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# Mpox: Epidemiological profile and factors associated with complications in the Isangi Territory, Democratic Republic of the Congo

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## ABSTRACT

### Introduction

The Mpox outbreak in non-endemic regions is now attracting global attention. The Isangi Territory has experienced Mpox epidemic outbreaks in recent years, during which several deaths were reported.

### Purpose

The objective of this study is to describe the epidemiological profile of this disease and to identify the factors associated with the occurrence of complications.

### Methods

This was a retrospective cohort study covering the period from January 1, 2023, to January 31, 2024. The subsequent field survey was conducted in February 2024. It included 230 patients with positive PCR test results. The analysis of factors associated with the occurrence of complications was done using odds ratios (ORs) and 95% confidence intervals (CIs).

### Results

During this period, 230 patients with positive PCR results for Mpox were diagnosed. The incidence of Mpox was 3.3 new cases per 100,000 person-months, equivalent to a cumulative incidence of 43 cases per 100,000 inhabitants over the study period, with a case fatality rate of 4.7%. The median age of patients was 20 years (IQR: 5–25), and females were dominant, with a sex ratio (females per 1 male) of 1.21. Most cases (99%) had no history of smallpox vaccination. Age under 18 years (OR, 95% CI: 61.7 [24.8–160.1]), a history of malnutrition and/or measles (OR, 95% CI: 34.9 [11.7–134.5]), seeking initial care at places of worship or from traditional healers (OR, 95% CI: 34.4 [15.0–82.7]), and low socioeconomic status (OR, 95% CI: 4.7 [1.3–25.8]) were associated with the occurrence of complications, while a high level of education proved to be a protective factor (OR, 95% CI: 0.4 [0.2–0.7]).

### Conclusion

Complications of Mpox infection are associated with certain sociodemographic, economic, and health factors. Specific actions are needed with regard to each factor.

## INTRODUCTION

Mpox is a zoonosis caused by the Mpox virus (MPXV), a double-stranded DNA virus of the *Orthopoxvirus* genus in the *Poxviridae* family (Petersen et al., 2019a). Clinically, it manifests as a prodromal fever and headache with myalgia, persistent cough, lymphadenopathy, and sore throat, progressing to cutaneous and mucosal involvement characterised by papular lesions that evolve into vesiculopapular lesions and resolve into crusts (Billioux et al., 2022). These lesions typically affect the face, scalp, palms, soles, trunk, perineum, and oral mucosa (Sklenovská et al., 2018).

Long considered a rare and self-limiting disease endemic to Central and West Africa, the unexpected epidemic and rapid spread of Mpox in non-endemic regions has now attracted global attention (Petersen et al., 2019a; Huang et al., 2022).

In Europe, out of 1,796 confirmed cases reported by the European surveillance system, 99.4% were men, and the majority were between 31 and 40 years old (792/1,796). The UK Health Security Agency (UKHSA) reported that 151 of 152 men interviewed identified as homosexual. Most of these cases were reported through sexual health services in the United Kingdom (UK Health Security Agency [UKHSA], 2022).

In Africa, Mpox epidemics are frequent. In the western and central regions where it is endemic, the increase in human Mpox cases since 2005 has been fuelled by climate change, deforestation, war, human migration, and the decline in herd immunity due to the discontinuation of smallpox vaccination (Durski et al., 2018; Petersen et al., 2019b; Simpson et al., 2020). In September 2017, the largest Mpox outbreak was recorded in Nigeria, caused by a strain belonging to the West African clade (Nguyen et al., 2021). This resurgence occurred after 40 years without any reported cases.

The Democratic Republic of the Congo (DRC) alone has reported nearly 85% of known human Mpox cases in recent years across several epidemics (Mandja et al., 2019). In 2020, 4,594 suspected cases of simian orthopoxvirosis, including 171 deaths (case fatality rate of 3.7%), were reported across 127 health zones in 17 of the 26 provinces of the DRC. The Kwilu and Tshopo provinces had the highest mortality rates, with 16.7% and 8.1%, respectively, during the same year. From October 2021 to the end of 2022, 6,032 suspected Mpox cases, including 233 deaths, were reported in 23 of the country's 26 provinces (World Health Organization [WHO], 2022a).

Several studies have evaluated the link between the occurrence of complications and various factors (Huhn et al., 2005; Mbala et al., 2017; Ogoina et al., 2020; Li et al., 2022). These studies have shown that immunosuppression, primarily linked to HIV, is a predominant factor in the occurrence of complications. The groups most at risk of progressing to severe forms of the disease in African countries include children, pregnant women, and immunocompromised individuals, including those with uncontrolled HIV infection.

While HIV-related immunosuppression has been widely identified as a risk factor for Mpox complications, our study proposes a more comprehensive approach by considering other immunosuppressive factors such as measles and malnutrition, which are particularly relevant in our context. In addition, we will analyse the impact of delayed healthcare seeking on the occurrence of complications.

In Tshopo Province, the Isangi Territory—where immunosuppressive conditions such as measles and malnutrition are prevalent—has experienced repeated Mpox outbreaks over the past three years, primarily in the Yakusu Health Zone.

In view of the resurgence of epidemic outbreaks and the absence of a previous conclusive study carried out in Tshopo Province, particularly in the Isangi Territory, the present study is being conducted to describe the epidemiological profile of the disease and to identify the factors associated with the occurrence of complications in this territory.

## METHODS

### *Study Setting*

This multicentre study was conducted in three health zones of the Isangi Territory, namely the Yakusu, Yahisuli, and Yabaondo health zones.

The Isangi Territory extends west of the city of Kisangani, at 0°47′ North, 24°14′ East. With a surface area of 15,770 km²


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and a population estimated at 701,548 inhabitants, it is the smallest territory in Tshopo Province but also the most densely populated (with a density of 24 inhabitants per km²). It is crossed from north to south by the Congo River, and to the east, the Lomami River flows into it at the town bearing the same name. The climate is equatorial, with dense forest cover. The population, which primarily engages in fishing, hunting, and traditional agriculture, faces recurring measles epidemics and widespread malnutrition.

### *Study Population*

The study population consisted of residents of the three selected health zones who were exposed to Mpox infection. In 2023, the Yakusu Health Zone had a population of 203,746, Yahisuli had 119,898, and Yabaondo had 208,448 (Division Provinciale de la Santé/Tshopo, 2023).

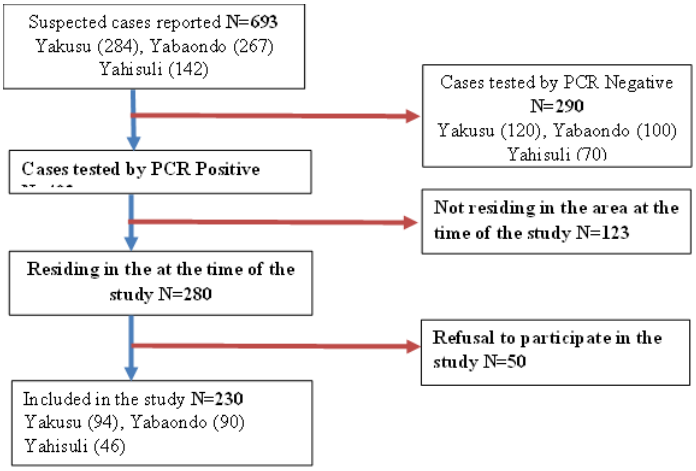
### *Study Type and Period*

This was a retrospective cohort study covering the period from 1 January 2023 to 31 January 2024. The subsequent field survey was conducted in February 2024.

### *Sampling*

We used a flow diagram to select and retain study participants. The three health zones reported a total of 693 suspected cases during the study period. After excluding patients who were non-residents or who declined to participate, 230 subjects were retained, as shown in the flow chart below:

**Figure 1:**
The Flowchart Used to Guide Respondent Selection




### *Inclusion Criteria*

The study included any individual who:

- Developed Mpox infection confirmed by an INRB result during the study period,
- Resided in the targeted health zones, and
- Agreed to participate in the study. Those not meeting these criteria were excluded.

### *Data Collection*

Data were collected using the case investigation form for Mpox cases from the National Programme for the Fight against Mpox and Viral Hemorrhagic Fevers of the DRC (Programme National de Lutte contre la Mpox et les Fièvres Hémorragiques Virales [PNLM/FHV], 2022), which was adapted to local conditions. This involved guided interviews using a survey questionnaire, supplemented by document analysis (case investigation forms or consultation records).

To reduce recall and selection bias, we trained the investigators, standardised the questionnaires, and combined both document analysis and guided interviews. The level of financial income was assessed based on population distribution by quintiles of economic well-being, following the model used in the 2013–2014 Demographic and Health Survey (Enquête Démographique et de Santé en République Démocratique du Congo II [EDS-RDC II], 2014). Subjects were divided into three categories: low, medium, and high financial income. For statistical analysis, this variable was dichotomised into low (low and medium) and high income levels.

The impact of immunodeficiency on the occurrence of complications was measured based on self-reported history of measles and/or malnutrition.

After being informed of the purpose and objectives of the study, head nurses (*Infirmiers Titulaires* – ITs) and the Plan MASHAKO supervisor—each equipped with KoboToolbox survey questionnaires—were deployed to households with one or more eligible individuals.

For respondents unable to answer the questionnaire directly, a parent or the head of the household provided assistance. The questions focused on sociodemographic, anthropological, cultural, and medical variables.

### *Mpox Complications*

An Mpox complication was defined as the presence of at least 100 skin lesions at any stage of the disease (World



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Health Organization [WHO], 2022b), in addition to clinical signs such as nausea and vomiting, painful cervical lymphadenopathy causing dysphagia, inadequate oral intake, eye pain, vision problems, hepatomegaly, septic state, dehydration, respiratory distress/pneumonia, and/or confusion.

### *Statistical Analysis*

Data were entered into Microsoft Excel and analysed using STATA version 13. Respondent characteristics were described using proportions for categorical variables and the median with interquartile range (IQR) for the continuous variable (age), as the data distribution was skewed. Statistical inferences for comparing results between health zones were made using Pearson's chi-square test and Fisher's exact test, as appropriate. Analysis of associated factors was conducted using odds ratios (OR) and 95% confidence intervals (CI).

## RESULTS

### *Extent and Case Fatality Rate of Mpox Infection in the Isangi Territory*

**Table 1:**
Mpox Incidence and Case Fatality Rate by Health Zone

| Health Zone | Incidence (n/N) | % | Case Fatality Rate (n/N) | % |
|---|---|---|---|---|
| Yakusu | 94/203,746 | 0.046 | 6/94 | 6.4 |
| Yabaondo | 90/208,448 | 0.043 | 3/46 | 6.5 |
| Yahisuli | 46/119,898 | 0.038 | 2/90 | 2.2 |
| All | 230/532,092 | 0.043 | 11/230 | 4.7 |

As shown in **Table 1**, the overall incidence of Mpox infection in the Isangi Territory was 43 per 100,000 population (0.043%), with an overall case fatality rate of 4.7%.

### *Sociodemographic Characteristics of Study Participants*

**Table 2:**
Distribution of Participants by Sociodemographic Characteristics (P-values based on Pearson's chi-square test unless otherwise stated)

| Variable/Hz | Yabaondo | Yahisuli | Yakusu | Total | P |
|---|---|---|---|---|---|
| **Age** *(years)* | | | | | 0.123* |
| *Median (IQR)* | *10 (5–17)* | *17 (5–30)* | *17 (5–24.5)* | *17 (5–25)* | |
| 0–17 | 43 (47.8%) | 19 (41.3%) | 31 (33%) | 93 (40.4%) | |
| ≥18 | 47 (52.2%) | 27 (58.7%) | 63 (67%) | 137 (59.6%) | |
| **Sex** | | | | | 0.762* |
| Female | 50 (55.6%) | 23 (50%) | 53 (56.4%) | 126 (54.8%) | |
| Male | 40 (44.4%) | 23 (50%) | 41 (43.6%) | 104 (45.2%) | |
| **Educational level** | | | | | 0.954** |
| Uneducated | 31 (34.4%) | 15 (32.6%) | 31 (33%) | 77 (33.5%) | |
| Primary school | 44 (48.9%) | 21 (45.7%) | 49 (52.1%) | 114 (49.6%) | |
| Secondary school | 13 (14.4%) | 8 (17.4%) | 12 (12.8%) | 33 (14.4%) | |
| Higher education | 2 (2.2%) | 2 (4.4%) | 2 (2.1%) | 6 (2.6%) | |
| **Profession** | | | | | |
| Out-of-school child | 24 (26.7%) | 10 (21.7%) | 18 (19.2%) | 52 (22.6%) | 0.470* |
| Student | 17 (18.9%) | 4 (8.7%) | 11 (11.7%) | 32 (13.9%) | 0.193* |
| Hunter | 24 (26.7%) | 5 (10.9%) | 23 (24.5%) | 52 (22.6%) | 0.098* |
| Farmer | 12 (13.3%) | 21 (45.7%) | 20 (21.3%) | 53 (23.0%) | <0.001* |
| Game merchant | 9 (10%) | 5 (10.9%) | 16 (17%) | 30 (13.0%) | 0.327* |
| Fisher | 4 (4.4%) | 1 (2.2%) | 6 (6.4%) | 11 (4.8%) | 0.621** |
| **Smallpox vaccination status** | | | | | 0.513** |
| Yes | 0 (0%) | 1 (2.2%) | 1 (1.1%) | 2 (1%) | |
| No | 90 (100%) | 45 (97.8%) | 93 (98.9%) | 228 (99%) | |
| **Socioeconomic level** | | | | | 0.152* |
| Low | 55 (61.1%) | 27 (58.7%) | 47 (50%) | 129 (56%) | |
| Medium | 32 (35.6%) | 13 (28.3%) | 37 (39.4%) | 82 (35.7%) | |
| High | 3 (3.3%) | 6 (13%) | 10 (10.6%) | 19 (8.3%) | |

**Note:** p from Pearson's chi-square test; p from Fisher's exact test.

Only the profession "farmer" showed a statistically significant difference between health zones, being more prevalent in Yahisuli.

### *Complications of Mpox Infection*

**Table 3:**
Occurrence and Type of Complication

| Variable/Hz | Yabaondo | Yahisuli | Yakusu | Total | P |
|---|---|---|---|---|---|
| **Complication occurrence** | | | | | 0.847* |
| Yes | 42 (46.7%) | 20 (43.5%) | 40 (42.6%) | 102 (44.4%) | |
| No | 48 (53.3%) | 26 (56.5%) | 54 (57.4%) | 128 (55.6%) | |
| **Type of complication** | | | | | |
| Respiratory infection | 42 (100%) | 19 (95%) | 35 (87.5%) | 96 (94.1%) | 0.048** |
| Secondary skin infection | 42 (100%) | 20 (100%) | 28 (70%) | 90 (88.2%) | <0.001** |
| Undernutrition | 14 (33.3%) | 6 (30%) | 7 (17.5%) | 27 (26.5%) | 0.247* |
| Acute respiratory distress | 8 (19%) | 6 (30%) | 8 (20%) | 22 (22%) | 0.315* |
| Coma | 6 (14.3%) | 6 (30%) | 8 (20%) | 20 (19.6%) | 0.345* |
| Blindness | 2 (4.8%) | 0 (0%) | 3 (7.5%) | 5 (4.9%) | 0.567** |

Respiratory and secondary skin infections were the most frequent complications. Secondary skin infections were significantly more frequent in Yabaondo and Yahisuli.

### *Analysis of Factors Associated with Mpox Complications*

**Table 4:**
Factors Associated with Mpox Complications

| Variable | Complication | | OR | Ci | P |
|---|---|---|---|---|---|
| | Yes N=102 n (%) | No N=128 n (%) | | | |
| **Age** | | | **61.7** | **[24.8 160.1]** | **<0.001** |
| 0-17 | 84 (82.4) | 9 (7) | | | |
| ≥ 18 | 18 (17.6) | 119 (93) | | | |
| **History of measles and/or malnutrition** | | | **34.9** | **[11.7 134.5]** | **<0.001** |
| Yes | 54 (52.9) | 4 (3.1) | | | |
| No | 48 (47.1) | 128 (96.9) | | | |
| **Pathway** | | | **34.4** | **[15.0 82.7]** | **<0.001** |
| From home to health centers/clinics/hospitals | 10 (9.8) | 101 (78.9) | | | |
| From home to prayer house/traditional healer, then to health centers/clinics/hospitals | 92 (90.2) | 27 (21.1) | | | |
| **Socioeconomic level** | | | **4.7** | **[1.3 25.8]** | **0.009** |
| Low | 99 (97) | 112 (87.5) | | | |
| High | 3 (3) | 16 (12.5) | | | |
| **Educational level** | | | **0.4** | **[0.2 0.7]** | **0.0009** |
| Uneducated | 46 (45.1) | 31 (24.2) | | | |
| Educated | 56 (54.9) | 97 (75.8) | | | |
| **Smallpox vac status** | | | | | **0.872** |
| Yes | 1 (1) | 1 (1) | | | |
| No | 101 (99) | 127 (99) | | | |
| **Transmission** | | | | | **0.171** |
| **Primary** | 28 (27.5) | 46 (35.9) | | | |
| **Secondary** | 74 (72.5) | 82 (64.1) | | | |

**Table 4** indicates that age below 17 years, a history of measles and/or malnutrition, initial care-seeking from prayer houses or traditional healers, low socioeconomic status, and lack of formal education were significantly associated with the occurrence of complications in Mpox patients.

## DISCUSSION

The incidence rate of Mpox infection in the Isangi Territory was 3.3 new cases per 100,000 person-months (equivalent to a cumulative incidence of 43 cases per 100,000 inhabitants during the study period), with an overall case fatality rate of 4.7%. Surveillance data of suspected monkeypox cases in the DRC showed that the incidence increased from 0.64 per 100,000 inhabitants in 2001 to 2.82 per 100,000 inhabitants in 2013 (Hoff et al., 2017). Between November 2005 and November 2007, the average cumulative annual incidence of confirmed monkeypox in nine health zones of the Sankuru District was 55.3 per 100,000 inhabitants, ranging from 21.8 to 144.2 per 100,000 (Rimoin et al., 2010).

Our findings are similar to those observed in the Sankuru Health Zone; however, the incidence in our study may be underestimated, as many cases were never investigated or reported due to mobility constraints of the surveillance teams, the remoteness of some health areas from their central offices, and the poor quality of certain collected samples (such as blood), which may explain some of the negative test results.

Regarding lethality, Mandja et al. (2019) noted in their study on the temporal and spatial dynamics of monkeypox in the DRC (2000–2015) that the case fatality rate varied depending on the viral clade. Historically, case fatality rates have ranged from 1% to 12% for infections due to clade 1, mainly in Central Africa, and less than 0.1% in most epidemics caused by clade 2a (Mandja et al., 2019). In Nigeria, Beer and Rao (2019) reported a case fatality rate of 2.8%, while the U.S. epidemic recorded no deaths. Our results corroborate those of the Integrated Disease Surveillance and Response (IDSR) system of the DRC between 2001 and 2013, which consistently reported an overall case fatality rate below 5% (Beer & Rao, 2019).

In our study, conducted in the Isangi Territory, we observed a significant association between age under 18 years and the occurrence of complications related to Mpox infection (OR, 95% CI: 61.7 [24.8–160.1]). These findings are consistent with those of Huhn et al. (2005), who also reported greater severity of infection and a higher proportion of complications in younger patients. Several hypotheses may explain this increased vulnerability in children and adolescents. Their developing immune systems may be less capable of controlling the infection, increasing the likelihood of complications. Additionally, children may be more prone to bacterial superinfections secondary to Mpox skin lesions, worsening the prognosis.
Our study also revealed a significant association between a history of immunosuppressive conditions—including measles and/or malnutrition—and the occurrence of Mpox-related complications (OR, 95% CI: 34.9 [11.7–134.5]). These results are consistent with previous studies. Yinka-

Ogunleye et al. (2019) highlighted the increased risk of complications in immunocompromised individuals, particularly those with uncontrolled HIV. Similar findings were reported by Ogoina et al. (2020), Majie et al. (2023), and Patel and Patel (2023), all of whom confirmed the role of immunodeficiency in the occurrence of Mpox complications.

The study further revealed a significant association between the patient's treatment pathway and the development of Mpox-related complications (OR, 95% CI: 34.4 [15.0–82.7]). Notably, patients who first consulted prayer houses or traditional healers before seeking care at formal health facilities were significantly more likely to experience complications compared to those who opted for medical care at symptom onset.

Several factors may explain this. Resorting first to traditional or religious practices may delay diagnosis and appropriate treatment, allowing the infection to progress and increasing the risk of complications. Furthermore, some traditional practices may aggravate the skin lesions associated with Mpox or facilitate secondary bacterial infections.

Our results also showed a significant association between socioeconomic status and the risk of Mpox-related complications. Individuals from low-income households had a markedly increased risk (OR, 95% CI: 4.7 [1.3–25.8]) compared to those with higher incomes. People living in poverty often face limited access to healthcare services, resulting in delayed diagnosis and treatment, which can worsen the infection and elevate the risk of complications. Additionally, overcrowded living conditions and poor hygiene practices further facilitate disease transmission and secondary infections. This underscores the impact of social determinants on health outcomes.

Lastly, the level of education appeared to be a protective factor against the development of complications related to Mpox (OR, 95% CI: 0.4 [0.2–0.7]). Sklenovská and Van Ranst (2018) also underscored the importance of patient education in enhancing understanding of the disease. Educated individuals showed significantly reduced risks of developing complications. Higher educational levels are often associated with better health literacy, enabling individuals to identify early symptoms, adopt preventive measures, seek timely medical attention, and adhere to professional health advice.

## CONCLUSION

Mpox remains a significant public health concern in the Isangi Territory due to its prevalence and associated complications. These complications are linked to sociodemographic factors (age, education level, and treatment-seeking behaviour), health factors (immune and nutritional status), and economic conditions (poverty). Targeted interventions—including awareness campaigns, improved access to formal healthcare, control of malnutrition and measles, and support for vulnerable populations—are essential to reduce Mpox-related complications in the Isangi Territory.

**Ethical Approval:** Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine and Pharmacy, University of Kisangani (FMP/UNIKIS). Authorisation was also granted by the Provincial Health Division (DPS/Tshopo) and the three participating health zones. Informed consent was obtained from all participants after a detailed explanation of the study's purpose, using forms written in Lingala, Swahili, and French. Anonymity was assured during analysis and will be maintained in the dissemination of findings.

**Conflicts of Interest:** None declared.

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