

Research Article

Evaluation of MPOX Epidemiological Surveillance in Senegal, 2024

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Abstract

Monkeypox (Mpox) is a zoonotic viral infection caused by a virus of the Orthopoxvirus genus. In response to global alerts, efforts in epidemiological surveillance and infection control have intensified, following WHO recommendations for enhanced monitoring, contact tracing, and the implementation of appropriate public health measures. This study aimed to assess the epidemiological surveillance of Mpox in Senegal in 2024. This was a retrospective, cross-sectional, descriptive, and analytical study conducted over a four-month period (from July 14 to November 10, 2024). The study population included all cases sampled as part of Mpox surveillance in Senegal during this period. Key strengths in the response included the adaptation to the IDSR Kit, training of personnel at all levels on the IDSR strategy, case definition and monitoring training, development of surveillance procedures, presence of focal points for surveillance, a diversified network of reference laboratories, and the use of an electronic case notification platform. A total of 56.25% of the initially planned priority activities were completed. During the surveillance period, 100 suspected Mpox cases were reported, corresponding to 6 cases per 1 million inhabitants. Biological samples were collected from all patients. At the time of the study, no confirmed cases of Mpox were detected. Alternative viral diagnoses were established in 32% of cases—most frequently varicella-zoster virus. Co-infections were observed in 4 patients (12.5%). The median delay between symptom onset and result availability was 7 days. Symptom duration had a median of 3 days, and the median interval from consultation to result delivery was 2 days. Longer delays were significantly observed in remote or hard-to-reach areas. Overall, patient-related delays were significantly longer than surveillance-related delays ($p = 0.002$). Strengthening epidemiological surveillance improves sample processing times and response effectiveness. This enhancement should be prioritized in border areas and hard-to-reach regions.

Keywords

Mpox, Epidemiological Surveillance, Senegal

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1. Introduction

Mpox, formerly known as “Monkeypox,” is a zoonotic viral disease caused by a virus of the Orthopoxvirus genus. Human cases of Mpox were first reported in 1970, in the Democratic Republic of the Congo [1]. Mpox shares clinical similarities with smallpox, though it exhibits lower mortality rates and limited human-to-human transmission. Since the eradication of smallpox in 1980, Mpox has emerged as a significant public health concern due to its reappearance in new geographic regions [1].

Clinically, Mpox presents with fever, skin rashes, and muscle aches, with an incubation period ranging from 5 to 21 days. Mpox transmission primarily occurs through direct contact with bodily fluids, infected skin lesions, or contaminated surfaces. Although the virus’s basic reproduction number is relatively low—estimated between 0.6 and 1.7; social and behavioral factors may increase the risk of transmission, particularly in settings involving close physical contact. Furthermore, the recent outbreak exhibited an atypical clinical profile, including isolated genital lesions, absence of a prodromal phase, and variable symptoms, which complicated early diagnosis and case surveillance in several regions worldwide [2].

Initially confined to rural areas of Central and West Africa, the virus has recently demonstrated signs of global spread. In 2022, Mpox cases were reported in non-endemic regions, including Europe, North America, and Asia—largely attributed to human travel and specific interpersonal interactions [1, 3]. Between January and July 2024, a total of 15,074 Mpox cases (2,853 confirmed; 12,221 suspected) and 461 deaths (case fatality rate: 3.06%) were reported in twelve African Union member states representing a 160% increase in cases and a 19% increase in deaths compared to the same period in 2023 [4].

On August 14, 2024, the WHO Director-General declared the resurgence of Mpox in Africa a Public Health Emergency of International Concern under the International Health Regulations [5]. In response to this health threat, an early detection system was implemented. This study evaluates the Mpox surveillance system in Senegal.

2. Methodology

2.1. Type and Period of Study

This was a retrospective, cross-sectional, descriptive, and analytical study carried out over four months, from July 14 to November 10, 2024.

2.2. Study Population

The study included all cases sampled as part of the Mpox surveillance initiative in Senegal during the defined study period.

2.3. Senegalese Health System Overview

At the central level we have the Ministry of Health, the National Health Information Service, the National Committee for Surveillance and Response Coordination, and the National Laboratory Network.

At the intermediate level: the country is divided into 14 medical regions, each comprising regional health services, hospitals, and laboratories.

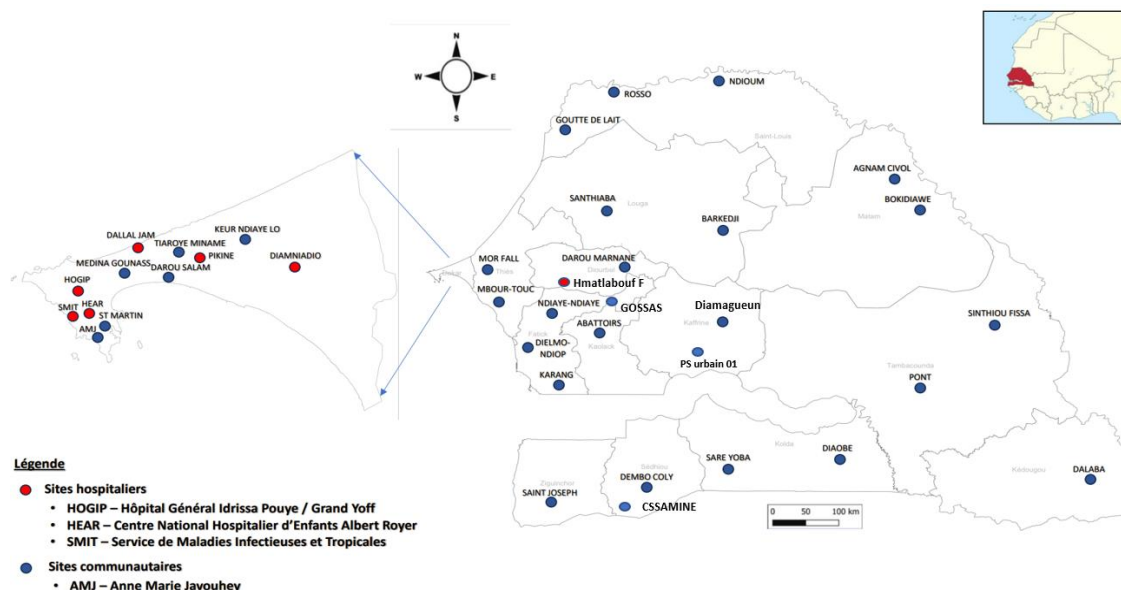


Figure 1. Location of sentinel surveillance sites in Senegal in 2024 [4].

At the peripheral level: there are 65 health districts, each with at least one health center, several health posts, and health huts.

In accordance with WHO/AFRO guidelines, Senegal implements four types of surveillance: active, passive, sentinel, and sero-epidemiological surveys. Two distinct information circuits exist: a routine health information system and a specific circuit for International Public Health Events.

Since 2012, the Ministry of Health, in collaboration with the Pasteur Institute of Dakar, has implemented an integrated sentinel surveillance system called the 4S network, aimed at early detection of emerging or re-emerging disease outbreaks. This syndromic sentinel surveillance network is based on data from febrile and diarrheal syndromes collected by sentinel practitioners, who report real-time data via an Android app or tablet. WHO case definitions are used to ensure consistency, and the data are validated and analyzed in real time using an Early Warning System.

The sentinel network expanded from 3 sites in Dakar in 2011 to 11 in 2012–2013, and to 25 in 2021, covering all 14 regions of Senegal (Figure 1).

2.4. Data Collection

Collection tool

Data were collected through our ministry DHIS2 platform for epidemiological surveillance.

Description of the MPOX Epidemiological Surveillance System

Upon the identification of a suspected case, a rigorous procedure was immediately triggered:

- 1) Immediate notification of the case to appropriate authorities;
- 2) Ensuring patient isolation, with implementation of contact and airborne transmission precautions and providing appropriate supportive care and reassurance to the patient;
- 3) Collecting and transporting samples—preferably a swab from the eruption site—under strict biosafety conditions to a reference laboratory for analysis;
- 4) Conducting risk communication, community engagement, contact tracing, and contact management;
- 5) Monitoring suspected cases to identify additional cases;
- 6) Sending a copy of the notification form to the Regional Health Directorate and national level via email to contribute to the centralized database;
- 7) Maintaining district-level and regional-level databases;
- 8) Entering data into the DHIS2 electronic platform for real-time evaluation.

Virological confirmation was based on specimen collection from lesions (crusts, dry swabs from multiple vesicles, or biopsy), as well as oropharyngeal or nasopharyngeal swabs. Blood or serum samples were also collected, primarily for serological testing, given the short duration of viremia.

Samples were packaged in triple containment, accompa-

nied by a completed notification form. They were refrigerated at 2–8 °C or frozen at –20 °C or below within one hour of collection and transported to the laboratory as soon as possible and within a maximum of 72 hours.

Samples were transported through:

- 1) The routine sample transport system, in compliance with timelines adapted to epidemic response requirements;
- 2) The 4S network pathway, coordinated between the surveillance site, district, regional health authorities, and the Institut Pasteur de Dakar. To shorten transportation delays for suspected Mpox samples, 4S network sites coordinated with surveillance focal points at the district and regional levels to facilitate interim shipments between scheduled EMS transfers.

Samples from suspected, probable, or confirmed Mpox cases, including clinical specimens, cultures, or viral isolates were transported as “Infectious Substance Affecting Humans,” Category A, under UN 2814. International shipment was only undertaken from national reference laboratories.

Reference laboratories included the Pasteur Institute of Dakar, the Institute for Health Research Epidemiological Surveillance and Training, and the National Public Health Laboratory. Laboratory confirmation was performed via polymerase chain reaction targeting Orthopoxvirus DNA from clinical samples.

Once a suspected case was identified, contact identification and follow-up began, while an in-depth investigation was launched to determine if the case could be classified as probable or confirmed. If reclassification excluded the case (i.e., no longer suspected or probable), contact tracing could be adjusted (e.g., redirected toward another sexually transmitted infection) or discontinued if no longer necessary.

Cases were interviewed as soon as possible to gather names and contact information for all potential contacts and to identify events, gatherings, and locations visited where exposure could have occurred. Contacts were notified within 24 hours of identification and advised to monitor their health and seek medical care if symptoms developed.

Operational definition of variables

The 7-1-7 Approach

The 7-1-7 concept in public health is an epidemic management approach adopted by the World Health Organization (WHO) to strengthen the surveillance and response capacities of health systems, particularly in the context of emerging infectious diseases. It is defined as:

- 1) 7 days: Detect and report any public health event or suspected outbreak within 7 days of its emergence (Detection).
- 2) 1 day: Initiate an appropriate investigation within 1 day of notification (Notify).
- 3) 7 days: Implement an effective initial response within 7 days of identification.

2.5. Data Analysis

Data were analyzed using R software (version 4.4.1). Graphs were generated with Microsoft Office Excel Professional Plus 2021 for MacOS, and maps were created using R software (version 4.4.1). Quantitative variables were described by mean, median, interquartile range (IQR) and standard deviation. For qualitative variables, absolute (n) and relative (%) frequencies were calculated. Time delay comparisons were performed using either the Wilcoxon rank-sum test or the Kruskal-Wallis one-way ANOVA, depending on the conditions of applicability, with a significance level set at 5%.

2.6. Ethical Considerations

This study's fundamental purpose is to evaluate the response to the Mpox epidemic in Senegal. The data concerning the cases, districts, and health regions are processed with respect to confidentiality. This study does not make value judgments; it contributes to acknowledging the work done.

3. Results

Currently, no Mpox cases have been detected in Senegal.

3.1. Assessment of Progress in Priority Activities

As part of preparedness efforts for a potential Mpox outbreak, a total of 48 priority activities were planned for the operational period from August 26 to September 25, 2024. At the time of the study, 56.25% of the planned activities had been completed, and 10.42% were in progress. The remaining unimplemented activities were those related to the actual management of Mpox cases.

3.2. Characteristics of Suspected Cases

A total of 100 suspected cases were identified. (6 cases per

million inhabitants). The highest number of suspected cases was reported in August (60%) during epidemiological week 34 of 2024. The mean age of patients was 20.34 ± 19.29 years, with a median age of 15 years (IQR: 28.75). Children under the age of 10 accounted for the largest proportion of cases (44%). A male predominance was observed (60%) with a sex ratio of 1.5 (Table 1).

Table 1. Epidemiological data of suspected MPOX cases in Senegal, 2024.

Epidemiological Data (N=100)	n	%
Month		
July	4	4
August	60	60
September	23	23
October	12	12
November	1	1
Age (years)		
<10	44	44
10-29	24	24
30-49	22	22
≥50	10	10
Gender		
Female	40	40
Male	60	60

Most of the suspected cases were in the Dakar area (29%) or the Diourbel area (10%) (Figure 2).

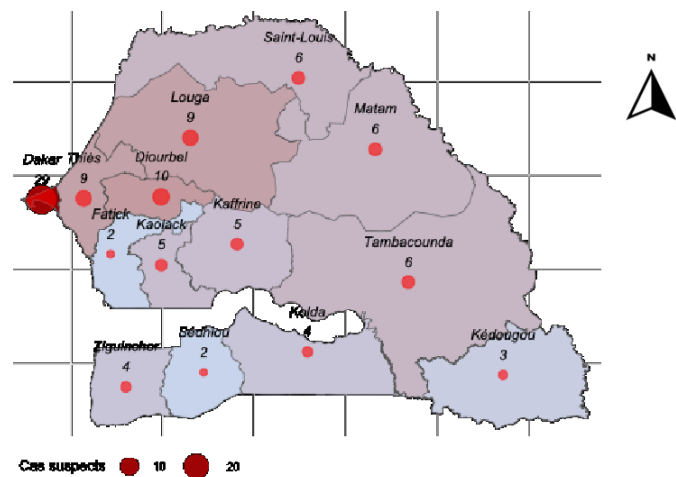


Figure 2. Number of suspected Mpox cases in Senegal from July 14 to November 10, 2024.

The main clinical manifestations included skin rash (99%), frequently associated with fever (80%). The rash primarily affected the trunk (84.9%) and face (65.7%). A biological sample was collected from all patients, consisted of a blood sample (80%, n=80) (Table 2).

Table 2. Clinical data of suspected Mpox cases in Senegal, 2024.

Clinical data	n	%
Clinical manifestations (N=100)		
Skin rash	99	99
Fever	80	80
Severe headache	36	36
Physical asthenia	29	29
Muscle pain	29	29
Localized lymphadenopathy	24	24
Generalized lymphadenopathy	11	11
Rash Location (N=99)		
Body	84	84.9
Face	65	65.7
Palms - Hands	64	64.7
Sole - Feets	60	60.6
External Genitals	11	11.1
Mouth	8	8.1
Anal region	3	3.3

An infectious etiology was identified in 32 patients (32%), predominantly varicella-zoster virus infection, which was

diagnosed in 20 patients (Table 3).

Table 3. Paraclinical data of suspected Mpox cases in Senegal, 2024.

Paraclinical data	n	%
Samples (N=100)		
Blood	80	80
Skin Lesions	65	65
Nasal	6	6
Scabs	5	5
Biopsy of lesions	2	2
Virus (N=32)		
Varicella-Zoster	20	62.5
Human Herpes Virus 7	3	9.48
Epstein Barr Virus	2	6.25
Herpes Simplex Virus 1	2	6.25
Measles	2	6.25
Rubella	2	6.25
Cytomegalovirus	1	3.13

No deaths were reported.
Overall, patient-related median delays were significantly longer than surveillance-related median delays (Table 4).

Table 4. Clinical data of suspected Mpox cases in Senegal, 2024.

Variables	Period from onset of symptoms to consultation – Patient-related delays (Days)	Period from consultation to results – Surveillance-related delays (Days)	P value
Suspected cases	5.65	3.96	0.0023
Gender			
Female	4	2	0.118
Male	3	2	0.167
Area			
Dakar	3	1	0.039
Diourbel	5.5	1	0.001
Fatick	3.5	7	0.258
Kaffrine	2	5	>0.9

Variables	Period from onset of symptoms to consultation – Patient-related delays (Days)	Period from consultation to results – Surveillance-related delays (Days)	P value
Kaolack	3	3	0.553
Kédougou	11	8	0.459
Kolda	3	8	0.102
Louga	3	1.5	0.227
Matam	3	3	0.474
Saint-Louis	2	5	0.074
Sédhiou	2.5	2.5	>0.9
Tambacounda	7.5	6	0.523
Thiès	4	1	0.068
Ziguinchor	2.5	1.5	0.4

Median detection and investigation delays (notify) were generally longer than the 7-1-7 target for early detection and response (Table 5).

Table 5. Clinical data of suspected Mpox cases in Senegal, 2024.

Variables	Detection	P value	Notify	P value
Global	5.65 ± 9.29	<0.0001	3.96 ± 5.31	<0.0001
Area				
Dakar	5.79 ± 6.54	0.177	2.52 ± 3.6	0.006
Diourbel	5.2 ± 2.66	0.079	1.3 ± 0.48	0.149
Kaffrine	5.2 ± 4.38	0.269	5.2 ± 0.84	0.0003
Kaolack	3.6 ± 1.82	0.058	3 ± 0.71	0.0032
Kédougou	33 ± 46.12	0.75	16 ± 13.86	0.174
Kolda	2.5 ± 1	0.089	7.75 ± 4.92	0.098
Louga	4.11 ± 2.26	0.019	2.75 ± 2.71	0.098
Matam	3.5 ± 3.02	0.058	8 ± 12.76	0.035
Saint-Louis	2.17 ± 1.17	0.035	6 ± 4.69	0.036
Tambacounda	7.5 ± 5.09	0.819	6.17 ± 3.19	0.031
Thiès	4.78 ± 3.96	0.131	1.78 ± 0.97	0.089
Ziguinchor	5.25 ± 5.85	0.854	2 ± 1.41	0.371

4. Discussion

In a public health emergency, especially those involving emerging infectious diseases, a robust surveillance system is essential to ensure timely reporting and an adequate response

[6]. The 7-1-7 framework, promoted by WHO, serves as a benchmark for evaluating the timeliness and effectiveness of outbreak response systems [7, 8]. Following the WHO declaration of Mpox resurgence as a Public Health Emergency of International Concern in August 2024 [5], Senegal implemented a specific Mpox detection and surveillance system.

At the time of the study, no confirmed cases of Mpox were detected, resulting in a 0% positivity rate. This finding leads to two hypotheses:

- 1) Hypothesis 1: No cases of Mpox were detected because our detection and surveillance system were ineffective.
- 2) Hypothesis 2: No cases of Mpox were detected because there were genuinely no cases of Mpox in Senegal.

Although no positive Mpox cases were found, the system allowed the detection of 100 suspected cases over the 4 months of surveillance, revealing some differential diagnoses for febrile rashes. Based on these observations, we can reject Hypothesis 1 and accept Hypothesis 2, concluding that no Mpox cases were detected because there were genuinely no cases in Senegal, especially considering that, no Mpox cases have been reported in the animal health sector.

Progress in Priority Activities

In terms of preparedness, 56.25% of priority activities were completed, with 10.42% ongoing. Most pending activities were linked to case management and were not activated due to the absence of confirmed cases. Excluding those, the actual implementation rate of preparedness activities was approximately 81.25%, indicating satisfactory operational readiness.

Characteristics of suspected cases

The highest number of suspected cases was recorded in August (60%), specifically during week 34. Lira [9] also noted a predominance of suspected cases in August, with a marked decrease in September and October. This could be explained by the fact that August is generally a month for holidays and travel. The observed increase in suspected cases during week 34 of 2024 correlates with the WHO's declaration of Mpox as an epidemiological emergency worldwide [5], as well as the subsequent media coverage and awareness campaigns.

Regarding the suspected cases, variations in age were noted across the series, with higher mean ages, but the male predominance remained evident [9-12]. The clinical profile of febrile rashes is similar across most series with varying rates [9, 11-15]. The nature of our samples for epidemiological surveillance aligns with WHO guidelines. According to the WHO [16], "In the absence of detectable skin or mucosal lesions, PCR can be performed on an oropharyngeal swab; an anal or rectal swab may be taken in case of exposure history. However, these types of samples may provide fewer sensitive results, and the interpretation of such results should be cautious." The WHO does not recommend PCR testing on blood samples [16], except for coinfection diagnosis. This was adhered to in our system. The viruses detected correspond to frequently identified infectious agents, notably Varicella-Zoster Virus [15, 17], Herpes Simplex Virus [14, 15, 18].

In our study, all patients had data on the various delays studied, showing that we met the WHO's epidemiological surveillance quality criteria, which stipulate traceability at every level. This further confirms the robustness of our system. Djuicy [10] reported cases of missing or insufficient data, primarily due to procedures in his system.

Delays are performance indicators in epidemiological surveillance. The longer the delays, the higher the risk of infectious transmission. The median delay between symptom onset and sample collection in our study was shorter than that of Thomas [19] (5 days), but comparable to Tan [20] (3 days), or Dou [13] (2 days). The median laboratory processing delay was relatively shorter than that of Thomas [19] (2-4 days) or Karmarkar [21] (4 days). The median diagnostic delay (7 days) aligns with Patalon [22] (6.5 days) and Thomas [19] (9 days). Overall, the median delays related to patients were significantly higher than the median surveillance delays. This indicates that some patients tended to delay consultation after symptom onset. However, once identified as a suspected case, the system performed diagnostic confirmation promptly. Further studies of this aspect could have helped identify and understand factors contributing to consultation delays.

Surveillance delays were significantly longer in rural and remote regions, likely due to challenges in sample transportation, geographic isolation, and limited laboratory infrastructure. Similar disparities were observed in Cameroon's Mpox surveillance system [10], highlighting the need for stronger logistical coordination and investment in remote health systems.

Limitations of the study

While our findings reflect the strength of the national Mpox surveillance system, this study faced limitations, including the retrospective design, limited qualitative data (e.g., no interviews), and the absence of financial performance analysis. Future studies may benefit from incorporating community feedback and cost-effectiveness assessments.

5. Conclusions

This study assessed the structure, performance, and relevance of Senegal's Mpox epidemiological surveillance system in 2024. The findings highlight a well-organized and responsive surveillance mechanism capable of rapidly detecting and managing suspected Mpox cases. The absence of confirmed cases during the study period, combined with a 0% positivity rate, suggests no active circulation of the Mpox virus in the country. Nonetheless, the analysis revealed disparities in performance across regions, particularly in remote and border areas, where delays in detection and response were more pronounced. These findings underscore the need to enhance logistics, laboratory capacity, and health worker deployment in underserved regions. Sustaining and enhancing this system is crucial for ensuring rapid and effective responses to future epidemiological threats.

Abbreviations

IDSR	Integrated Disease Surveillance and Response
WHO	World Health Organization

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Author Contributions

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Jean Augustin Diégane Tine: Conceptualization, Methodology, Validation, Writing – review & editing

Boly Diop: Conceptualization, Investigation, Methodology, Resources, Software, Writing – review & editing

Ibrahima Seck: Conceptualization, Methodology, Validation, Writing – review & editing

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Data Availability Statement

The data used in this study are not publicly available due to the confidentiality of data concerning suspected Mpox cases at the national level. However, they can be provided by the corresponding author if the request is deemed relevant after approval from the Senegalese Epidemiological Surveillance Direction.

Conflicts of Interest

The authors declare no conflicts of interest.

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