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Evaluation of Mpox surveillance system in Nigeria: A sub-national analysis

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ABSTRACT: An effective sub-national disease surveillance system contributes significantly to early detection, prevention and control of reemerging diseases such as Mpox. Nigeria recorded its first recognized Mpox outbreak in 2017 highlighting the resurgence of the disease in West Africa thirty-nine years after the eradication of smallpox. Despite reporting cases since 2017, its Mpox surveillance system has never been evaluated. This study, therefore, evaluated the Mpox surveillance system in Bayelsa State, Nigeria focusing on its key attributes and challenges. A cross-sectional study adopting the US CDC's 2001 updated guidelines for evaluating public health surveillance systems was conducted. Mpox surveillance dataset from 2017 to 2023 was analyzed, conducted key informant interviews, and administered questionnaires to all twenty-eight surveillance officers in Bayelsa State Nigeria. Data were analyzed with IBM SPSS version 20. The mean age of participants was 43± 8 years with (82.1%) persons having ≤ 15 years of work experience. Mpox surveillance data analysis revealed males (63.3%) and individuals less than 20 years old (39.2%) were predominantly affected with a positivity rate of 32.8% and 21.7% pending/inconclusive results. In assessing system attributes, 96.4% of respondents indicated flexibility, 92.6% confirmed clarity in Mpox case definitions, and all participants highlighted the system's acceptability and usefulness in resource allocation and decision-making. However, under-reporting and inadequate laboratory capacity were identified as major gaps by all key informants influencing the quality of data. While the Mpox surveillance system in Bayelsa State Nigeria possesses some good attributes, it is challenged by the above-stated critical gaps. Strengthening laboratory testing capacity, training surveillance officers in data management and mobility support for field surveillance are recommended to enhance Mpox surveillance at sub-national levels.

Keywords: Bayelsa State, data quality, surveillance attributes, laboratory capacity.

INTRODUCTION

Mpox, previously known as monkeypox, is an infectious disease caused by the monkeypox virus (MPXV) belonging to the genus orthopoxvirus in the poxviridae family (NCDC, 2019; WHO, 2023). The disease spreads mainly through direct contact with infected animals or exposure to infected sores, scabs and fluids (Upadhayay *et al.,* 2022; WHO, 2022), and it is characterized mainly by a painful rash, enlarged lymph nodes, and fever (WHO, 2022).

Mpox generally is a self-limiting disease managed by supportive care (NCDC, 2019), and studies have demonstrated that vaccination against smallpox has been

approximately 85% effective in preventing the disease (Institut Pasteur's strategic plan, 2022). Phylogenetic studies have identified two distinct clades of MPXV: a more severe clade called the Congo basin clade (clade I) prevalent in Central Africa and a less severe clade called the West African clade (clade II) common in West Africa (NCDC, 2019; WHO, 2018).

Mpox was first identified in 1958 among captive monkeys for research in Denmark, but human cases were not recorded until 1970 in the Democratic Republic of Congo (Karagoz *et al*., 2023; Ogoina *et al.,* 2019). Subsequently, cases were reported across Central and West Africa, particularly in rural, forested regions where humans live in close contact with wildlife (Upadhayay *et al*., 2022). The first case outside Africa was identified in the United States in 2003 in connection to zoonotic transmission from infected pet prairie dogs housed with Gambian stuffed rats and dormice brought from West Africa, precisely Ghana (Upadhayay *et al.,* 2022).

Mpox re-emerged in 2017 in Bayelsa State Nigeria after a hiatus period of thirty-nine years and since then has evolved into an endemic disease in the region (Karagoz *et al*., 2023; Ogoina *et al.,* 2019). Formerly Mpox was limited to rural regions with zoonotic transmission and in children younger than 15 years of age, but since its re-emergence in 2017 up till the 2022 global outbreak, Mpox has been observed to be increasingly prevalent in urban areas and transmission has been found to occur through sexual means (Chieloka *et al*., 2022; Ogoina and Yinka-Ogunleye, 2022).

Laurenson-Schafer et al in their 2023 study, examined the 2022 global Mpox outbreak, highlighting significant shifts in the epidemiology of the disease. They noted Mpox cases emerging in areas previously unaffected and without any epidemiological links to the western and central regions of Africa where the disease is traditionally endemic (Laurenson-Schafer *et al.,* 2023). In recent times, increasing outbreaks of Mpox continue to occur across Central Africa and other parts of Africa with DRC accounting for most cases (Djuicy *et al.,* 2024). The surge in cases prompted the declaration of Mpox a Public Health Emergency of International Concern in August 2024 (Callaby and Gordon, 2023; Djuicy *et al.,* 2024).

Globally, as of 1st January 2022 to 31st September 2024, WHO had recorded a total of 109,699 laboratory-confirmed cases in 123 countries affecting disproportionately the population of men who have sex with men (WHO, 2024). Whereas, in the Africa region, since the beginning of 2022 up until 15th October 2024, 8115 laboratory-confirmed Mpox cases and 1100 deaths (CFR = 13.6) had been reported in 18 member states with Central Africa accounting for 86.4% of cases and 99.5% of death (WHO, 2024). Since September 2017 up until 6th October 2024, 5114 suspected cases have been reported from 36 states and FCT in Nigeria, with 1180 confirmed cases (23.1%) and 17 deaths. Bayelsa State accounted for most cases with ~70% of males predominantly affected (NCDC, 2024).

The 2022 global outbreak and the recent surge in cases in the African continent reflect a shift in the epidemiology of Mpox and underscores the importance of a robust public health surveillance system to effectively contain the outbreak and prevent cross-border transmission of the disease (Callaby and Gordon, 2023). Furthermore, the MPXV has shown a tendency for zoonotic transfer from animal reservoirs to human beings and is easily transmitted within human populations, therefore, surveillance is essential since resurgence and ongoing spill-over episodes are possible (Roper *et al.,* 2023).

Additionally, outbreaks of infectious diseases like Mpox often start small, affecting local communities before potentially escalating into national or even international health crises. Because of this, it is essential to periodically evaluate sub-national surveillance systems to reduce the chances of cross-border transmission (Callaby and Gordon, 2023).

Mpox has become a persistent problem with a continuous increase in the number of cases in Africa including Nigeria and Bayelsa State, yet its true burden in the region is unknown due to a paucity of research and underreporting. This situation is exacerbated by limited resources, weak public health infrastructure and inadequate surveillance systems (Olawade *et al.,* 2024).

Bayelsa State, Nigeria reported the first case of Mpox in 2017 highlighting the resurgence of the disease in West Africa, yet its Mpox surveillance system has never been evaluated. This presents a significant gap, as the system's ability to detect, report, and respond to cases remains uncertain. Without an evaluation, there is a risk of delayed detection, inefficient resource allocation, and missed opportunities for strengthening the system. These gaps could lead to larger outbreaks, higher morbidity, and strain on healthcare resources. Given Bayelsa's role in the Mpox resurgence, evaluating its surveillance system is critical for improving public health preparedness and response. This study therefore evaluated the performance of the Mpox surveillance system in Bayelsa State, Nigeria and assessed its key attributes.

METHODOLOGY

Study area

Bayelsa State is a coastal and oil-producing state located in the south-south geopolitical zone of Nigeria and nestled in the Niger Delta. The state was carved out of the old Rivers State in 1996 and has eight Local Government Areas (LGAs) with Yenagoa serving as its capital city. The state shares borders with Delta State to the east and Rivers State to the west, while the Atlantic Ocean dominates its southern boundaries. Bayelsa State is the least populous state in Nigeria covering a landmass of 10,773 square kilometres and with an estimated population

of about 2,537,400 individuals in 2023 (NPC, 2006). The state has 311 healthcare facilities comprising 50 private health facilities and 261 public health facilities (DPRS, SMOH).

Study design

A descriptive study was conducted using the 2001 updated guidelines for evaluating public health surveillance systems by the US Centers for Disease Control and Prevention (CDC, 2001). This comprised a record review, secondary data analysis of the Mpox surveillance dataset (2017 to 2023) obtained from the Bayelsa State Ministry of Health, a semi-structured self-administered questionnaire, and a key informant interview.

Sampling method

No sample size was calculated as total sampling was adopted. No sample size, therefore, the total population of designated State and LGA DSNOs and assistant DSNOs in the Bayelsa State Ministry of Health was used.

Data collection

The evaluation was conducted using a mixed method data collection approach to obtain relevant insights into the operations of the Mpox surveillance system, including information about the system's data flow, the system's attributes as well as challenges and gaps that have been observed and to ensure that the findings from this evaluation inform public health policy and decision making. Variables on socio-demographics and laboratory results were abstracted from the Mpox surveillance data set (2017 to 2023) in the Bayelsa State Ministry of Health for analysis, a semi-structured questionnaire was administered to 28 Local Government Area (LGA) Disease Surveillance and Notification Officers (DSNOs), and key informant interview (KII) was conducted among 3 key state stakeholders (the State Epidemiologist, State DSNO and one LGA DSNO). Five-year monthly summary forms were also reviewed from 2018 to 2023 to assess the timeliness and completeness of reporting.

Data analysis

Quantitative data were analysed using IBM SPSS 20 and visualized using MS Excel 2019. Frequencies, proportions, means and standard deviations were used to summarise the data collected. Timeliness of reporting was determined using the number of monthly facility reports received on or before the 5th day of the next month as a proportion of the total number of facility reports expected, while completeness of reporting is the number of facility reports received as a proportion of the expected total number of health facility reports. KII were evaluated thematically where similar responses were grouped together, thematic areas include the system's adaptability to change, data quality, ease of data collection and reporting, and gaps and challenges.

Ethical approval

Ethical approval was obtained from the Bayelsa State Health Research Ethics Committee (Approval number: BSHREC/Vol.1/23/06/05). Informed consent was obtained from all participants.

RESULTS

Description and operation of the Mpox surveillance system in Bayelsa state, Nigeria

The Mpox surveillance system in Bayelsa state consists of state-level and LGA-level actors involved in the collection, analysis, and dissemination of information for planning and effective operation. In 2019, Mpox was classified as a priority disease for immediate and routine reporting through the Integrated Disease Surveillance and Response Strategy (Riser *et al*., 2022).

The Epidemiology Unit of the Department of Public Health in the Bayelsa State Ministry of Health, Nigeria, plays a central role in overseeing the coordination of the Mpox surveillance system in the state. Healthcare professionals who are stationed at various healthcare facilities, many of which function as reporting sites for priority diseases, have the responsibility of reporting suspected cases detected within their communities to the LGA DSNOs. The LGA DSNOs are tasked with conducting investigations, including sample collection of all rumours and reported suspected cases, promptly alerting the State DSNO and the State Epidemiologist, who in turn communicates to the Nigeria Centre for Disease Control and Prevention, as shown in Figure 1.

All data collected during surveillance are collated and inputted into the Surveillance Outbreak Response Management and Analysis System (SORMAS) platform, while hard copies are archived in the Epidemiology Unit to ensure effective storage and confidentiality.

Socio-demographic characteristics of participants

The demographic characteristics of participants are summarised in Table 1. Overall, 28 respondents and three key informants participated in the study with a mean age and standard deviation of 43 ± 8 years. Twenty-three (82.1%) participants had ≤15 years of work experience in

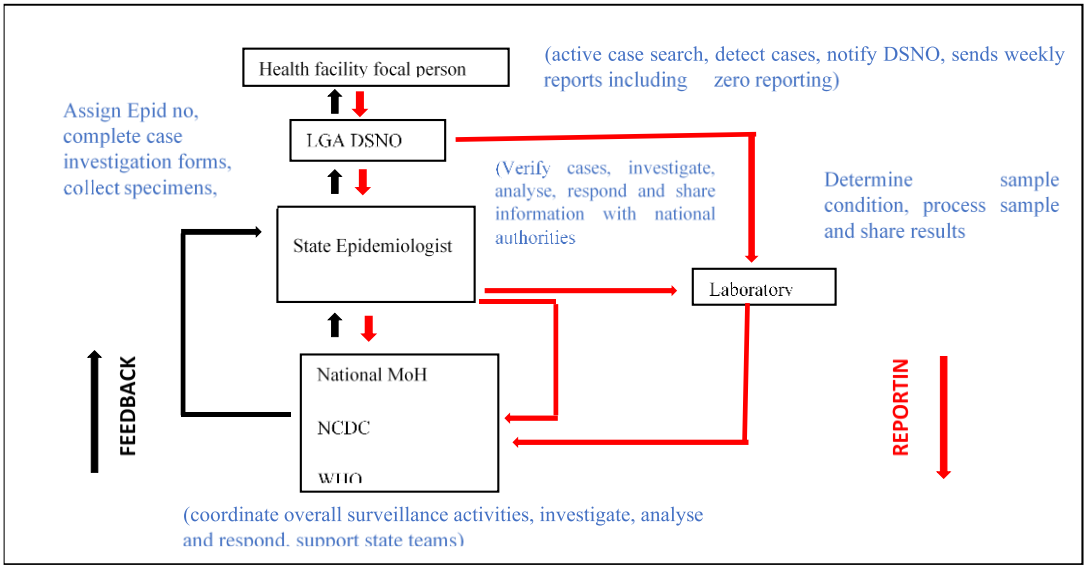

Figure 1. Mpox surveillance data flowchart.

Table 1. Socio-demographic characteristics of Participants (Secondary data analysis).

Variables	Frequency (%)
Age group (years)	
<=20	96 (39.2)
21 -30	53 (21.6)
31 – 40	67 (27.4)
41 - 50	19 (7.8)
51 and above	10 (4.1)
Mean age ± SD	23.83 ± 15.14
Gender	
Male	159 (63.3)
Female	92 (36.7)
Test outcome	
Negative	115 (45.4)
Positive	83 (32.8)
Pending/inconclusive	55 (21.7)
Living status	
Alive	250 (99.2)
Dead	2 (0.8)
LGA	
Brass	7 (2.8)
Ekeremor	13 (5.2)
Kolokuma/Opokuma	3 (1.2)
Nembe	6 (2.4)
Ogbia	37 (14.7)
S/Ijaw	17 (6.8)
Sagbama	4(1.6)
Yenagoa	164 (65.3)

Mpox surveillance. Secondary Mpox surveillance data had 252 suspected cases, among which 82(32.8%) were laboratory-confirmed positive, and 2 (CFR = 2.4%) reported death. Males 159 (63.3%) within the age group ≤20 (39.2%) years of age were predominantly affected. Headache (30.0%), fever (29.0%), and sore throat (35.4%) were the most commonly reported symptoms.

Bayelsa state's Mpox surveillance attributes

Usefulness

A public health surveillance system is said to be useful if it contributes to preventing and controlling adverse health-related events, including an improved understanding of the public health implications of such events (Armstrong *et al.,* 2001). The Mpox surveillance system in Bayelsa state provides data that is useful in describing the epidemiology, burden, and emerging trends of the disease. In the seven years under review, the Mpox surveillance system has detected outbreaks, and the trend reflects a steady decline in the number of cases from 57.1% in 2018 to 27.5% in 2022 (Figure 2). All respondents, including the key informants, mentioned that the Mpox surveillance data has been useful in resource allocation, policy, and decision-making.

Simplicity

Simplicity as an attribute of a public health surveillance system refers to the system's structure and ease of operation (Amede *et al.,* 2022). The majority of respondents mentioned that data collection tools were easy to fill (96%), and Mpox case definitions were clearly defined (92.9%). All 3 key informants opined that the aspect of the Mpox surveillance system that might confer a bit of complexity is the system requirements for all suspected cases to be confirmed by laboratory testing of

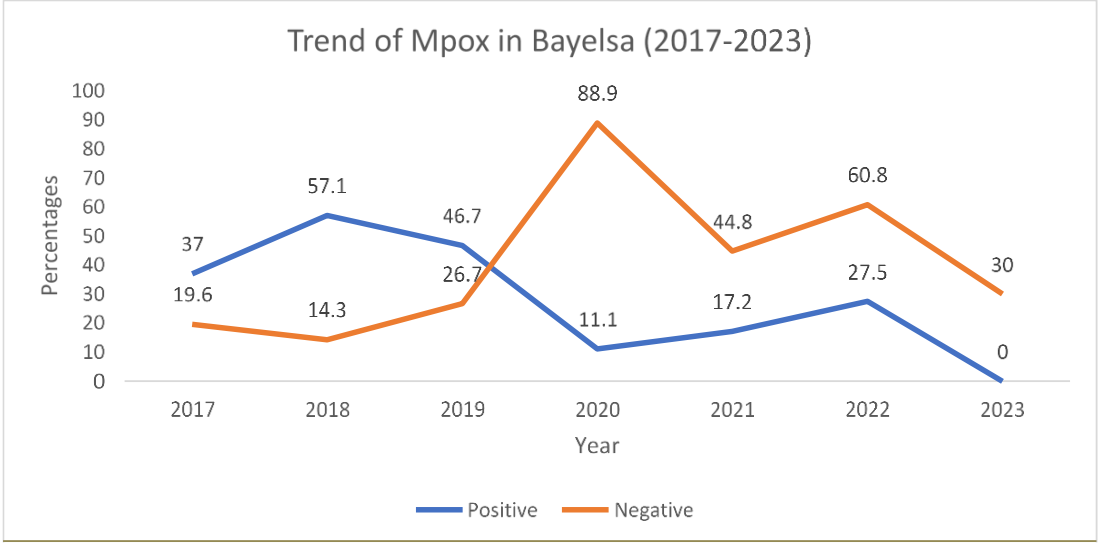

Figure 2. Trend of Mpox cases in Bayelsa State, Nigeria 2017-2023.

which they noted that laboratory services are distantly located from the state. They identified inadequate laboratory infrastructure, equipment, technical expertise to test for Mpox, mobility support for surveillance activities at the LGA level, and administrative commitment as major gaps or challenges hindering effective mpox surveillance in Bayelsa State.

Flexibility

A public health surveillance system is said to be flexible if it adapts to changing information needs or operating conditions with little additional time, personnel, or allocated funds. E.g. if it can accommodate new health-related events and changes in case definitions or technology (Amede *et al.*, 2022). In this evaluation, the majority of respondents (96.4%) including key informants, described the Mpox surveillance system as flexible because the system is adaptable to change.

Data quality

Data quality reflects the completeness and validity of the data recorded in the public health surveillance system. Quality of data is influenced by the performance of the screening and diagnostic tests (i.e. the case definition) for the health-related event, the clarity of hardcopy or electronic surveillance forms, the quality of training and supervision of persons who complete these surveillance forms, and the care exercised in data management (Armstrong *et al*., 2001).

Overall, 25 (89%) of respondents had received training on Mpox surveillance, 19(67.9%) identified inconsistencies between the paper-based datasets and the electronic datasets, while 8 (28.5%) identified missing data for important socio-demographic variables in their datasets. Blank cells were observed for variables such as age and gender (2.07%). Less than half (21.7%) of laboratory outcomes were cumulatively classed as pending or inconclusive. Figure 3 shows that data quality improved over the years.

Acceptability

Acceptability as an attribute of a disease surveillance system encompasses the willingness of persons on whom the public health surveillance system depends on to provide accurate, consistent, complete, and timely data. The IDSR system of operation has been in existence since 1980 and has been adopted by all 36 states of Nigeria including the FCT (Visa *et al.,* 2020). All respondents, including key informants, mentioned that the Mpox surveillance system is acceptable because state-level and LGA-level stakeholders willingly and consistently report data to the next level in their reporting line.

Representativeness

A public health surveillance system that is representative is one that accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person (Armstrong *et al*., 2001). All respondents including key informants adjudged the Mpox surveillance system to be representative. Twenty-three (82.1%) respondents mentioned the surveillance data reflects the true burden of the disease in the population and 89.3% opined that the case definitions reflect all at-risk populations.

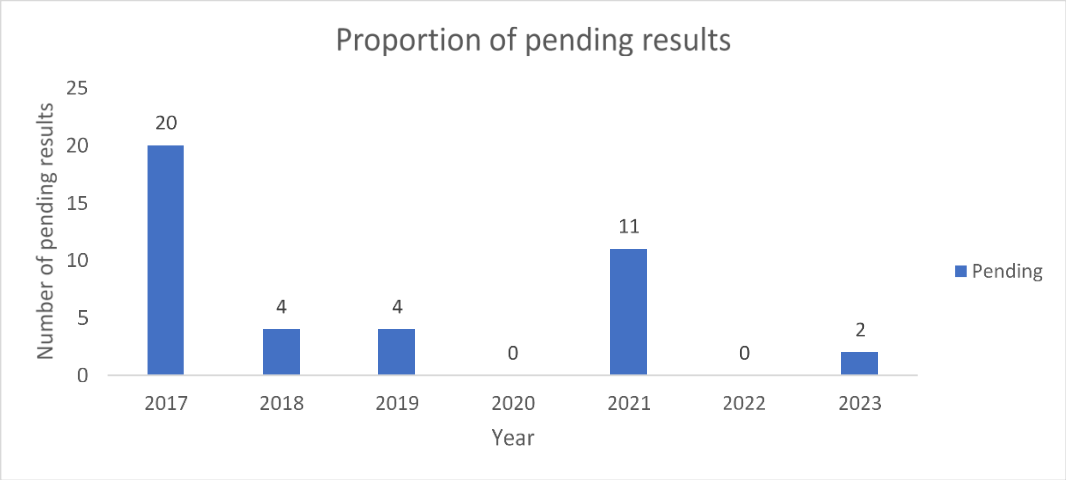

Figure 3. The proportion of pending mpox laboratory results.

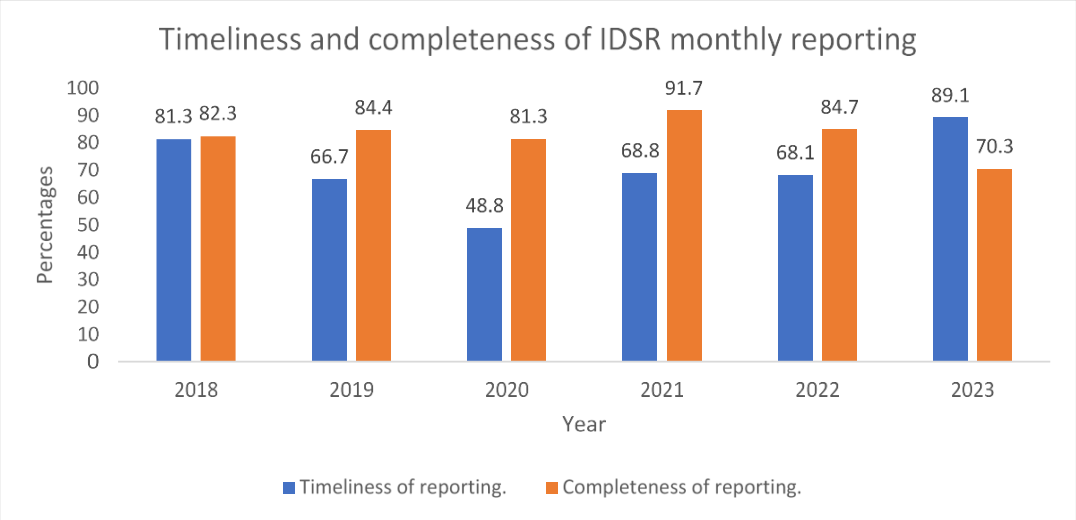

Figure 4. Annualized timeliness and completeness of IDSR monthly reporting in Bayelsa State.

Timeliness and completeness of reporting

Timeliness reflects the speed between steps in a public health surveillance system (Armstrong *et al.,* 2001). In Bayelsa State, DSNOs are expected to report weekly and monthly using the routine weekly and monthly IDSR reporting forms (IDSR 002 and IDSR 003). In this evaluation, Figure 4 reflects there was a decline in the completeness of reporting from 91.7% in 2021 to 70.3% below the threshold of WHO in 2023, whereas the timeliness of reporting improved from 68.8% in 2021 to 89.1%, surpassing the WHO threshold in 2023.

DISCUSSION

The 2022 Mpox global outbreak poses new challenges to global health. Findings from the outbreak suggest a changing epidemiology of the disease where transmission was found to have occurred in countries with no epidemiological linkage to the Central and West African regions where the disease is known to be endemic. Therefore, an effective surveillance system is essential for pandemic preparedness.

In evaluating the performance of the Mpox surveillance system in Bayelsa State, Nigeria, the study revealed the Mpox surveillance system has attributes of a well functioning public health surveillance system. Specifically, the system is deemed useful, simple, flexible, representative, acceptable, and timely in its operation. The key informants attested to the user-friendliness and ease of operation of the system, it is well-structured and flexible to changes as needed (Amede *et al*., 2022; Visa *et al*., 2020; Armstrong *et al*., 2001).

The ease of operation of the system could be attributed to its integration with the Integrated Disease Surveillance and Response (IDSR) system to public health events, the simplified channels of communication and reporting of data on SORMAS, and the availability of sufficient and competent staff willing and ready to carry out surveillance activities. However, the overall data quality of the Mpox surveillance system is termed to be poor possibly due to missing variables and pending/inconclusive results in the surveillance dataset. This is in corroboration with the opinions of Roper *et al*. (2023) who highlighted the importance of increased surveillance activities and integrated surveillance of Mpox with untreated HIV and other immunocompromised populations with a high risk of severe outcomes in areas of resurgence.

Furthermore, the key informants attested to the challenges identified in the Mpox surveillance system in the state, these include inadequate laboratory services, technical capacity to test for Mpox, mobility support for surveillance activities at the LGA level, and poor administrative commitment which may have serious public health implications such as delayed responses to outbreaks, increase disease burden, disrupt livelihoods, and reduce public confidence in the health system.

Limited mobility for field surveillance could lead to difficulty in detecting cases early, tracing contacts, and investigating outbreaks, leaving communities vulnerable to uncontrolled disease spread. Similarly, without sufficient local laboratory capacity, there could be delays in confirming cases, a higher risk of misdiagnosis, and gaps in the epidemiological data needed to make informed decisions. A lack of administrative commitment could further compound these issues by limiting resources, weakening coordination, and demotivating health workers. Similar findings were observed with that of Olaleke *et al*. (2022) in their work which highlights a shortage of highly skilled staff, poor testing capacity, instability of power supply, poor healthcare systems and stigmatization from misinformed communities and co-epidemic surveillance burden as key challenges that weaken the surveillance system for Mpox. All these challenges hinder surveillance activities for Mpox.

Additionally, Roper *et al.* (2023) in their review noted that "Monkeypox (Mpox) requires continued surveillance, vaccines, therapeutics and mitigating strategies" and reported the need for community engagement in non-stigmatizing ways, increased resources, and additional coordination as tools to address challenges in surveillance and readiness to combat continued transmission, resurgence, and repeated spillover of Mpox virus.

The decline in completeness of reporting from 91.7% in 2021 to 70.3% in 2023, falling below the WHO threshold, underscores potential gaps in the reporting process, such as limited capacity, inadequate supervision, or logistical challenges. These gaps could hinder the system's ability to capture and respond effectively to Mpox cases. Similar findings were observed by Zavuga *et al*. (2023), a Ugandan study which highlighted a consistent failure to meet reporting targets in certain regions and higher-level facilities.

Sub-national strengthening of the Mpox surveillance system contributes to overall national surveillance capacity eventually preventing transmission across borders and maintaining global health security. To prevent future outbreaks and safeguard communities, it is essential to address identified gaps by improving mobility support for field surveillance, decentralizing laboratory testing to local laboratories, and fostering stronger administrative leadership through advocacy, policy and strategic planning.

Strengths and limitations of the study

The study adopted a standard guideline: "the US CDC's 2001 updated guidelines for evaluating public health surveillance systems (CDC, 2001)" and utilized both quantitative and qualitative data collection approaches to assess key attributes of the Mpox surveillance system in Bayelsa State, Nigeria. The standardized data collection approach could have improved the internal validity of the study; however, the small sample size could be a limitation to the generalizability of our findings.

Incomplete or missing data in the retrospective record review and self-reported data posed challenges to data accuracy and reliability, but efforts were made to cross-check records and minimize bias. Similarly, the selection of three key informants for their critical roles in decision-making and data reporting provided valuable insights but limited the diversity of perspectives, particularly from community-level stakeholders. Despite these limitations, the study illustrated the effectiveness of the Mpox surveillance system in Bayelsa State, Nigeria and identified its challenges.

Recommendation

From the findings of this evaluation, the following are recommended: Enhanced Mpox surveillance through improved supervision, training and retraining of surveillance officers on data management, upgrade of laboratory infrastructure and equipment, and decentralize laboratory Mpox testing to the sub-national level laboratories to improve completeness, data quality and prompt early response to outbreak alerts.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

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