

Research Article

Analysis of Health System Preparedness for Monkeypox Response in Benin

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Abstract

Introduction: Benin, as a West African country sharing borders with high-risk areas, is on the front lines of the threat of Monkeypox (Mpox) epidemics. This study aimed to assess the preparedness of the Beninese health system for this emerging zoonotic risk. **Method:** A cross-sectional, descriptive, and qualitative approach was conducted from April to September 2025, structured into three phases: documentary analysis of national regulatory documents, interviews with strategic managers (central and departmental directorates), and direct observation of Epidemic Treatment Centers (ETCs). **Results:** The analysis revealed a robust regulatory framework (National Preparedness and Response Plan for Monkeypox, updated Standard Operating Procedures (SOPs)) aligned with the International Health Regulations (IHR 2005). Interviews confirmed strong inter-institutional coordination, led by the Public Health Emergency Operations Center (PHEOC). Observation of the ETCs revealed high operational capacity, with trained human resources, Personal Protective Equipment (PPE), and medical supplies satisfactorily prepositioned. **Conclusion:** These results demonstrate good overall preparedness of the Beninese health system, transforming lessons learned from previous crises into a proactive and organized response strategy, although the sustainability of logistical supplies and regular simulation exercises must remain a priority.

Keywords

MPOX, Response, Health System Preparedness, Benin

1. Introduction

Monkeypox, caused by an orthopoxvirus, is a zoonosis historically endemic to Central and West Africa. However, the global emergence in 2022, followed by the resurgence of more virulent strains in 2024, has radically altered the epidemiological profile of this disease [1, 2]. It was declared a

Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) and a Continental Security Emergency by the Africa Centres for Disease Control and Prevention (Africa CDC) due to accelerated human-to-human transmission modes (notably sexual) and unprece-

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dented geographical spread [3, 4].

In West Africa, the threat is twofold. The region faces endemic viral circulation, exacerbated by intense cross-border mobility and dense trade with hotspot areas [5]. Health systems endure a "double burden": managing endemic diseases (Malaria, Lassa fever) while preparing for re-emerging threats [6]. Benin, situated at a regional transit crossroads (the Abidjan-Lagos corridor), is particularly exposed to risks of viral importation [7].

The ability of a health system to respond effectively relies on three pillars: a regulatory framework aligned with the International Health Regulations (IHR 2005), functional coordination, and operational field capacities [8]. However, recent literature, particularly *Global Health Security Index* reports, highlights a persistent gap between "paper-based preparedness" (strategic plans) and "operational readiness" (the actual capacity to treat a patient) [9, 10]. Lessons learned from the Ebola and COVID-19 epidemics underscore that the mere existence of documents does not guarantee health system resilience [11].

Therefore, assessing preparedness cannot be limited to documentary analysis; it must include granular verification at operational sites. This study aimed to analyze the preparedness level of the Beninese health system, from the development of strategic documents to the actual readiness of Epidemic Treatment Centers (ETCs), in the face of a potential Mpox epidemic.

2. Materials and Methods

2.1. Study Setting, Type, and Duration

This was a cross-sectional, descriptive, and evaluative study with a qualitative component, conducted in Benin from April to September 2025 [11]. The study covered the strategic (central), intermediate (departmental), and peripheral (operational) levels of the health system.

2.2. Study Population and Sampling

We employed a purposive sampling strategy [12] to select study sites based on epidemiological risk and geographic strategic importance:

- 1) Zone 1 Atlantique/Littoral (South): Selected due to the presence of the International Airport and highest population density.
- 2) Zone 2 Zou (Center): Selected as the major transit hub connecting the coast to the hinterland.
- 3) Zone 3 Atacora (North): Selected for its proximity borders with Burkina Faso and Togo, representing a high risk of cross-border importation. Consequently, the three corresponding Epidemic Treatment Centers (ETCs) and Departmental Health Directorates (DHDs) were included.

A total of 16 Key Informants (KIIs) were recruited based

on their decision-making roles:

- 1) Central Level (n=5): Managers of the departments and centers involved in the response (Directorate of Epidemiological Surveillance and Response (DESR) and the PHEOC, Directorate of Vaccination and Logistics, Public Health Emergency Operations Center, Directorate of Hospital Medicine and Diagnostic Investigations, Viral Hemorrhagic Fever Reference Laboratory.
- 2) Intermediate Level (n=3): Three (03) Departmental Health Directorates (DHDs) selected for their strategic location in terms of cross-border population migration: Plateau, Borgou, Atacora.
- 3) Operational Level (n=8): Three ETCs: Abomey-Calavi (South), Zou (Center), and Natitingou (North) [13].

2.3. Data Collection

Data collection was carried out in three successive phases, allowing for triangulation of sources and cross-validation of information [14].

Phase I: Document Analysis (Normative Framework)

A document analysis grid was used to assess the existence, revision date, and consistency of the following strategic documents:

- 1) Health Risk Maps.
- 2) Public Health Emergency Operations Center Manual.
- 3) National Health Security Action Plan (NHSAP).
- 4) National Disease Elimination Plan.
- 5) National Multi-Risk Plan for Health Emergency Response Operations.
- 6) National Preparedness and Response Plan for MPOX.
- 7) Standardized Operating Procedures specific to MPOX.

Phase II: In-Depth Interviews (Coordination and Planning)

Individual semi-structured interviews lasting 45 to 60 minutes were conducted with managers from central and departmental directorates. The interview guides covered: the distribution of roles and responsibilities, coordination and reporting mechanisms, the integration of MPOX guidelines into routine practices, and the budget allocated to epidemic preparedness. The visit to the three DHDs allowed for verification of the implementation of national guidelines at the intermediate level.

Phase III: Direct Observation (Scoring Framework)

We developed an observation checklist adapted from the WHO Joint External Evaluation (JEE) tool and the "Ready, Set, Go" framework.

- 1) Scoring Criteria: The checklist comprised 40 specific indicators across three domains: Human Resources, Logistics/Infrastructure, and Medical Inputs.
- 2) Weighting: All indicators were weighted equally (1 point per item).
- 3) Calculation: The Operational Readiness Score was calculated as: $(\text{Number of items present} / \text{Total items}) \times 100$.
- 4) Interpretation: A score >80% was classified as "Opti-

mized Capacity," 50-80% as "Functional Capacity," and <50% as "Limited Capacity."

The aspects observed included:

- 1) Human Resources (HR): Existence of dedicated response teams and training rates on Mpox protocols and PPE use.
- 2) Materials and Logistics: Availability and functionality of triage/isolation areas, state of infrastructure (water, sanitation), and presence of biological sampling kits.
- 3) Medical Inputs: Storage of symptomatic medications, disinfectants, and Personal Protective Equipment (PPE) (FFP2 masks, aprons, gloves).

2.4. Study Variables

The main variables were: the status (Existence/Absence/Update) of regulatory documents; the functionality of the PHEOC; the staff training rate (data extrapolated from KIIs); and the operational readiness score of the CTEs (based on observations of HR, logistics, and inputs, scored from 0 to 100%).

2.5. Data Analysis

Qualitative Analysis: Audio recordings were transcribed. We performed an inductive thematic analysis. Codes were generated (e.g., "Logistical bottleneck," "Protocol clarity") and grouped into major themes.

Quantitative Analysis: Operational scores were calculated using Microsoft Excel. Descriptive statistics (means, percentages) were used. ETC observation data were quantified to generate an aggregated preparedness score.

3. Results

3.1. Normative Framework and Operating Procedures

The document review confirmed that Benin has a comprehensive set of strategic documents, including the National Preparedness and Response Plan for Mpox (NPRP-Mpox), updated following the 2022 global outbreak. The NPRP-Mpox is distinguished by its "One Health" approach, integrating components on zoonotic surveillance and human-animal interfaces, in accordance with the recommendations of international organizations.

The Standard Operating Procedures (SOPs) specific to Mpox are a strong point. They not only detail the differential diagnosis with chickenpox, measles, and other dermatoses, but also incorporate a specific triage algorithm for patients with rashes associated with a travel history or high-risk contacts. Alignment with the IHR is demonstrated by the inclusion of maximum notification times (48 hours) and standardized case definitions for early detection, including at points

of entry.

3.2. Coordination

Key Informants (KIIs) highlighted the role of the Public Health Emergency Operations Center (PHEOC). Its functionality is no longer solely reactive, but proactive, illustrated by the holding of simulation exercises and the quarterly review of the NPRP-Mpox.

3.3. Roles and Responsibilities

Analysis of the 16 interviews highlighted the pivotal role of the PHEOC. Central managers reported a substantial clarification of roles following the post-COVID-19 restructuring.

- 1) DESR (Directorate of Epidemiological Surveillance and Response): Responsible for alerts and field investigations.
- 2) Directorate of Vaccination and Logistics: Expanded mandate to plan ring vaccination campaigns around confirmed cases.
- 3) Viral Hemorrhagic Fevers Reference Laboratory: has the technical capacity for confirmatory PCR diagnosis of MPOX.

An official illustrated this synergy:

"The PHEOC has served as a melting pot to harmonize the approaches of the DESR, Vaccination, and laboratories. We no longer work in silos. MPOX management is now an inter-sectoral effort and not just a matter of surveillance."

3.4. Communication

Visits to the Departmental Health Directorates (DHDs) of Plateau, Borgou, and Atacora validated the cascade of information. The DHDs do not wait for the alert to act; they have integrated MPOX awareness into their routine meetings with the heads of peripheral health centers. The Plateau DHD (border area with Nigeria) has implemented bilingual awareness posters (in French and local languages) and accelerated reporting protocols for cases detected at border posts, demonstrating local adaptation of the national PNPR-MPOX.

3.5. Operational Capacity of Epidemic Treatment Centers

Direct observation of the three Epidemic Treatment Centers (ETCs) – Abomey-Calavi (South), Zou (Center), and Natitingou (North) – made it possible to quantify physical preparedness. Mean Overall Operational Readiness Score was 91.25%, confirming an "Optimized Capacity" status.

3.6. Human Resources and Skills

Human resources

Rapid response teams (doctors, nurses, hygienists, and la-

laboratory technicians) were clearly identified. The rate of staff trained in Mpox protocols and the safe use of PPE was estimated at 95% on average across the three observed sites. The checklist analysis showed that dressing/undressing procedures were posted and visible in 100% of the observed changing rooms. These trainings included tabletop exercises and practical dressing/undressing simulations (average dressing time: 3.5 minutes; undressing: 7 minutes), considerably reduced compared to early COVID-19 experiences [20]. The ETC in Natitingou (North) posted a rate of 92% (slightly lower), mainly due to staff turnover in remote areas, highlighting a continued need for capacity building in rural areas. The ETC in Abomey-Calavi (South) posted 97%, benefiting from its proximity to the Ministry of Health.

3.7. Logistics and Waste Management

The functionality of the isolation areas was optimal (score of 100%), with clearly delineated circuits (green, orange, red zones) and strict separation between patient/staff flows and logistics flows. All sites possessed functional incinerators or valid contracts for waste destruction.

A key verification point was the waste disposal protocol. The observed ETCs had color-coded bags and functional on-site incinerators (for the Zou and Natitingou ETCs) or a specialized destruction contract with a certified company (for the Abomey-Calavi ETC). All sites had compliant water points and sanitary facilities, with showering and washing areas dedicated to response teams.

Biological sampling kits for MPOX diagnosis were pre-positioned and secured (score of 92%). They were ready for delivery to the Viral Hemorrhagic Fevers Reference Laboratory in triple packaging, in accordance with WHO regulations.

3.8. Availability of Inputs

Table 2 summarizes the average operational readiness score of the three ETCs, based on logistics and input indicators.

The score of 88% for the availability of PPE (Personal Protective Equipment) indicates that, although there are buffer stocks (estimated at 3 months of average consumption for a moderate response), the supply chain is not considered fully resilient. However, interviewees noted that these stocks rely heavily on partner funding. Stocks of symptomatic medicines (85%) included antipyretics, strong analgesics, and treatments for bacterial superinfections, but the availability of specific antiviral treatments was not always guaranteed at the operational level at the time of the study, relying solely on a central strategic reserve stock. Diagnostic Capacity and Sentinel Surveillance.

The study revealed effective integration of the laboratory into the response system. The Viral Hemorrhagic Fevers Reference Laboratory not only has reagents for MPOX PCR,

but also rapid strip diagnostic protocols (for initial screening). The maximum time between sample receipt and result reporting is set at 24 hours, in line with international standards.

The DESR has established a sentinel surveillance network involving dermatologists and infectious disease departments of major hospitals to report any atypical rash, even in the absence of a known epidemiological link to MPOX. Epidemiological surveillance focal points exist at all levels of the health pyramid. The primary actors, those closest to the population, are community relays and qualified community health workers.

4. Discussion

The objective of this study was to analyze the preparedness of the Beninese health system for the risk of an Mpox epidemic. Results reveal a high level of preparedness, evidenced by a robust regulatory framework and an operational readiness score of 91.25% in the targeted Epidemic Treatment Centers (ETCs). These data suggest that Benin has effectively transitioned from a reactive posture to a proactive strategy, integrating the "One Health" approach to align its National Plan (NPRP-Mpox) with IHR (2005) requirements [8, 12]. This performance aligns with the framework of "high-performing health systems" described by Kruk et al., which prioritizes adaptability and resilience to exogenous shocks [13].

Our observations contrast positively with other assessments conducted in the West African sub-region. While a systematic review by Adedokun and Bamidele highlighted critical gaps in the preparedness of frontline workers across West Africa [14], our study reports a 95% training rate within specialized Beninese facilities. This disparity is notable compared to neighboring Nigeria, where recent studies have highlighted significant knowledge deficits and logistical barriers in tertiary hospitals [15, 16]. It is important to note that our sampling, targeting ETCs (referral structures), reflects the creation of "islands of excellence." This strategy secures the management of index cases and limits nosocomial transmission, a critical point identified during previous outbreaks [17]. Furthermore, the integration of updated case definitions including sexual transmission into Standard Operating Procedures (SOPs) demonstrates a local adaptation of WHO and Africa CDC recommendations, which is often lacking in resource-limited settings [18, 19].

The pivotal role of the Public Health Emergency Operations Center emerges as the determining factor in this preparedness. Information and command fragmentation were identified as major barriers during COVID-19 responses in Africa [20]. In Benin, the institutionalization of the PHEOC has enabled the establishment of a unified and coherent chain of command [21]. The ability of Departmental Directorates of health to translate national guidelines into local protocols (e.g., border surveillance in Plateau) confirms effective decentralization, which is essential for border reactivity [22].

Despite these positive indicators, the analysis reveals

structural vulnerabilities. The availability of PPE (88%) and symptomatic medications (85%), while satisfactory, relies largely on buffer stocks. Nkengasong et al. warned that reliance on external supply chains constitutes the main fragility of African health systems during global crises [23]. Additionally, the centralization of specific antivirals, while logistically justified, could induce harmful delays, highlighting the need to balance central strategic stocks with peripheral pre-positioning [24].

However, this study has some limitations. First, the purposive sampling of strategic sites likely reflects a "best-case scenario" and may not represent the readiness of remote, non-specialized health centers. Second, the assessment of readiness was cross-sectional; operational capacity can fluctuate rapidly with staff turnover. Finally, qualitative data is subject to social desirability bias, although we attempted to mitigate this through direct observation and triangulation.

5. Conclusion and Implications

Benin’s health system demonstrates a robust capacity to respond to Mpox, supported by a clear normative framework and trained personnel. However, sustainability remains the main challenge. To maintain this optimized capacity, it is essential to secure autonomous national funding for logistics and to extend simulation exercises beyond ETCs to the primary care level.

Abbreviations

Africa CDC	Africa Centres for Disease Control and Prevention
DESR	Directorate of Epidemiological Surveillance and Response
DHD	Departmental Health Directorate
ETC	Epidemic Treatment Center
FFP2	Filtering Facepiece 2 (Respiratory Protection Mask)

Appendix

IATA	International Air Transport Association
IHR	International Health Regulations
JEE	Joint External Evaluation
KII	Key Informant Interview
Mpox	Monkeypox
NHSAP	National Health Security Action Plan
NPRP-Mpox	National Preparedness and Response Plan for Monkeypox
PCR	Polymerase Chain Reaction
PHEIC	Public Health Emergency of International Concern
PHEOC	Public Health Emergency Operations Center
PPE	Personal Protective Equipment
SOP	Standard Operating Procedure
WHO	World Health Organization

Author Contributions

Padonou Setondji Geraud Romeo: Conceptualization, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing

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Conflicts of Interest

The authors declare no conflicts of interest.

Table 1. Update Status of Major Strategic Response Documents in Benin.

Normative Document	Status (2024/2025 Update)	Level of Alignment (IHR 2005)
Health Risk Mapping	Updated	High
Manual of the PHEOC	Revised	Very High
National Health Security Action Plan (NHSAP)	Active (2020-2025)	High
National Multi-Hazard Plan for Health Emergency Response Operations	Revised	High
NPRP-Mpox	Very Recent (2024)	Very High

Normative Document	Status (2024/2025 Update)	Level of Alignment (IHR 2005)
SOPs for Mpox Triage/Isolation	Available and Posted	High

Table 2. Aggregate Operational Readiness Score for the Three Observed CTEs (n=3).

Operational Readiness Indicator	Mean Score (out of 100%)	Key Observations
Availability of PPE (3-month Stock)	88%	Buffer stocks identified and secured.
Functionality of Isolation Zones	100%	Patient/personnel pathways clearly delimited.
Availability of Sampling Kits	92%	Ready for shipment to the Viral Hemorrhagic Fevers Reference Laboratory.
Stock of Symptomatic Medications	85%	Level considered sufficient for a first wave.
Overall Operational Readiness Score	91.25%	Readiness rated as "Very Good".

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