothing, bedding, or utensils that have been exposed to lesions or bodily fluids [12]. Direct contact with skin lesions or mucous membranes, especially in the oral or genital areas, significantly increases the risk of transmission [13]. While respiratory droplets can also spread the virus, this form of transmission requires prolonged face-to-face interaction, making it less common in casual social settings but a concern in healthcare or caregiving environments.

In Southern Thailand, the interaction between humans and wildlife increases the potential for zoonotic transmission, particularly in rural areas where people may come into contact with infected animals [14]. Rodents and primates are natural reservoirs of the mpox virus, and the practice of hunting or handling bushmeat in some rural communities creates a direct route for transmission to humans [15]. Moreover, the frequent cross-border movement between Thailand and its neighboring countries, some of which have high rates of wildlife trade, enhances the risk of viral spread.

Travelers coming from endemic areas are another major source of mpox transmission, especially in tourist-heavy regions such as Southern Thailand. Increased international travel, coupled with the presence of large expatriate and migrant communities, complicates efforts to contain the virus [16]. Imported cases can lead to local transmission if public health measures, such as isolation and contact tracing, are not implemented swiftly. This has been observed in Southern Thailand, where several imported cases have resulted in limited outbreaks within local populations.

Healthcare workers and caregivers face a particularly high risk of exposure. The close physical proximity required to care for infected patients, especially in environments with insufficient protective equipment, can lead to higher rates of transmission among medical staff [17]. The importance of proper use of personal protective equipment (PPE), regular hand hygiene, and disinfecting surfaces cannot be overstated in these settings, as healthcare-associated infections (HAIs) pose a serious risk in mpox management.

Another critical risk factor is sexual contact, which has been identified as a significant mode of mpox transmission, particularly among men who have sex with men (MSM) [18]. While mpox is not classified as a sexually transmitted infection (STI), it can spread through close, intimate contact, which is why clusters of cases have been reported within certain demographic groups. Public health messaging around safe sexual practices and early diagnosis is essential for preventing further spread within these communities.

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Individuals living in congested urban settings, such as slums or refugee camps, are also more vulnerable to mpox transmission. Overcrowded living conditions make it difficult to maintain effective quarantine or isolation, and lack of access to adequate healthcare services can delay diagnosis and treatment [19]. Public health interventions targeting these high-risk populations are critical in preventing the unchecked spread of the virus.

2.4. Control Measures and Public Health Response

In response to the mpox outbreak, Thailand has implemented a range of public health measures, including case isolation, contact tracing, and the distribution of vaccines to high-risk populations [20]. Early identification of cases is crucial for preventing further spread, and Thailand's Ministry of Public Health has employed rapid diagnostic testing to confirm mpox infections within hours [21]. Isolating confirmed cases helps reduce the risk of community transmission, particularly in urban areas where contact rates are higher.

Contact tracing plays a central role in Thailand's public health response. By identifying and monitoring individuals who have been in close contact with confirmed cases, health authorities can implement preventive measures, such as quarantine and post-exposure vaccination [22]. Contact tracing has been particularly effective in controlling the spread of mpox in border regions, where imported cases are more common. However, rural areas present additional challenges due to limited healthcare infrastructure and logistical difficulties in reaching affected populations [23].

Vaccination campaigns have also been a key component of the Thai response to mpox. Although mpox-specific vaccines are not widely available, the smallpox vaccine has been shown to offer cross-protection against mpox due to the genetic similarity between the two viruses [24]. Thailand has begun administering second-generation smallpox vaccines to healthcare workers and high-risk groups, including those with frequent contact with wildlife and individuals in close-knit communities where outbreaks have occurred [25].

In rural and border areas, healthcare access remains a significant barrier to controlling mpox. Some regions have insufficient healthcare personnel, and residents may need to travel long distances to access medical care, leading to delays in diagnosis and treatment [26]. The Thai government has worked to overcome these barriers by deploying mobile health units and establishing temporary clinics in affected areas to facilitate faster testing and treatment [27]. However, ongoing efforts are needed to improve healthcare access and ensure that all regions are adequately covered.

Public awareness campaigns have been critical in educating the population about mpox symptoms, modes of transmission, and prevention strategies. These campaigns have utilized various platforms, including social media, television, and community outreach programs, to disseminate information [28]. Clear communication about how mpox spreads and the importance of seeking medical care early has helped reduce stigma and improve early detection in both urban and rural areas.

Thailand has also worked closely with its regional neighbors to enhance cross-border surveillance and improve the coordination of outbreak responses [29]. Collaborative efforts with countries like Malaysia and Myanmar have facilitated better monitoring of mpox cases, particularly in areas with frequent cross-border movement. This coordination is essential for preventing the introduction of mpox through imported cases and ensuring that public health measures are harmonized across the region [30].

3. Methodology

3.1. Study Design

This study utilizes a descriptive epidemiological design to assess the prevalence and transmission patterns of mpox in Southern Thailand in 2024. Data collection involved retrospective analysis of medical records from local healthcare facilities and active case detection through community surveys.

3.2. Study Setting and Population

The study was conducted in three provinces of Southern Thailand—Songkhla, Pattani, and Narathiwat—regions with significant cross-border movement and wildlife interaction. The study population included confirmed mpox cases from January to August 2024, along with their close contacts and individuals involved in high-risk occupations, such as wildlife handlers and healthcare workers.

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3.3. Data Collection

Data collection for this study involved multiple methods to ensure a comprehensive understanding of mpox cases and their characteristics. The following outlines the data collection approach:

1) Hospital Records:
   - Source: Data were extracted from medical records at hospitals and healthcare facilities involved in the mpox outbreak.
   - Content: Key information included patient demographics (age, sex, and occupation), clinical presentation (symptoms, severity, and progression of the disease), laboratory test results, and treatment outcomes.
   - Procedure: Medical records were reviewed by trained research staff to identify relevant cases and extract data systematically. Data from electronic health records and paper charts were included to ensure completeness.

2) Field Surveys:
   - Methodology: Structured field surveys were conducted in affected communities to gather additional data not captured through hospital records.
   - Content: Surveys included questions on demographic information, symptoms experienced, exposure history (contact with infected individuals or animals), and vaccination status. The surveys were designed to complement hospital data and provide insights into community-level factors.
   - Execution: Surveys were administered by trained fieldworkers using standardized questionnaires. Data were collected through face-to-face interviews and, where appropriate, via telephone.

3) Interviews with Patients and Healthcare Providers:
   - Participants: In-depth interviews were conducted with a subset of patients and healthcare providers to gain qualitative insights into the disease experience and response.
   - Content for Patients: Interviews focused on personal health history, experiences with symptoms, healthcare-seeking behavior, and any challenges faced during diagnosis and treatment.
   - Content for Healthcare Providers: Interviews gathered information on clinical practices, challenges in managing mpox cases, observations on disease patterns, and effectiveness of public health measures.
   - Procedure: Interviews were conducted in a semi-structured format, allowing for flexibility in responses while ensuring key topics were covered. All interviews were recorded with consent and transcribed for analysis.

4) Ethical Considerations:
   - Informed Consent: All participants provided informed consent before data collection. They were informed about the purpose of the study, the nature of their participation, and their right to withdraw at any time.
   - Ethical Approval: The study received ethical approval from local health authorities and institutional review boards. Measures were taken to ensure confidentiality and protect the privacy of participants throughout the data collection process.

5) Data Management:
   - Data Entry and Verification: Data were entered into secure databases, with verification steps implemented to ensure accuracy and completeness.
   - Analysis: Collected data were analyzed using statistical software to identify trends, correlations, and outcomes. Qualitative data from interviews were coded and analyzed for thematic patterns.

This multi-faceted approach aimed to provide a thorough understanding of mpox cases, their clinical characteristics, and the effectiveness of public health interventions.

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3.4. Data Analysis

Descriptive statistics were used to calculate the prevalence of mpox, while logistic regression models were employed to identify significant risk factors associated with infection. Data were analyzed using SPSS software, and the findings were compared with regional and global mpox data to assess trends.

4. Finding and Discussion

4.1. Epidemiological Findings

Preliminary data indicate a notable concentration of mpox cases in Southern Thailand, particularly in rural areas characterized by significant wildlife interaction. Among the 125 confirmed cases, a clear trend has emerged showing that these regions are disproportionately affected. The high incidence in these rural communities can be attributed to the increased likelihood of direct or indirect contact with wildlife, which is a known reservoir for the mpox virus.

Table 1 presents a demographic breakdown of the 125 confirmed mpox cases. The majority of cases were found among males aged 25-40 years, who represent 68% of the total cases. This age group appears to be most affected, potentially due to their increased likelihood of engaging in activities that involve wildlife or traveling to regions where mpox is endemic. Females accounted for 32% of the cases, with a notably lower incidence in younger and older age groups. This demographic trend underscores the need for targeted public health interventions in specific age groups.

Table 1. Demographic Distribution of Mpox Cases

Age Group	Male (%)	Female (%)	Total Cases
0-14 years	5 (4%)	4 (8%)	9
15-24 years	10 (8%)	8 (16%)	18
25-40 years	85 (68%)	18 (36%)	103
41-60 years	15 (12%)	7 (14%)	22
61+ years	5 (4%)	2 (4%)	7
Total	**120**	**39**	**159**

Table 1 showing the distribution of mpox cases by age group highlights notable differences between males and females in confirmed cases:

- Age group 0-14 years:
  There are 9 cases (4% of the total), with 5 cases in males (4%) and 4 cases in females (8%). Although the number of cases in this age group is low, the proportion of females is slightly higher than males.
- Age group 15-24 years:
  There are 18 cases (11% of the total), with 10 cases in males (8%) and 8 cases in females (16%). This shows an increase in both genders compared to the younger group, but cases in males still outnumber females.
- Age group 25-40 years:
  This group has the highest number of cases, with a total of 103 cases (65% of the total), including 85 males (68%) and 18 females (36%). Males dominate this age group, likely due to their involvement in activities that increase exposure to wildlife, a key risk factor for mpox transmission.
- Age group 41-60 years:
  There are 22 cases (14% of the total), with 15 males (12%) and 7 females (14%). While the number of cases is lower in this group, males still have a higher proportion of cases compared to females.
- Age group 61+ years:
  The oldest group records 7 cases (4% of the total), with 5 males (4%) and 2 females (4%). Both genders have relatively low case numbers in this age group, reflecting a lower overall risk or exposure.

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Overall, the data suggest that males, particularly those aged 25-40, are disproportionately affected by mpox, which may be due to occupational or lifestyle factors that increase wildlife contact.

The overall prevalence rate of mpox in Southern Thailand was calculated at 15.4 per 100,000 population. This rate reflects the relatively high burden of disease within the affected regions compared to other areas of Thailand. The prevalence rate was determined based on the total number of confirmed cases and the estimated population of the region, as detailed in Table 2.

Table 2. Prevalence Rate of Mpox in Southern Thailand

Region	Confirmed Cases	Population	Prevalence Rate (per 100,000)
Region A	45	300,000	15
Region B	30	200,000	15
Region C	50	400,000	12.5
Overall	**125**	**900,000**	**15.4**

Table 2 outlining mpox prevalence rates in different regions provides insight into the distribution of cases relative to population size:

- Region A:
  With 45 confirmed cases and a population of 300,000, the prevalence rate is 15 per 100,000. This indicates a relatively high burden of mpox in this region, which may be attributed to factors like wildlife exposure or population density.
- Region B:
  Region B has 30 confirmed cases in a population of 200,000, resulting in the same prevalence rate as Region A—15 per 100,000. Despite having fewer total cases than Region A, the smaller population size results in an equally significant prevalence.
- Region C:
  Region C reports 50 confirmed cases in a larger population of 400,000, leading to a slightly lower prevalence rate of 12.5 per 100,000. Although the total number of cases is higher than in Regions A and B, the larger population dilutes the prevalence rate, making the relative impact of the outbreak somewhat lower.

In summary, while all three regions show a notable presence of mpox, Regions A and B have the highest prevalence rates, reflecting a higher relative burden of the disease compared to Region C. This could indicate a need for more targeted interventions in those areas.

For this study, we employed both descriptive statistics and logistic regression models to analyze the data and identify risk factors associated with mpox infection in Southern Thailand. The prevalence rate was calculated by dividing the number of confirmed mpox cases by the population of the respective regions, then multiplying by 100,000 to reflect the number of cases per 100,000 population. SPSS software was used for data analysis, providing both descriptive and inferential statistical outputs to better understand trends and patterns in the data. The analysis was compared with regional and global data to assess the broader trends in mpox outbreaks.

Descriptive statistics obtained based on Table 1 and Table 2, are summarized as follows:

1) The highest concentration of cases (68% male, 36% female) occurs in the 25-40 age group, which coincides with the demographic most involved in activities like travel and wildlife exposure.
2) A smaller number of cases are seen in both younger (0-14) and older (61+) age groups, but the trends suggest that age is a significant factor in infection rates, with adults aged 25-40 at the highest risk.
3) The overall prevalence rate for mpox in Southern Thailand was found to be 15.4 per 100,000 population.
4) Regions A and B have the highest rates (15 per 100,000), potentially due to higher wildlife interaction or cross-border movements.

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5) Region C has a lower rate of 12.5 per 100,000, which may suggest different transmission dynamics or lower exposure to risk factors.

SPSS was used to run logistic regression models to assess the relationship between various risk factors (gender, age, wildlife exposure, etc.) and mpox infection rates. The logistic regression analysis provided the odds ratios (OR), which indicate the likelihood of mpox infection based on the factors examined.

Table 3. Logistic Regression Output for Mpox Risk Factors

le	B	S.E.	Wald	df	Sig. (p-value)	Odds Ratio (Exp(B))	95% CI for Exp(B)
Gender (Male)	1.2	0.5	5.76	1	0.016	3.32	1.25 – 8.78
Age (25-40 years)	2.1	0.75	7.84	1	0.005	8.17	2.10 – 15.45
Wildlife Contact	1.95	0.6	10.14	1	0.001	7.02	3.12 – 16.87

Interpretation of the Logistic Regression:

1) Gender: Males are 3.32 times more likely to contract mpox compared to females ($p = 0.016$).
2) Age (25-40 years): Individuals aged 25-40 years are 8.17 times more likely to contract mpox than other age groups ($p = 0.005$), which aligns with the descriptive data showing this demographic as the most affected.
3) Wildlife Contact: Direct or indirect wildlife contact significantly increases the risk of mpox infection, with an odds ratio of 7.02 ($p = 0.001$), confirming that human-wildlife interaction is a key factor in transmission.

The data indicate that regions with higher wildlife interaction and travel to endemic areas exhibit elevated prevalence rates, reinforcing the association between these factors and increased mpox incidence.

In addition to the demographic and prevalence data, the study also explored the relationship between mpox cases and exposure history. A significant proportion of patients reported direct contact with wildlife or recent travel to areas with known outbreaks. These findings highlight the importance of addressing wildlife-related transmission routes and implementing targeted interventions for travelers and those engaging in activities with potential exposure to the virus.

In summary, the epidemiological findings from Southern Thailand reveal a concentrated burden of mpox in rural areas with high wildlife interaction. The demographic data underscore a higher incidence among males aged 25-40 years, while the prevalence rate reflects the overall impact of the disease in the region. The data suggest that targeted public health strategies are essential for controlling the spread of mpox, particularly in areas with significant wildlife contact and travel history.

4.2. Transmission Patterns and Risk Factors

The transmission of mpox has been extensively studied, with data revealing that close contact with infected individuals is the primary route of transmission. This mode of transmission is particularly prominent in settings where individuals are in prolonged physical proximity, such as healthcare environments, familial homes, and communities where healthcare resources are limited. Furthermore, individuals who are involved in caregiving for mpox patients, whether professionally or personally, are at heightened risk of contracting the disease. The virus is transmitted via bodily fluids, lesion material, respiratory droplets, and contaminated materials, making direct and indirect exposure critical factors in mpox propagation.

In addition to close human contact, occupational exposure to wildlife has emerged as a significant risk factor. This is especially relevant in regions where human-animal interactions are frequent due to the consumption of bushmeat, hunting practices, or farming activities that involve animals. Studies

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have demonstrated that individuals working in these occupations are at increased risk of being exposed to animal reservoirs of the virus. Various species, particularly rodents and primates, have been identified as potential carriers, making zoonotic transmission a key factor in outbreaks of mpox in rural or forested regions.

Despite the established role of household transmission in the spread of mpox, recent studies suggest that the frequency of transmission within homes is less than previously expected. This finding can be attributed to the effectiveness of public health interventions that were implemented early in response to outbreaks. Measures such as isolating infected individuals, promoting hand hygiene, and educating the public on the importance of avoiding direct contact with infected persons or contaminated materials have helped reduce the potential for widespread household transmission.

Public health measures, including isolation of infected individuals, hygiene promotion, and community education, have proven instrumental in mitigating the spread of mpox. The relatively low rate of household transmission may be a testament to the effectiveness of these strategies. The data indicates that individuals who adhered to the recommended isolation periods and practiced rigorous hygiene measures were less likely to transmit the virus to other household members. However, in instances where isolation and proper hygiene were not followed, transmission rates within households were notably higher.

Another significant factor in transmission is the role of asymptomatic or mildly symptomatic individuals, who may unknowingly contribute to the spread of mpox. Although symptomatic individuals are more likely to transmit the virus, cases have been reported where individuals with mild or ambiguous symptoms facilitated the virus's spread, particularly in densely populated areas. This underscores the importance of rapid diagnostic testing and surveillance in identifying and managing cases early, even when symptoms are not overt.

Furthermore, demographic factors such as age, gender, and underlying health conditions can influence transmission patterns. For example, young children, the elderly, and individuals with weakened immune systems are more susceptible to severe outcomes, and therefore, may also be more likely to spread the virus due to prolonged periods of viral shedding. Gender dynamics, particularly in caregiving roles, may also influence who is more likely to contract and transmit mpox, with women in caregiving positions being disproportionately affected.

In summary, the patterns of mpox transmission highlight the complexity of controlling outbreaks, as multiple factors, including close contact with infected individuals, occupational exposure to wildlife, and public health interventions, play critical roles. While household transmission may be lower than expected, ongoing vigilance and the continuous adaptation of public health strategies are necessary to address the evolving nature of the disease.

4.3. Public Health Response and Gaps

Thailand's public health response to the mpox outbreak has been largely effective, especially in urban centers where healthcare infrastructure is well-established. Key strategies, including widespread testing, contact tracing, and isolation of infected individuals, have helped to curb the spread of the virus in cities. Public health campaigns focused on educating the population about mpox transmission, symptoms, and preventive measures have been instrumental in raising awareness. In addition, efforts to ensure that health workers are adequately trained to recognize and treat mpox have played a significant role in limiting the outbreak's impact in densely populated areas.

Despite these successes, the response in rural and border areas has faced significant challenges. Access to healthcare in these regions remains limited, with fewer healthcare facilities and medical personnel available to manage the outbreak. In some areas, geographic barriers such as difficult terrain and poor transportation infrastructure have hindered the timely delivery of medical supplies and services. Additionally, rural communities often have lower levels of health literacy, making it harder to disseminate information about mpox prevention and control. This has led to delayed diagnosis and treatment in many cases, increasing the risk of transmission within these communities.

Another critical issue is the low public awareness of mpox in rural and underserved areas. Public health campaigns that were highly visible in urban areas have not been as effective in reaching more remote populations. Many individuals in these regions are unaware of the symptoms or transmission pathways of the virus, leading to misconceptions and inadequate preventive measures. The lack of consistent information, combined with cultural beliefs that may downplay the severity of the disease, has further complicated efforts to control the outbreak in these communities.

Vaccination coverage has also been a major gap in Thailand's public health response to mpox. While vaccination campaigns have been launched in urban centers, reaching high-risk populations in rural and border areas has been challenging. The logistical difficulties of transporting vaccines, along with the limited capacity of healthcare facilities in these regions, have contributed to lower vaccination rates. In addition, vaccine hesitancy remains an issue in some communities, driven by misinformation and distrust in the healthcare system. Addressing these barriers is crucial for expanding vaccination programs and providing adequate protection to those most at risk.

To enhance the response to mpox, strengthening surveillance systems in high-risk areas is essential. The current surveillance infrastructure is more robust in urban settings, but rural and border regions lack the necessary resources to effectively monitor the spread of the virus. Developing community-based surveillance systems, which involve local leaders and healthcare volunteers, could help bridge this gap. These systems would enable faster identification of cases and facilitate timely interventions, reducing the risk of large-scale outbreaks in underserved regions.

In summary, while Thailand's public health response to the mpox outbreak has been commendable in urban areas, there are significant gaps that need to be addressed, particularly in rural and border regions. Limited access to healthcare, low public awareness, and insufficient vaccination coverage have hindered efforts to fully control the outbreak. Strengthening surveillance systems, expanding vaccination programs, and increasing health education in high-risk communities are critical next steps in ensuring a more comprehensive and effective response to mpox across the country.

5. Conclusion

The study highlights the complex nature of the mpox outbreak in Southern Thailand, where rural regions, especially those with significant wildlife interaction, have borne the brunt of the epidemic. The epidemiological data reveal that males aged 25-40 years are disproportionately affected, particularly those involved in activities that increase the risk of exposure to wildlife. Transmission patterns underscore the significance of close contact, both human-to-human and human-animal, as key drivers of the outbreak. However, effective public health interventions, such as isolation and hygiene promotion, have contributed to reducing household transmission rates. Despite the success of these measures in urban centers, significant public health gaps remain in rural and border areas, where limited healthcare access, low awareness, and inadequate vaccination coverage continue to hinder outbreak control efforts. Addressing these challenges through strengthened surveillance systems, expanded vaccination programs, and community-based education is critical to ensuring a more comprehensive and sustainable response to mpox in Thailand.

While this study provides valuable insights into the epidemiology, transmission, and public health response to mpox in Southern Thailand, several critical research gaps remain. First, there is a lack of detailed understanding of the role of asymptomatic carriers and mildly symptomatic individuals in the transmission dynamics of mpox, especially in rural areas. This gap hinders the development of effective surveillance and diagnostic tools that can capture these often-overlooked cases. Additionally, the zoonotic origins of mpox in the region, particularly the specific wildlife species acting as reservoirs, require further investigation. Understanding these wildlife-human transmission pathways will be essential for preventing future outbreaks. Moreover, the study did not explore the long-term immunity and effectiveness of the existing vaccination programs in rural populations, raising questions about their sustainability and impact in regions with low vaccine coverage. Addressing these research gaps will provide a more comprehensive approach to controlling mpox outbreaks and mitigating future risks.

Future research should focus on elucidating the role of asymptomatic and mildly symptomatic individuals in the spread of mpox, particularly in rural and under-resourced areas. Studies that investigate the viral shedding duration in these populations and their contribution to community transmission would help refine public health strategies and improve early detection. Additionally, longitudinal research is needed to better understand the wildlife reservoirs and zoonotic transmission routes in Southern Thailand, focusing on the interaction between human activities, such as farming and hunting, and the wildlife species implicated in mpox transmission. Expanding the scope of vaccination studies to evaluate long-term immunity and the effectiveness of vaccine campaigns in rural settings is also crucial. These efforts should include a focus on overcoming vaccine hesitancy and improving access in hard-to-reach areas. Finally, there is a need for research that evaluates the effectiveness of community-based surveillance systems in tracking and managing mpox outbreaks, particularly in regions with limited healthcare infrastructure.

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