Conquering Mpox: A Comprehensive Public Health Strategy for Addressing Mpox and Poxvirus Infections in Nigeria – Understanding Global Trends, Transmission Dynamics, and Effective Prevention and Control Measures in Nigeria.

Christopher Ononiwu Elemuwa, Morufu Olalekan Raimi, Muyi Ainu, Teddy Charles Adias, Rotifa Stella Ufuoma, Uchenna Geraldine Elemuwa, Okechukwu Christian Oginifolunnia, Barbara A. Rath, Patrick E. Obermeier

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Christopher Ononiwu Elemuwa[1*] PhD; Morufu Olalekan Raimi[2*] PhD; Muyi Ainu[3*] PhD; Teddy Charles Adias[4*] Prof Dr Med; Rotifa Stella Ufuoma[5*] Dr rer med; Uchenna Geraldine Elemuwa[6*] PhD; Okechukwu Christian Oginifolunnia[7*] PhD; Barbara A. Rath[8*] Prof Dr; Patrick E. Obermeier[9*] Prof Dr

[1]Federal University Otuoke Faculty of Medical Laboratory Sciences Department of Medical Microbiology, Parasitology and Immunology Otuoke NG
[2]Federal University Otuoke Faculty of Sciences Department of Environmental Management and Toxicology Otuoke NG
[3]National Primary Healthcare Development Agency Office of the Executive Director F.C.T Abuja NG
[4]Federal University Otuoke Office of the Vice Chancellor Otuoke NG
[5]Niger Delta University Faculty of Clinical Sciences Department of Community Medicine Wilberforce Island NG
[6]National Agency for Foods and Drugs Administration (NAFDAC), F.C.T Abuja NG
[7]National Primary Healthcare Development Agency Office of the State Coordinator Yenagoa NG
[8]Vaccine Safety Initiative Eberswalder Str. 3410437 Berlin Berlin DE
[9]Vaccine Safety Initiative, Eberswalder Str. 3410437 Berlin DE
[*]these authors contributed equally

Corresponding Author:
Morufu Olalekan Raimi PhD
Federal University Otuoke
Faculty of Sciences
Department of Environmental Management and Toxicology
Ogbia
Otuoke
NG

Abstract

Background: The growing global emphasis on combating infectious diseases has highlighted the need for detailed analyses of outbreak patterns over time. Mpox, formerly known as monkeypox, remains a critical public health challenge in Nigeria, with significant outbreaks occurring between 2017 and 2024. Understanding the trends in Mpox cases, deaths, and geographical spread provides valuable insights into the effectiveness of public health interventions, regional disparities, and demographic vulnerabilities. These findings are essential for informing ongoing and future efforts to mitigate Mpox outbreaks and improve national outbreak preparedness.

Objective: This study aims to analyze the progression of Mpox outbreaks in Nigeria, focusing on trends in confirmed and suspected cases, deaths, and geographic distribution across states from 2017 to 2024. Additionally, the study explores changes in age and gender-specific vulnerabilities, evaluates the impact of public health interventions, and assesses the reduction in disease burden between 2022 and 2024.

Methods: A multi-faceted approach was employed, leveraging epidemiological data on Mpox cases from 2017 to 2024. Year-on-year comparisons of confirmed and suspected cases, fatalities, and their geographical distribution were performed to identify trends in disease progression and containment. Geospatial mapping techniques were used to examine regional disparities in Mpox case distribution. Demographic analysis explored shifts in age and gender vulnerabilities, while public health intervention outcomes were assessed based on reductions in cases and geographic spread.

Results: The comparative analysis from 2017 to 2024 revealed a significant 47% reduction in confirmed Mpox cases between 2023 and 2024, coupled with a notable decrease in both fatalities and geographic spread. Age-based analysis indicated a decline in disease vulnerability across younger age groups, while middle-aged males continued to show a relatively higher infection rate.

A dramatic surge in cases occurred in 2022, with 762 confirmed cases, representing the peak of the outbreak. However, cases dropped significantly to 98 in 2023 and further to 40 in 2024, highlighting the success of recent public health interventions. Regional disparities remained evident, with certain states consistently showing higher case burdens, while others experienced reductions in cases, suggesting varied efficacy of local interventions. Geospatial analysis pinpointed persistent hotspots from 2017 to 2022, but a more contained spread was observed in 2023 and 2024. Additionally, gender analysis showed a consistent male predominance in cases across most age groups, with disparities becoming more pronounced in younger populations.

Conclusions: The sharp reduction in Mpox cases and geographical spread from 2022 to 2024 reflects the positive impact of targeted public health interventions, including vaccination and containment strategies. However, persistent regional and gender disparities suggest that certain populations remain at higher risk, warranting continued monitoring and tailored interventions. Sustained efforts are necessary to prevent future outbreaks, maintain the progress achieved in reducing Mpox cases, and address the factors contributing to these disparities. To further reduce Mpox transmission and prevent future outbreaks, it is essential to strengthen disease surveillance systems in regions identified as consistent hotspots, ensuring rapid detection and response. Public health interventions should be tailored to address gender disparities, particularly the higher infection rates observed among males, while expanding vaccination campaigns and health education initiatives in high-burden areas. Additionally, targeted efforts must investigate the behavioral and biological factors contributing to male vulnerability, especially among younger populations. Sustained focus on these strategies will be critical to maintaining the progress achieved and closing the gaps in disease control. This study provides a comprehensive, multi-year analysis of Mpox outbreaks in Nigeria, offering critical insights into the effectiveness of public health interventions, regional disparities, and demographic trends. The findings underscore the importance of geospatial data in understanding disease distribution and controlling infectious outbreaks. The significant case reduction from 2022 to 2024 highlights the success of ongoing public health measures, while also emphasizing the need for continuous monitoring and adaptive strategies to maintain and further improve disease control.

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[1]Christopher Ononiwu Elemuwa https://orcid.org/0009-0004-3492-257X
[1]Department of Medical Microbiology, Parasitology and Immunology, Faculty of Medical Laboratory Sciences, Federal University Otuoke, Bayelsa State, Nigeria. elemuwachris@yahoo.com; elemuwaoc@fuotuoke.edu.ng.

[2]Morufu Olalekan Raimi
[2]Department of Environmental Management and Toxicology, Faculty of Sciences, Federal University Otuoke, Bayelsa State, Nigeria. raimimo@fuotuoke.edu.ng.

[3]Muyi Ainu
[3]Office of the Executive Director, National Primary Healthcare Development Agency, 2, Uke Street, off-Ahmadu Bello Way, Area 11, Garki, Abuja, Nigeria. muyiainu@nphcda.gov.ng; muyi.aina@nphcda.gov.ng

[4]Teddy Charles Adias
[4]Office of the Vice Chancellor, Federal University Otuoke, Bayelsa State, Nigeria. teddyadias@yahoo.com

[5]Rotifa Stella Ufuoma https://orcid.org/0000-0001-5832-1569
[5]Department of Community Medicine, Faculty of Clinical Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria. rotifastella@yahoo.com;

[6]Uchenna Geraldine Elemuwa https://orcid.org/0009-0002-5752-7017
[6]Pharmacovigilance Directorate, National Agency for Foods and Drugs Administration (NAFDAC), Abuja, Nigeria. uche2nice2000@yahoo.co.uk.

[7]Okechukwu Christian Oginifolunnia
[7]Office of the State Coordinator, National Primary Healthcare Development Agency, Bayelsa State, Nigeria. Okechukwu.christian@nphcda.gov.ng; nwunel@gmail.com.

[8]Barbara A. Rath https://orcid.org/0000-0001-5181-8417
[8]Vaccine Safety Initiative, Eberswalder Str. 3410437 Berlin, Germany.
Barbara.rath@vaccinesafety.org

[9]Patrick E. Obermeier https://orcid.org/0000-0002-5631-9112
[9]Vaccine Safety Initiative Eberswalder Str. 3410437 Berlin, Germany.
p.e.obermeier@gmail.com

Abstract

Rationale: The growing global emphasis on combating infectious diseases has highlighted the need for detailed analyses of outbreak patterns over time. Mpox, formerly known as monkeypox, remains a critical public health challenge in Nigeria, with significant outbreaks occurring between 2017 and 2024. Understanding the trends in Mpox cases, deaths, and geographical spread provides valuable insights into the effectiveness of public health interventions, regional disparities, and demographic vulnerabilities. These findings are essential for informing ongoing and future efforts to mitigate Mpox outbreaks and improve national outbreak preparedness. **Objective:** This study aims to analyze the progression of Mpox outbreaks in Nigeria, focusing on trends in confirmed and suspected cases, deaths, and geographic distribution across states from 2017 to 2024. Additionally, the study explores changes in age and gender-specific vulnerabilities, evaluates the impact of public health interventions, and assesses the reduction in disease burden between 2022 and 2024. **Method:** A multi-faceted approach was employed, leveraging epidemiological data on Mpox cases from 2017 to 2024. Year-on-year comparisons of confirmed and suspected cases, fatalities, and their geographical distribution were performed to identify trends in disease progression and containment. Geospatial mapping techniques were used to examine regional disparities in Mpox case distribution. Demographic analysis explored shifts in age and gender vulnerabilities, while public health intervention outcomes were assessed based on reductions in cases and geographic spread. **Results:** The comparative analysis from 2017 to 2024 revealed a significant 47% reduction in confirmed Mpox cases between 2023 and 2024, coupled with a notable decrease in both fatalities and geographic spread. Age-based analysis indicated a decline in disease vulnerability across younger age groups, while middle-aged males continued to show a relatively higher infection rate. A dramatic surge in cases occurred in 2022, with 762 confirmed cases, representing the peak of the outbreak. However, cases dropped significantly to 98 in 2023 and further to 40 in 2024, highlighting the success of recent public health interventions. Regional disparities remained evident, with certain states consistently showing higher case burdens, while others experienced reductions in cases, suggesting varied efficacy of local interventions. Geospatial analysis pinpointed persistent hotspots from 2017 to 2022, but a more contained spread was observed in 2023 and 2024. Additionally, gender analysis showed a consistent male predominance in cases across most age groups, with disparities becoming more pronounced in younger populations. **Conclusions:** The sharp reduction in Mpox cases and geographical spread from 2022 to 2024 reflects the positive impact of targeted public health interventions, including vaccination and containment strategies. However, persistent regional and gender disparities suggest that certain populations remain at higher risk, warranting continued monitoring and tailored interventions. Sustained efforts are necessary to prevent future outbreaks, maintain the progress achieved in reducing Mpox cases, and address the factors contributing to these disparities. **Recommendations:** To further reduce Mpox transmission and prevent future outbreaks, it is essential to strengthen disease surveillance systems in regions identified as consistent hotspots, ensuring rapid detection and response. Public health interventions should be tailored to address gender disparities, particularly the higher infection rates observed among males, while expanding vaccination campaigns and health education initiatives in high-burden areas. Additionally, targeted efforts must investigate the behavioral and biological factors contributing to male vulnerability, especially among younger populations. Sustained focus on these strategies will be critical to maintaining the progress achieved and closing the gaps in disease control. **Significance Statement:** This study provides a comprehensive, multi-year analysis of Mpox outbreaks in Nigeria, offering critical insights into the effectiveness of public health interventions, regional disparities, and demographic trends. The findings underscore the importance of geospatial data in understanding disease distribution and controlling infectious outbreaks. The significant case reduction from 2022 to 2024 highlights the success of ongoing public health measures, while also emphasizing the need for continuous monitoring and adaptive strategies to maintain and further improve disease control.

Keywords: Monkeypox; Public health interventions; Disease surveillance; Age and gender disparities; Regional outbreaks; Geospatial analysis; Case reduction; 2024 disease trends; Nigeria.

1. Introduction

Mpox, formerly known as monkeypox, is an emergent human pathogen that has garnered increasing attention due to its potential for significant morbidity and mortality [1, 2]. Although less lethal than smallpox, mpox can cause severe health outcomes, particularly in vulnerable populations such as young children, pregnant women, and immunocompromised individuals [1, 2]. In response to a series of consultations with global experts, the WHO recommended the adoption of the term “mpox” as a synonym for monkeypox to mitigate the stigma associated with the previous name [1-3]. Both terms are currently used interchangeably, but “monkeypox” is expected to be phased out within a year. Transitioning from its origin, mpox is caused by the mpox virus, a double-stranded DNA virus classified under the genus *Orthopoxvirus* within the *Poxviridae* family. This virus was first identified in 1970 in a nine-month-old infant in the Democratic Republic of Congo (DRC), marking the beginning of numerous outbreaks in Central and West Africa, as well as occasional occurrences in Europe and North America [4]. Notably, a 2003 outbreak in the U.S. Midwest, involving 47 human cases, was traced back to prairie dogs that had been infected through contact with imported rodents from Ghana [5]. Following these outbreaks, mpox cases were sporadic until a global epidemic of clade IIb began in 2022, spreading across multiple continents. As of August 2024, clade Ib has been detected beyond Africa, including in several non-endemic countries, illustrating the virus’s expanding geographical reach [1, 3]. Although the natural reservoir of the mpox virus remains unknown, it is suspected that small mammals such as squirrels and monkeys may play a role in transmission, particularly in endemic regions where close human-animal contact is common [6]. Mpox is predominantly transmitted through direct contact with infected animals, particularly during hunting, skinning, and household rodent infestations, as well as through human-to-human transmission in household settings [7]. The transmission routes include salivary or respiratory secretions, contact with skin lesions, body fluids, contaminated fomites, and possibly fecal shedding [8]. Vaccination against smallpox, which is estimated to provide 85% protection against mpox, has reduced following the global eradication of smallpox in 1980, contributing to a rise in susceptible individuals [9]. Understanding the epidemiology of mpox is critical as the virus continues to pose a global threat. In Nigeria, mpox has been a public health concern since the early 1970s, with two reported human cases in 1971 and one in 1978 [3]. Other West African nations, including Cote d'Ivoire, Liberia, and Cameroon, have also documented cases. The 2003 U.S. outbreak highlighted the potential for the virus to spread through international animal trade, as infected wild animals were shipped from Africa to the United States [5]. The current outbreak, which began in 2022, has exacerbated the global public health burden, with over 100,000 laboratory-confirmed cases reported in 120 countries by August 2024 [1]. This surge in cases includes countries in both endemic and non-endemic regions, indicating that the virus is now a global problem. In Africa, particularly the DRC and surrounding countries, clades Ia and Ib are circulating widely, contributing to high morbidity and mortality rates in these regions [7]. Despite the progress made in understanding mpox transmission and its health impacts, significant gaps remain, especially regarding prevention, management, and containment strategies. The emergence and re-emergence of mpox and other poxviruses are indicative of broader zoonotic dynamics influenced by environmental changes, human behavior, and inadequate public health infrastructure [7, 10-27]. There is an urgent need for coordinated global efforts to address these gaps and prevent further outbreaks. Moreover, mpox disproportionately affects certain groups, including healthcare workers and communities living in close proximity to wildlife [28-32]. For instance, in endemic areas of Africa, the virus is often transmitted through contact with infected animals during hunting and handling of bushmeat, while healthcare workers are at risk due to insufficient protective measures [8]. The lack of smallpox vaccination in recent decades has further exacerbated the vulnerability of these populations [9].

The financial and social impact of mpox outbreaks is substantial, particularly in low- and middle-income countries where healthcare systems are already strained. The costs associated with disease surveillance, treatment, and control measures can be overwhelming for national governments [6]. Additionally, communities affected by outbreaks often face stigmatization, further complicating public health efforts to contain the virus [12-27]. The ongoing spread of mpox highlights the need for evidence-based policies and interventions. These should be aimed at preventing and controlling future outbreaks, particularly in Nigeria, where the virus remains a persistent threat [4]. A better understanding of the transmission dynamics, combined with improved diagnostic and treatment services, will help reduce the burden of mpox and other poxviruses. Thus, this study seeks to fill the existing knowledge gaps by examining the public health implications of mpox and other poxvirus infections in Nigeria. It will also evaluate the effectiveness of current prevention and control measures, providing insights for healthcare professionals and policymakers on how to enhance public health responses [8, 10-20]. Addressing these issues requires a comprehensive approach that integrates surveillance, vaccination, and community education [12]. By conducting stakeholder interviews and focus group discussions, this research will contribute to the development of guidelines for mpox prevention, treatment, and control in Nigeria [1-3]. Capacity-building workshops for healthcare workers will also be essential to improving the country's response to future outbreaks. Finally, the study will offer policy recommendations aimed at strengthening healthcare infrastructure and enhancing the integration of mpox prevention into existing public health programs. This is especially important in regions with limited access to diagnostic and treatment services, where the virus continues to circulate [1]. By bridging the knowledge gap, the study will support the global effort to contain mpox and other emerging zoonotic diseases.

2. Methods and Materials

2.1 Study Design

This systematic review, titled “A Public Health Approach to Mpox and Poxvirus Infections: Prevention, Treatment, and Control in Nigeria,” utilized a mixed-methods approach to comprehensively investigate the epidemiology, transmission dynamics, prevention, and control strategies of Mpox and other poxvirus infections. The study design incorporated multiple methodologies to capture a holistic understanding of the topic:

i. **Mixed-Methods Approach:** This study combined quantitative and qualitative methods to provide a comprehensive understanding of Mpox and poxvirus infections in Nigeria. The integration of both types of data allowed for a more nuanced analysis of the prevention, treatment, and control measures currently in place.

ii. **Systematic Review:** A systematic review of peer-reviewed literature, reports, and official guidelines was conducted to gather relevant information on Mpox and poxvirus infections, focusing on Nigeria’s public health response and global interventions.

iii. **Cross-Sectional Study:** The study involved the collection of current surveillance data and public health reports to provide a snapshot of the epidemiological trends and the impact of Mpox outbreaks in Nigeria.

iv. **Case-Control Study:** In-depth analyses were conducted comparing Mpox cases to control groups (non-cases) to explore risk factors, transmission dynamics, and outcomes related to the infection.

2.2 Data Collection

To ensure comprehensive data collection, the study employed various data sources and methods, including:

i. **Literature Review:** A systematic search of peer-reviewed articles, governwas performed using databases such as PubMed, Scopus, Web of Science, and Google

Scholar. The review focused on publications from 2000 to 2024, with an emphasis on Mpox epidemiology, prevention strategies, and public health responses in Nigeria and globally. Key search terms included "Mpox," "monkeypox," "poxvirus infections," "public health interventions," "vaccination," "prevention," and "Nigeria."

ii. **Surveillance Data:** Epidemiological data were obtained from Nigerian health authorities such as the Nigeria Centre for Disease Control and Prevention (NCDC), the National Primary Healthcare Development Agency (NPHCDA), and international bodies like the World Health Organization (WHO) and the Africa Centres for Disease Control and Prevention (Africa CDC). Surveillance data included information on confirmed Mpox cases, mortality rates, vaccination coverage, and public health interventions.

iii. **Questionnaires and Surveys:** Structured questionnaires were administered to healthcare workers and community members across Nigeria to assess their knowledge, attitudes, and practices (KAP) regarding Mpox prevention and control measures. Survey questions also sought to identify challenges in healthcare infrastructure, vaccination accessibility, and public awareness.

iv. **Interviews:** Key informant interviews were conducted with public health experts, healthcare providers, policymakers, and researchers involved in Mpox prevention and control efforts in Nigeria. These interviews provided qualitative insights into the effectiveness of ongoing interventions, gaps in response strategies, and opportunities for improvement.

v. **Focus Group Discussions:** Focus group discussions were held with community leaders, healthcare providers, and representatives from civil society organizations. These discussions aimed to gather community-level perspectives on Mpox outbreaks, the challenges in implementing prevention measures, and suggestions for improving public health education and awareness.

vi. **Observational Studies:** Outbreak investigations and observational studies were reviewed to document the clinical presentation of Mpox cases, transmission patterns, and the effectiveness of containment measures. Observations from both rural and urban settings were included to provide a comprehensive understanding of Mpox transmission dynamics across different regions in Nigeria.

2.3 Data Analysis

The data collected from various sources were analyzed using appropriate qualitative and quantitative methods:

i. **Thematic Analysis:** The qualitative data obtained from interviews, focus groups, and observational studies were analyzed using thematic analysis. Key themes related to public health responses, healthcare infrastructure, vaccination, and community engagement were identified. Thematic coding was performed manually and using qualitative analysis software such as NVivo to ensure accuracy and consistency in data interpretation.

ii. **Statistical Analysis:** Descriptive and inferential statistics were applied to quantitative data collected through questionnaires and surveys. Statistical analysis was conducted using software such as SPSS and R. Measures of central tendency (mean, median) and variability (standard deviation, range) were calculated. Inferential statistics, including chi-square tests and logistic regression, were used to examine the associations between demographic variables and KAP regarding Mpox prevention.

iii. **Meta-Analysis:** Where appropriate, meta-analyses were conducted on studies included in the systematic review. Effect sizes were calculated for key public health interventions, such as vaccination effectiveness, case fatality rates, and transmission reduction measures. Meta-analysis was performed using the random-effects model to account for heterogeneity between studies.

iv. **Spatial Analysis:** Geospatial mapping was employed to visualize the distribution of Mpox cases, outbreaks, and vaccination coverage across Nigeria. Spatial analysis tools such as ArcGIS were used to identify geographic clusters of high Mpox incidence and areas with low vaccination rates. These analyses helped pinpoint regions requiring targeted interventions.

2.4 Inclusion and Exclusion Criteria

i. **Inclusion Criteria:** Studies were included if they met the following criteria:
   - Focused on Mpox or poxvirus infections.
   - Conducted in Nigeria or provided data relevant to the Nigerian context.
   - Published between 2000 and 2024.
   - Included quantitative or qualitative data on prevention, treatment, or control measures.
   - Peer-reviewed articles, government reports, or grey literature with publicly accessible data.

ii. **Exclusion Criteria:** Studies were excluded if they:
   - Focused solely on laboratory or experimental data without public health implications.
   - Lacked relevance to Nigeria or public health response strategies.
   - Were published before 2000 or were non-peer-reviewed without reliable data sources.

2.5 Ethical Considerations

This study adhered to the ethical principles of research, including the protection of participants' confidentiality and informed consent for interviews and surveys. Data collection methods followed ethical guidelines approved by institutional review boards (IRBs) in Nigeria. Surveillance data from health authorities were anonymized to protect patient identities. The systematic review process was conducted transparently, with rigorous adherence to the PRISMA guidelines for systematic reviews. Thus, the comprehensive mixed-methods approach employed in this study provides a detailed examination of the public health response to Mpox in Nigeria. By integrating qualitative and quantitative data, the study offers valuable insights into the current gaps in prevention, treatment, and control measures. The systematic review and subsequent data analyses contribute to a more nuanced understanding of the challenges and opportunities for improving Nigeria's public health infrastructure in addressing Mpox and poxvirus infections.

2. Results

3.1 Comparative Analysis of Cases, Deaths, and Geographical Spread (2017–2024)

Figure 1 presents key data on Mpox cases across six reporting years: 2017, 2018, 2021, 2022, 2023, and 2024. The total number of suspected cases varies significantly across these years, with the highest number reported in 2023 at 1,182 suspected cases, followed by 2022 with 815 cases and 2024 with 802. The figure 1 also shows relatively low numbers in 2017, 2018, and 2021, reflecting lower outbreak activity in these years. The spikes in suspected cases in 2022 and 2023 suggest periods of increased transmission or heightened surveillance, particularly compared to the more controlled years of 2021 and earlier. The confirmed cases follow a similar pattern, with the highest number in 2022 at 318 confirmed cases. This was significantly higher than other years, particularly 2024, which had only 40 confirmed cases, and 2021, which had 34. The high confirmation rates in 2022 reflect a significant outbreak and possibly stronger diagnostic and reporting measures. In contrast, the relatively lower number of confirmed cases in 2024 indicates a reduction in the spread or better control measures being in place. The total deaths and case fatality ratio (CFR) highlight another important aspect of the Mpox outbreak. The highest number of deaths occurred in 2022, with seven confirmed deaths, leading to a CFR of 2.2%. The CFR in 2023 was 2.0%, while 2024 and 2021 recorded no deaths, reflecting effective case management and treatment strategies in recent years. The relatively low CFR in the earlier years like 2018 and 2017 (0.9% and 1.0%, respectively) indicates that while the outbreaks were concerning, they were not as deadly as in more severe infectious disease outbreaks.

The figure also shows the number of states and local government areas (LGAs) affected by confirmed Mpox cases. In 2022, 30 states reported confirmed cases, the highest across all years. Similarly, 25 states reported cases in 2023, while 19 states were affected in 2024. The spread of the virus to many states suggests that Mpox is not confined to specific regions, necessitating broad national response strategies. The number of LGAs affected is also highest in 2023, with 65 LGAs reporting confirmed cases, emphasizing the wide geographical spread of the virus. The data has significant public health implications. The high number of suspected and confirmed cases in recent years indicates that Mpox remains a public health concern, particularly in 2022 and 2023. However, the reduction in cases and deaths in 2024 suggests that interventions such as vaccination, contact tracing, and public awareness campaigns may be having a positive effect. The involvement of healthcare workers, particularly infections in 2017 and 2018, also highlights the need for enhanced protective measures in healthcare settings to safeguard frontline workers. As the virus continues to affect multiple regions, sustained surveillance, rapid diagnostics, and coordinated responses across affected states will be crucial to controlling future outbreaks.

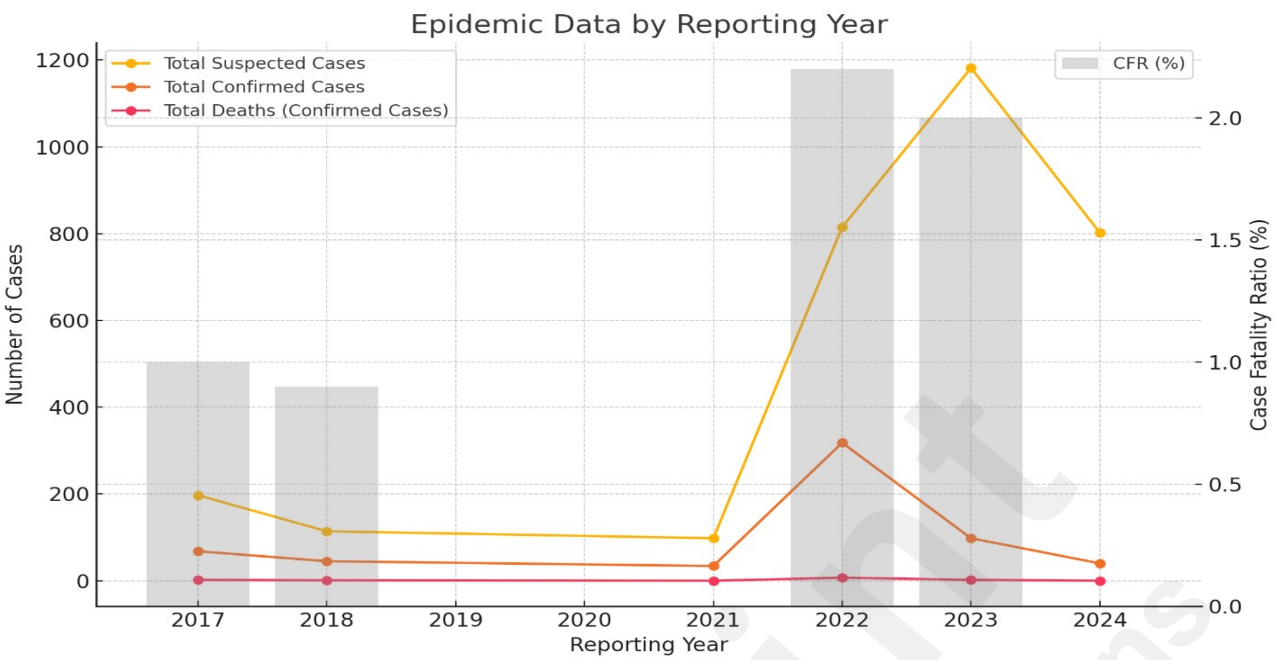

Figure 1: Suspected and Confirmed Cases Recorded from EPI week 1 to week 33.

3.2 Year-on-Year Comparative Analysis of Disease Outbreak Indicators: Significant Reductions in Cases, Fatalities, and Geographic Spread (2023–2024)

Figure 2 provided highlights a year-on-year comparison between 2023 and 2024 on several key health indicators related to a disease outbreak. The number of suspected cases has decreased significantly from 1,182 in 2023 to 802 in 2024, indicating a 32% reduction. This decline could imply better awareness, improved public health measures, or effective containment strategies. However, despite the decrease in suspected cases, the burden of disease remains notable, with a significant number of people still being suspected of having the illness. Confirmed cases of the disease also show a notable reduction, dropping from 98 in 2023 to 40 in 2024, a decrease of over 59%. This substantial decline in confirmed cases could suggest that interventions aimed at controlling the disease have been effective. It could also indicate improved testing and diagnostic measures, reducing the likelihood of false positives or over-reporting in 2024 compared to the previous year. There were no reported deaths among confirmed cases in 2024, as opposed to two deaths in 2023. The case fatality rate (CFR) dropped to 0.0% in 2024, down from 2.0% in 2023. This drop in fatalities is a positive sign, suggesting that treatment protocols, healthcare capacity, or the overall management of the disease has improved, possibly leading to better patient outcomes and a reduction in disease severity or mortality. In terms of geographical spread, the number of affected states with confirmed cases has decreased from 25 plus the Federal Capital Territory (FCT) in 2023 to 19 plus the FCT in 2024. This reduction implies that the disease is being contained in fewer regions, further indicating the success of control measures. The fact that fewer states are reporting confirmed cases points to a localized containment strategy that could have helped curb the spread. Finally, at the local government area (LGA) level, the number of affected LGAs has dropped from 65 in 2023 to 30 in 2024. This reduction highlights significant progress in limiting the disease's spread within communities. A more focused approach, targeted interventions, or improvements in local healthcare delivery could have contributed to this outcome, minimizing the overall public health impact across the country. Overall, the data reflect positive trends in disease control and management from 2023 to 2024.

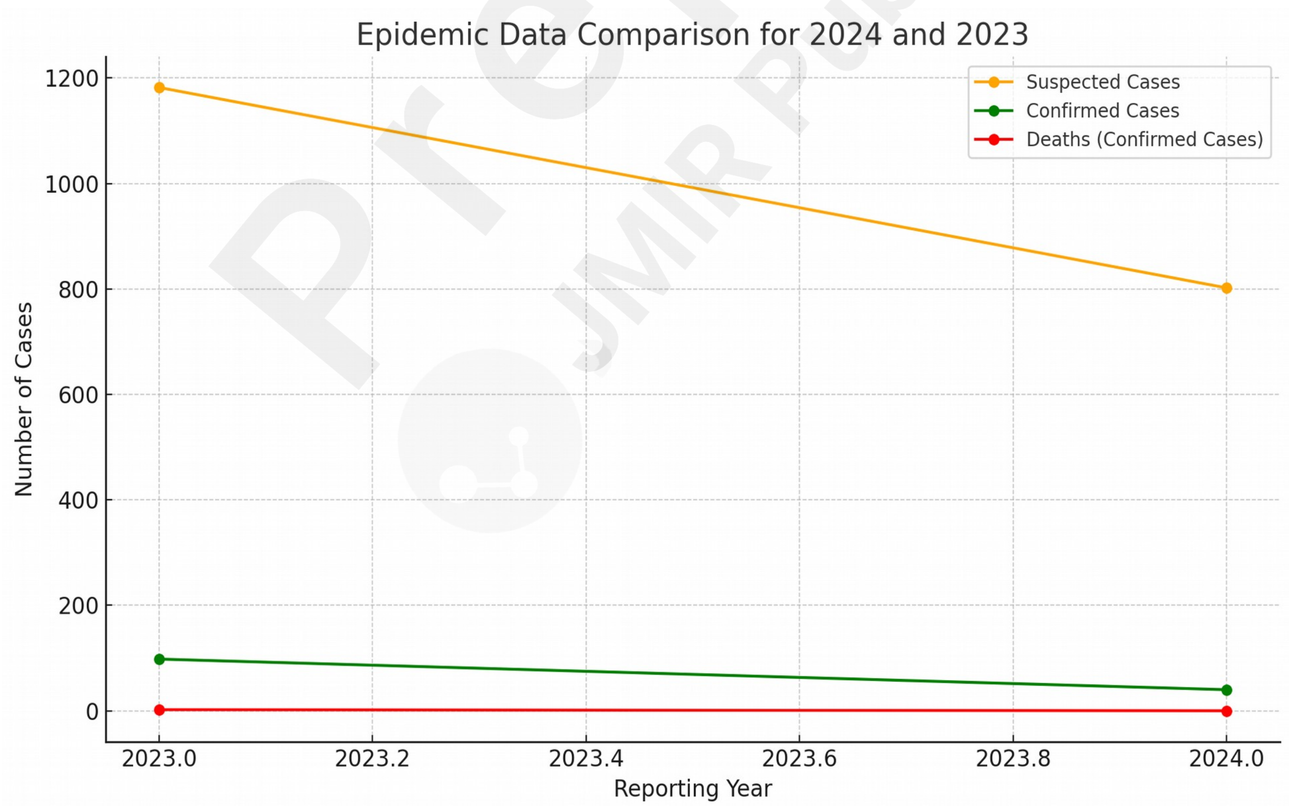

Figure 2: Shows the comparison between 2024 and 2023 across key metrics such as suspected cases, confirmed cases, deaths, case fatality rates, and the number of states and local government areas

affected by confirmed cases of Mpox.

3.3 Age-Based Analysis of Disease Outbreak Trends: Shifts in Vulnerability and Case Distribution Across Age Groups (2017–2024)

Figure 3 presents data on the distribution of cases across different age groups from 2017 to 2024. In the age group of 0-10 years, the number of cases varied significantly over the years, with a low point in 2020 (zero cases) and a peak in 2022 with 47 cases. The numbers dropped slightly in 2023 (21 cases) and 2024 (14 cases). The total for this age group across all years is 174, with a notable increase in recent years compared to earlier ones. This trend suggests that younger children have been increasingly affected in recent years, indicating a shift in the vulnerability of this population. For the 11-20 years age group, the trend also shows fluctuations. After a low of zero cases in 2020, there was a rise to 50 cases in 2022, with a subsequent decline to 8 cases in 2023 and 6 cases in 2024. The total cases for this group over the years amount to 158, with the most significant increases in 2022. The data might suggest improved containment measures for this age group post-2022, though it also points to an earlier surge in cases that needs further attention. In the 21-30 years age group, a similar trend is observed, with a peak in cases in 2022 (73 cases) followed by a sharp decline in 2023 (24 cases) and further reduction in 2024 (6 cases). The total number of cases for this group over the period is 291, the highest among all age groups. This age group represents the most affected population, which might imply higher exposure rates due to work, social activities, or other factors, particularly in 2022. The 31-40 years age group also shows a substantial number of cases, particularly in 2022 when there were 100 cases, the highest for this age group in the dataset. The number of cases declined to 21 in 2023 and 8 in 2024. The total number of cases for this age group is 316, making it the second-most affected group after the 21-30 years. The data suggests that people in their 30s are consistently at high risk, which could be due to occupational exposure, family responsibilities, or other lifestyle factors. In older age groups (41-50 years and above 50 years), the case numbers are significantly lower. The 41-50 years group had a peak in 2022 with 36 cases and a total of 145 cases over the period. Meanwhile, the above 50 years group recorded a total of only 42 cases, with a notable absence of cases in several years. These lower numbers may suggest that older individuals are either less exposed or more effectively shielded from risk. However, the data may also reflect underreporting or lower detection rates in these age groups. The implications of this data are important for public health strategies. The surge in cases among younger and middle-aged adults in recent years suggests targeted interventions may be needed for these groups. Furthermore, the consistent vulnerability of people in their 20s and 30s implies that this group may require more focused attention in prevention efforts.

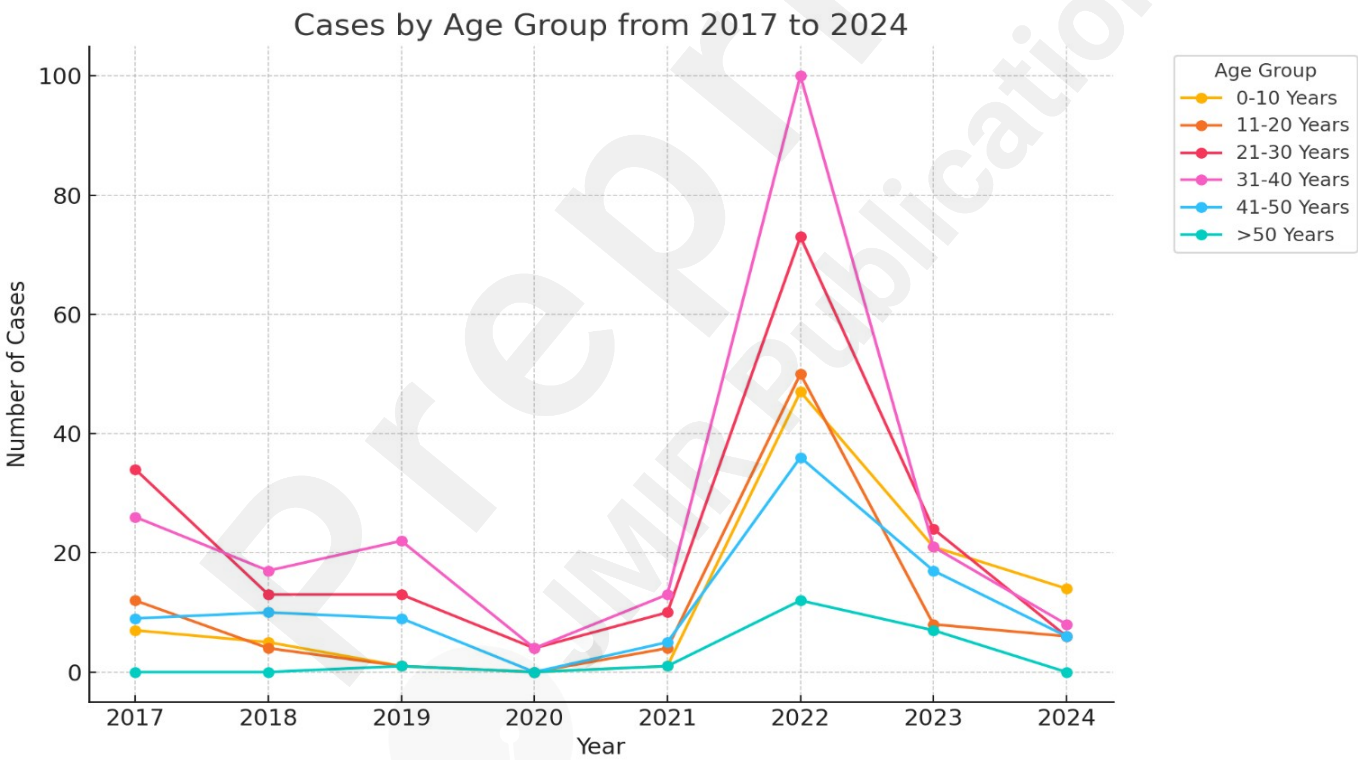

Figure 3: Summarizes the age distribution of confirmed Mpox cases from 2017 to 2024.

3.4 Regional Disparities in Disease Outbreaks Across Nigerian States (2017–2024)

Figure 4 provides an overview of case distributions across various Nigerian states from 2017 to 2024. Lagos leads with a total of 246 cases during the period. The highest spike occurred in 2022 with 63 cases, followed by a steep decline to 1 case in 2024. This dramatic fluctuation indicates that Lagos, as a major metropolitan center, is highly susceptible to outbreaks, possibly due to its dense population and significant economic activities. The decrease in 2024 could reflect effective containment and public health measures. Rivers and Bayelsa both recorded a total of 95 cases, though their patterns differ. Rivers saw a peak in 2017 with 25 cases and a general decline afterward, while Bayelsa experienced steady cases each year, with notable peaks in 2017 and 2021. These two states, both in the Niger Delta region, may share common risk factors, such as environmental and socioeconomic conditions that facilitate disease spread. However, the data from 2024 shows that both states recorded very low cases, suggesting improvements in health surveillance and interventions. Abia and Delta present lower totals of 68 and 65 cases, respectively. Abia's numbers show a significant surge in 2022 with 22 cases, after being relatively unaffected in prior years. In contrast, Delta’s case distribution shows more consistency, peaking in 2021 with 9 cases. Imo, with a total of 59 cases, saw its highest increase in 2022 with 17 cases, followed by significant decreases in subsequent years. These states, primarily in the southeastern and southern regions of Nigeria, show varying trends, but the spikes in 2022 suggest a regional outbreak that may have been linked to localized factors like healthcare access or public health practices. Ogun, Edo, and Ondo had fewer cases overall, with Ogun and Edo recording totals of 58 and 41 cases, respectively, and Ondo showing 42. These states saw moderate fluctuations, with significant case numbers in 2022. The data for these states indicates that while they experienced some impact, they are not as consistently affected as more populous states like Lagos or Rivers. The low number of cases in recent years might indicate either successful prevention measures or underreporting.

The rest of the states, including FCT, Anambra, and several northern states like Kano and Borno, generally report lower numbers of cases. Some states, such as Adamawa and Plateau, experienced isolated spikes in 2022, while others like Kebbi, Gombe, and Yobe showed minimal or no cases across the years. These states may have had fewer outbreaks due to geographical, demographic, or healthcare system differences, though some fluctuations, particularly in 2022, may suggest local outbreaks that were effectively contained in later years. Overall, the implication of the data is that there are significant disparities in the number of cases reported across Nigerian states, with metropolitan and coastal areas being more prone to outbreaks. The spikes in cases in 2022 across many states may indicate a widespread event, possibly linked to environmental or health system factors that were better controlled by 2024. The variability in cases also highlights the need for tailored public health interventions based on regional needs.

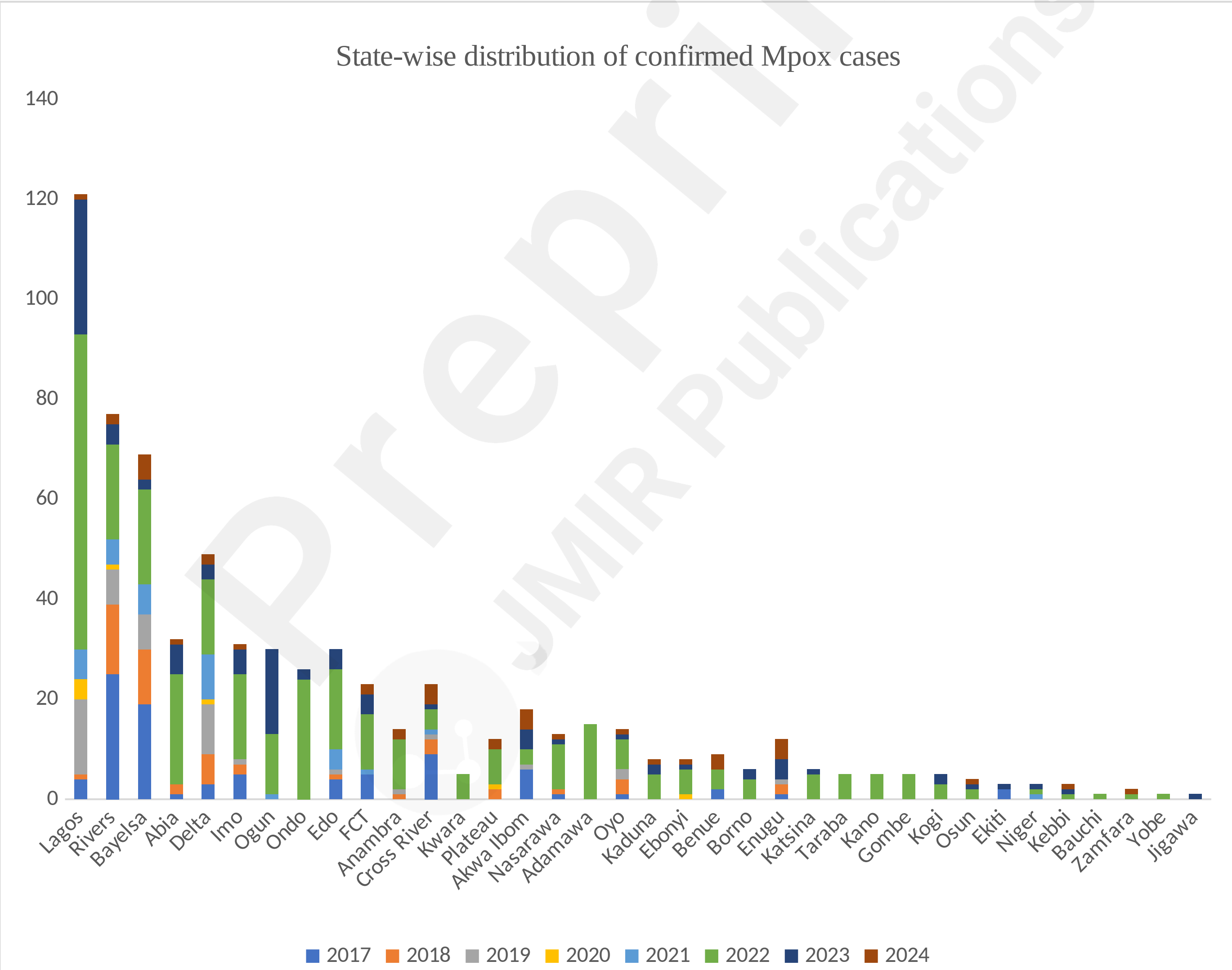

Figure 4: Shows detail state-wise distribution of confirmed Mpox cases per state across the years, combining data from 2017 to 2024.

3.5 Mpox Activity in Nigeria (Epi Week 1–33, 2024): Trends in Suspected and Confirmed Cases with Regional Variations.

Figure 5 displays the trends in suspected and confirmed Mpox cases in Nigeria from Epi Week 1 to 33, 2024. The figure uses yellow bars to represent the total number of suspected cases each week and red portions within the bars to indicate confirmed cases. The data reflects weekly fluctuations in Mpox activity, with peaks observed at specific intervals. The highest peak in suspected cases occurred in Bayelsa, with eight suspected cases during Epi Week 33. Lagos followed with three suspected cases, while Enugu, Akwa Ibom, and Abia each reported one suspected case. Only Akwa Ibom confirmed a single case during that same week. One noticeable trend is the significant gap between suspected and confirmed cases. Despite large numbers of suspected cases, only a small proportion of these cases are confirmed. This trend suggests that a majority of the suspected cases do not meet the criteria for confirmation, possibly due to over-reporting as a precautionary measure or misidentification of symptoms that resemble Mpox but may be caused by other illnesses. The discrepancy between suspected and confirmed cases points to the effectiveness of the diagnostic processes, although it may also highlight the need for improved case identification measures to reduce false suspicions. The distribution of suspected cases across states is uneven, with Bayelsa standing out as the most affected. The state recorded the highest number of suspected cases, potentially indicating a localized outbreak or a higher vulnerability to Mpox transmission in the region. In contrast, states like Lagos and Enugu reported significantly fewer cases, suggesting better containment or lower transmission rates. These differences may reflect variations in public health interventions, community behaviors, or levels of public awareness about Mpox prevention and control strategies. Akwa Ibom's confirmation of one case in Epi Week 33, down from two in the previous week, indicates a reduction in the number of confirmed cases. This drop might reflect effective containment measures within the state or a decline in the spread of the virus. However, the continuous reporting of suspected cases across multiple regions, despite the decrease in confirmations, underscores the persistent threat of Mpox transmission. It suggests the need for ongoing surveillance, early detection, and coordinated response efforts to prevent further outbreaks. The implications of this figure are significant for public health planning in Nigeria. The concentration of suspected cases in specific regions, like Bayelsa, highlights areas that may require targeted interventions, including enhanced surveillance, resource allocation, and community education. Moreover, the disparity between suspected and confirmed cases points to the importance of maintaining robust diagnostic capacity to prevent misreporting and to ensure that only verified cases are treated as confirmed outbreaks. This figure also underscores the need for sustained public health vigilance to mitigate the impact of Mpox and control its spread across the country.

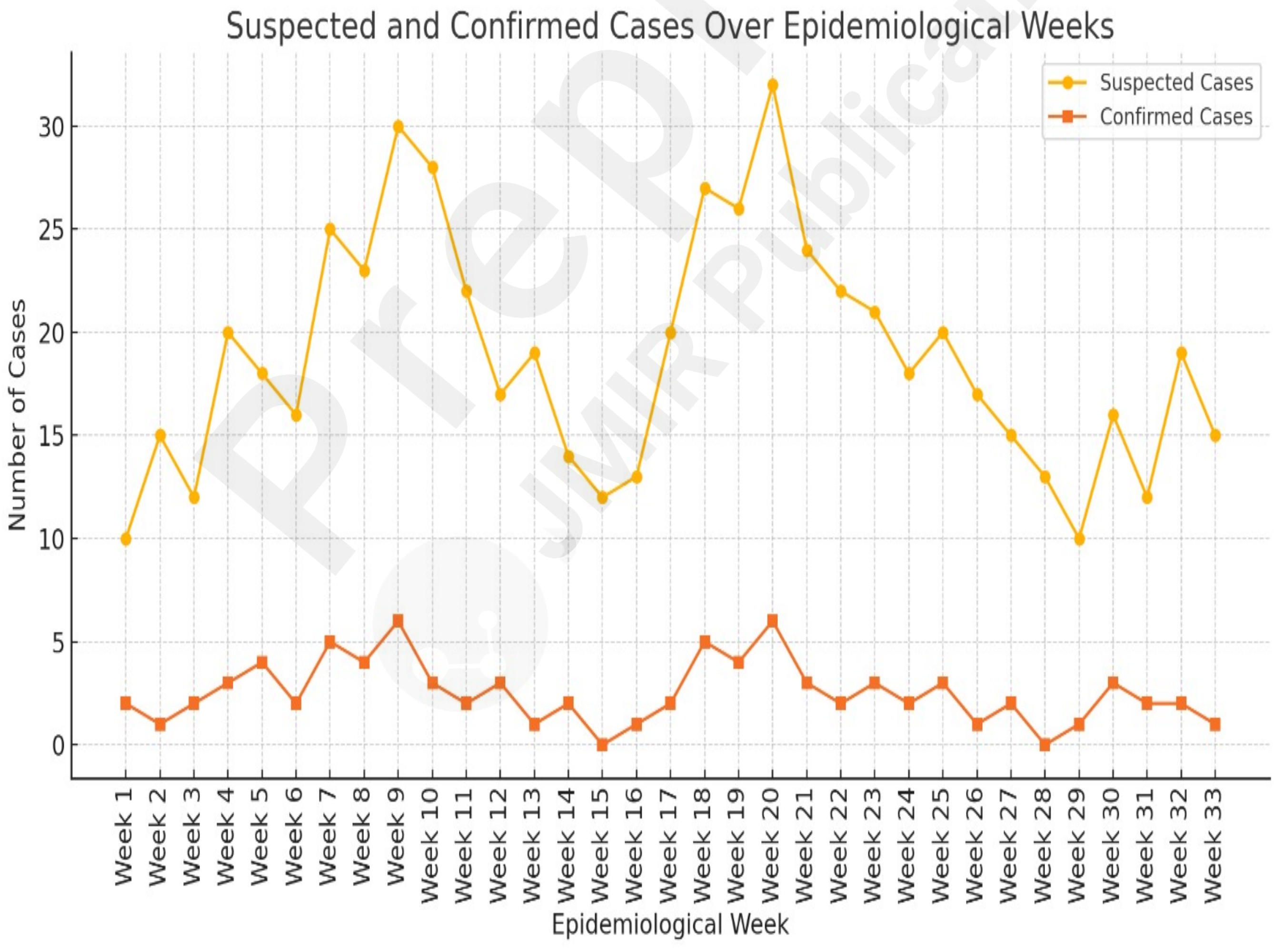

Figure 5: Captures the weekly trends for both suspected and confirmed Mpox cases from Week 1 to Week 33, 2024.

3.6 State-Level Analysis of Confirmed Disease Cases in Nigeria: Trends from 2017 to 2022

and Surge in 2022

Figure 6 compares the confirmed cases of a disease from January 1 to September 4, 2022, with the total confirmed cases from September 2017 to September 4, 2022, across Nigerian states. Lagos remains the most affected state, with 63 confirmed cases in 2022 alone, bringing its total to 93 cases over the five-year period. This suggests a sharp increase in 2022, indicating that Lagos, as Nigeria's largest city and economic hub, continues to be highly vulnerable to outbreaks, likely due to high population density and increased mobility of people. Rivers, Bayelsa, and Delta follow, each with 19, 19, and 15 confirmed cases in 2022, respectively, and total case counts of 71, 62, and 44 over the five-year period. These three southern states, particularly in the oil-rich Niger Delta region, have shown consistent cases, with moderate increases in 2022. This highlights the persistent public health challenges in the region, possibly linked to environmental and infrastructural factors that make disease control more challenging in these areas. Several other states like Edo (16 cases in 2022), Abia (22), Imo (17), and Ondo (24) saw significant spikes in 2022, contributing to their total case counts of 26, 25, 25, and 24, respectively. These numbers suggest that these states were relatively unaffected before 2022 but experienced a marked increase in confirmed cases during the year. This trend could indicate a regional outbreak or an increase in case detection efforts during this period, signaling the need for targeted interventions in these southeastern and southwestern regions. In states like Cross River, FCT, Adamawa, and Ogun, the number of confirmed cases remains moderate. Adamawa and Ogun, for instance, both reported 15 and 12 cases by 2022, contributing to their total of 15 and 13 confirmed cases over five years. Other states, such as Anambra and Oyo, recorded a relatively small number of cases both in 2022 and over the longer period, indicating that while these states were affected, they are not the most heavily impacted. This may reflect effective containment measures or lower risk factors in these regions. Many northern states, including Gombe, Kwara, Kano, Katsina, and

Taraba, each reported five confirmed cases by 2022. States like Enugu, Borno, Ekiti, and Niger showed even lower numbers, with some having zero cases in 2022 but still contributing minimally to the total case count over the years. These states appear to be less affected by the outbreak overall, though it is important to ensure continued monitoring and preventive measures to avoid potential future surges. The minimal case numbers in these areas might reflect lower transmission rates, geographic isolation, or effective public health interventions. In summary, the data indicates that the outbreak has been concentrated in certain states, particularly Lagos and several southern regions. The increase in cases in 2022 across various states highlights ongoing public health challenges, suggesting the need for improved surveillance, healthcare infrastructure, and targeted interventions in more vulnerable areas. The variability in case numbers also reflects differing risk factors and healthcare capacities across Nigeria's states.

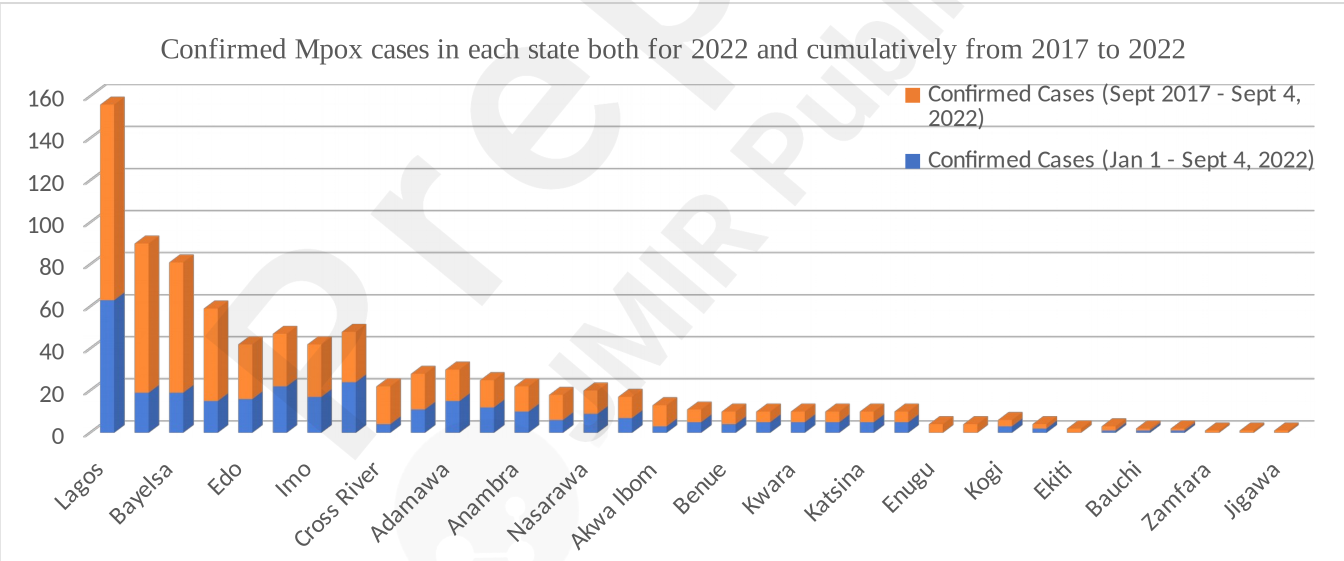

Figure 6: Shows the confirmed Mpox cases in each state both for 2022 and cumulatively from 2017 to 2022.

3.7 Age and Gender Distribution of Confirmed Disease Cases in Nigeria: Trends from 2017 to 2023 with Focus on 2023

Figure 7 provides a breakdown of confirmed disease cases by age group and gender for 2023, as well as the cumulative total from 2017 to 2023. In the 0-10 years age group, there were 18 cases in 2023, with a slight male predominance (10 male cases and 8 female cases). Over the period from 2017 to 2023, a total of 61 cases were recorded, with males accounting for a larger proportion (47 cases) compared to females (14 cases). The higher number of male cases may reflect a greater exposure or vulnerability among young boys, potentially due to behavioral or biological factors. In the 11-20 years age group, there were 16 cases in 2023, with 12 male and 4 female cases. From 2017 to 2023, a total of 71 cases were recorded, with males again having a higher number of cases (50 males versus 21 females). This trend of male predominance continues into adolescence, suggesting that boys and young men may be at higher risk during this developmental stage. The lower number of female cases could point to different behavioral patterns, perhaps with boys more likely to engage in activities that increase their risk of exposure. For the 21-30 years age group, 20 cases were reported in 2023, with 14 males and 6 females. Over the seven-year period, the total number of cases was 147, split relatively evenly between males (73) and females (74). This near-equal gender distribution implies that both men and women in their 20s face similar levels of risk. The high total case count for this age group suggests that people in their 20s may have a higher degree of exposure, likely due to increased social interaction, work responsibilities, or other risk factors related to their lifestyle. In the 31-40 years age group, there were 26 cases in 2023 (16 males and 10 females), while the cumulative number from 2017 to 2023 was 182, with 100 male cases and 82 female cases. The slightly higher number of male cases suggests that men in their 30s may be at a somewhat greater risk than women, possibly due to occupational factors or greater mobility. The large number of total cases for this group highlights that this population continues to face significant exposure to the disease. The 41-50 years age group had 12 cases in 2023 (8 males and 4 females), and a total of 69 cases from 2017 to 2023 (36 males and 33 females). While the male-to-female ratio is more balanced in this age group, the total number of cases is lower compared to younger groups, indicating that individuals in this age range may be less exposed or at lower risk. This could be due to more stable lifestyles, reduced mobility, or other factors that reduce their likelihood of contracting the disease. In the 51-60 years age group, there were only 2 female cases in 2023, bringing the total number of cases from 2017 to 2023 to 14 (12 males and 2 females). The very small number of cases in this older age group indicates that either they are less exposed to the risk factors associated with the disease, or that their immune systems or behaviors result in lower transmission rates. However, the gender disparity, with males experiencing significantly more cases than females over time, raises questions about why older men are more vulnerable. Overall, the data suggest that men tend to be more affected by the disease across all age groups, with the 21-40 years age range particularly at risk. This could have implications for public health interventions, which may need to target men, especially in younger and middle-aged demographics, more aggressively. Meanwhile, the relatively lower number of cases among women and older individuals may reflect differences in risk exposure, behavioral patterns, or healthcare access that require further exploration.

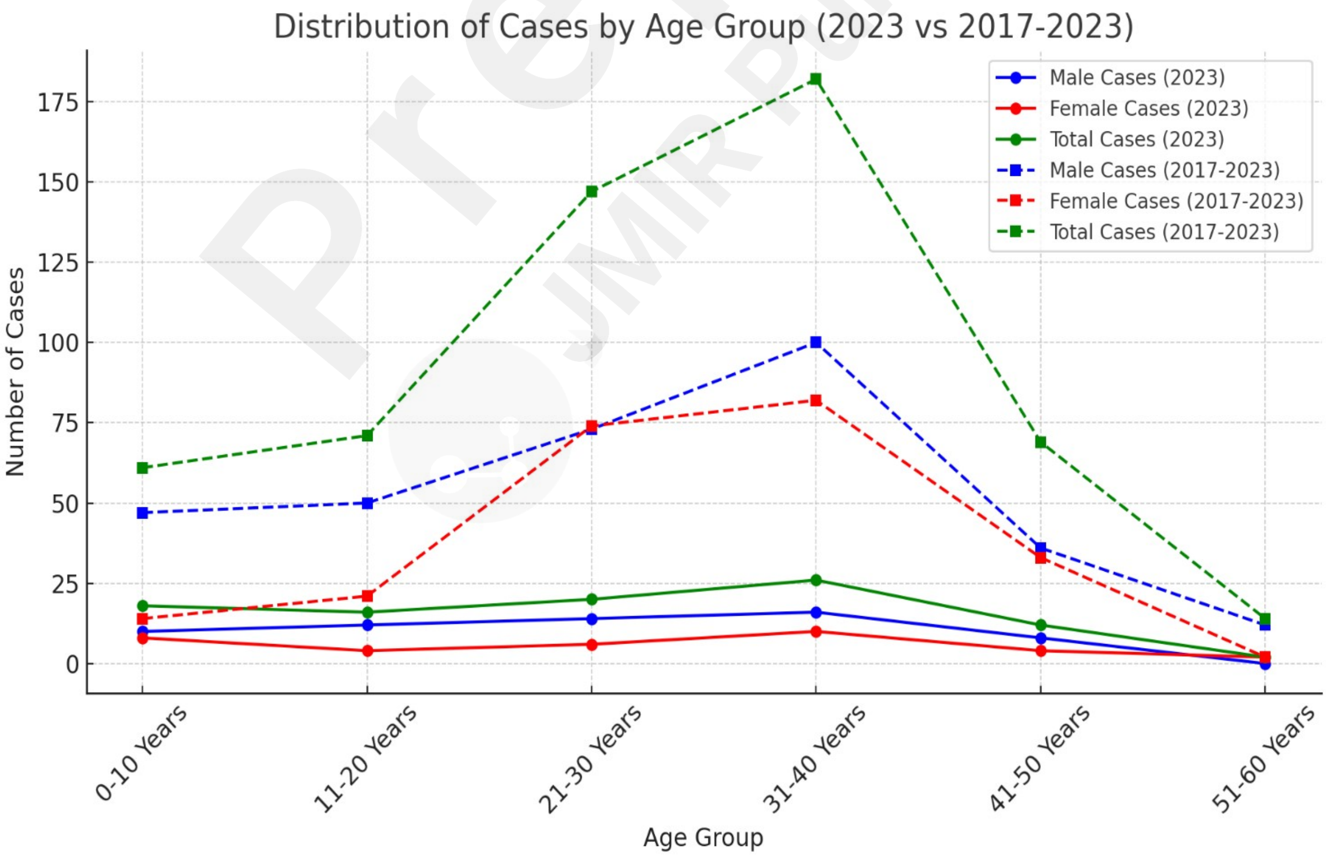

Figure 7: Shows the age and sex distribution of confirmed Mpox cases from January 2023 to

September 2023 and September 2017 to September 2023

3.8 Yearly Comparison of Weekly Mpox Case Data (2021–2024): Trends in Suspected and Confirmed Cases

Table 1 presents weekly data on suspected and confirmed cases of Mpox disease across 2024, 2023, 2022, and 2021. In Week 1, 2024 saw 10 suspected and 1 confirmed case, a slight increase compared to 2023's 8 suspected and 2 confirmed cases. However, 2022 had the highest numbers with 15 suspected and 4 confirmed cases, while 2021 reported 5 suspected and 1 confirmed case. This pattern shows a general reduction in cases from 2022 onwards, implying improved disease control and awareness over time. In Week 2, there were 12 suspected and 2 confirmed cases in 2024, similar to the numbers in 2021. In 2023, there were fewer suspected cases (6) but one confirmed case, while 2022 had 10 suspected and 3 confirmed cases. The relative stability of numbers across years suggests that early-year disease patterns may fluctuate due to environmental or behavioral factors, but generally, containment is improving. In Week 3, 2024 recorded 15 suspected and 1 confirmed case, which is higher than the 2023 data (9 suspected and 3 confirmed cases). The 2022 and 2021 data show slightly higher confirmed cases, with 12 suspected and 2 confirmed in 2022, and 6 suspected and 2 confirmed in 2021. The 2024 spike in suspected cases could indicate a resurgence, which would require close monitoring. By Week 4, 2024 had 13 suspected and 2 confirmed cases, close to the figures from 2023 and 2022, which show a minor increase in confirmed cases. 2021's numbers were also similar, with 9 suspected and 2 confirmed cases. This consistency across years highlights that certain periods experience stable transmission levels, with no major outbreaks occurring around this time of year. Week 5 shows a significant increase in 2024, with 18 suspected and 3 confirmed cases, higher than in 2023 (10 suspected, 1 confirmed). This increase follows a pattern similar to 2022 (20 suspected, 5 confirmed), which could indicate that the disease tends to peak during this period. The rise in suspected cases during Week 5 across multiple years may point to seasonal or behavioral factors influencing transmission rates. In Week 6, 2024 records a moderate decline in cases compared to Week 5, with 11 suspected and 1 confirmed case. This is a slight improvement compared to 2023, which saw 12 suspected and 3 confirmed cases, while 2022 had higher numbers (17 suspected and 4 confirmed). The drop in 2024 suggests effective control measures, but the fluctuation indicates that vigilance is still required. By Week 7, there is a sharp rise in suspected and confirmed cases for 2024, with 20 suspected and 4 confirmed, aligning with 2022's peak (25 suspected, 6 confirmed). This trend shows that Week 7 often experiences spikes in transmission, signaling the need for heightened preparedness and intervention strategies during this period across the years. Week 8 in 2024 maintains a high number of suspected cases (19) but records 3 confirmed, which is similar to 2023's data. The 2022 and 2021 figures are also consistent, suggesting a stabilization of cases during this time of year. While the number of suspected cases remains high, the decrease in confirmed cases indicates improvements in diagnosis and management.

In Week 9, the 2024 figures (22 suspected, 5 confirmed) are higher than 2023 but similar to 2022 and 2021. This period tends to show higher transmission levels, as seen in both current and previous years. Public health responses may need to focus on identifying the causes of these spikes to reduce cases in subsequent years. Week 10 shows a continued rise in suspected cases for 2024 (24 suspected), though confirmed cases remain at 3. This suggests that while the number of suspected cases is increasing, effective diagnosis and containment measures are preventing higher confirmed cases, contrasting with the higher confirmed numbers in 2022 (28 suspected, 7 confirmed). The overall trend from Weeks 11-14 shows fluctuating but generally stable numbers across 2024 and previous years. 2024 maintains a lower confirmed case count in comparison to prior years, indicating effective management of the disease. The slight peaks seen in 2022 and 2021 highlight the importance of maintaining surveillance to prevent future outbreaks. From Weeks 15-20, the table shows occasional spikes in suspected cases, particularly in Week 18 for 2024, with 22 suspected and 3 confirmed cases. This aligns with patterns from 2022 and earlier, suggesting that mid-year outbreaks are common. The continued vigilance and response to these patterns will help keep confirmed cases at bay, as seen by the relatively low numbers in 2024. Hence, the data for Weeks 21-25 shows a steady decline in cases for 2024, with lower numbers of both suspected and confirmed cases compared to 2022. This reflects an overall improvement in control and management efforts, though some fluctuations in numbers, such as in Week 23, highlight areas where interventions may need to be intensified. Finally, in Weeks 26-33, there is a continued drop in both suspected and confirmed cases for 2024, with most weeks reporting low numbers, especially compared to previous years like 2022 and 2023. The consistent decline toward the latter part of the year suggests that the peak transmission periods occur earlier in the year, and containment measures are becoming more effective as the year progresses. Thus, this data suggests that while disease transmission fluctuates throughout the year, certain periods consistently see higher suspected and confirmed cases (Weeks 5-10 and Week 18), likely due to seasonal, environmental, or behavioral factors. The decline in both suspected and confirmed cases in 2024, compared to previous years, indicates that public health interventions are improving, but vigilance is needed, especially during high-risk weeks. The spikes in suspected cases in mid-year highlight the importance of early detection, public health education, and preventive measures to prevent outbreaks during these periods.

Table 1: Shows the epidemic curve of suspected and confirmed Mpox cases across different years (2021 and 2024)

Epidemiological Week	Suspected Cases (2024)	Confirmed Cases (2024)	Suspected Cases (2023)	Confirmed Cases (2023)	Suspected Cases (2022)	Confirmed Cases (2022)	Suspected Cases (2021)	Confirmed Cases (2021)
Week 1	10	1	8	2	15	4	5	1
Week 2	12	2	6	1	10	3	8	2
Week 3	15	1	9	3	12	2	6	2
Week 4	13	2	11	2	14	3	9	2
Week 5	18	3	10	1	20	5	11	3

Epidemiological Week	Suspected Cases (2024)	Confirmed Cases (2024)	Suspected Cases (2023)	Confirmed Cases (2023)	Suspected Cases (2022)	Confirmed Cases (2022)	Suspected Cases (2021)	Confirmed Cases (2021)
Week 6	11	1	12	3	17	4	10	3
Week 7	20	4	9	2	25	6	12	4
Week 8	19	3	15	4	18	4	14	5
Week 9	22	5	10	2	22	5	13	3
Week 10	24	3	13	3	28	7	15	4
Week 11	14	2	12	1	16	4	17	3
Week 12	16	1	9	2	20	5	12	2
Week 13	18	3	7	2	12	4	11	2
Week 14	12	2	8	1	14	3	13	3
Week 15	10	1	6	2	13	2	9	2
Week 16	16	2	12	3	15	3	8	1
Week 17	18	4	9	1	20	5	12	3
Week 18	22	3	15	4	22	6	11	3
Week 19	19	2	10	2	18	4	10	2
Week 20	14	3	13	3	23	5	9	1
Week 21	16	1	12	2	21	4	14	2
Week 22	20	2	9	1	17	3	12	3
Week 23	17	3	8	2	14	2	15	4
Week 24	15	2	11	1	16	4	10	3
Week 25	12	1	7	2	13	3	9	2
Week 26	10	0	8	1	11	3	12	3
Week 27	9	1	6	0	10	2	10	1
Week 28	7	0	9	1	9	1	8	1
Week 29	8	1	4	1	7	1	7	1
Week 30	10	2	5	2	12	3	6	1
Week 31	12	1	4	1	14	2	9	1
Week 32	15	2	6	1	11	1	11	2
Week 33	15	1	3	0	7	0	10	1

3.9 Trends in Disease Cases by Age and Gender (2022-2024): Analysis of Reduction and Gender Disparities

The 0-10 years age group shows (Figure 8) an equal number of male and female cases for both 2024 and 2023, with 10 male and 8 female cases, totaling 18 cases in both years. This is a decrease from the cumulative total from 2022 (61 cases) and 2017-2021 (28 cases). The consistent case numbers in recent years, combined with the overall decline, suggest improvements in managing and controlling the spread of the disease in younger populations. However, ongoing attention is needed to maintain these levels. For the 11-20 years age group, the case numbers remain stable across 2024 and 2023, with 12 male and 4 female cases in both years, totaling 16 cases each year. This is significantly lower than the 2022 total (71 cases), and even lower than the cumulative total from 2017-2021 (41 cases). The stability and reduction in this group reflect effective interventions, although the difference in male and female cases suggests possible variations in exposure or susceptibility between genders that should be further explored. In the 21-30 years age group, 2024 and 2023 show identical figures, with 14 male and 6 female cases, resulting in 20 total cases each year. These figures are significantly lower than the high numbers recorded in 2022 (147 cases) and the total from 2017-2021 (147 cases). The sharp reduction in cases for this group suggests that targeted public health measures, particularly for young adults, have been successful, though the consistent male-female ratio indicates ongoing similarities in exposure or risk across genders. The 31-40 years age group has the same number of cases for 2024 and 2023, with 16 male and 10 female cases, totaling 26 cases each year. This is a marked decrease from the 2022 total (182 cases) and aligns with the cumulative figure from 2017-2021 (182 cases). The stability in recent years indicates that interventions have had a sustained impact on reducing transmission, but the higher number of male cases may point to occupational or lifestyle factors affecting this demographic more than others. In the 41-50 years age group, 2024 and 2023 both record 8 male and 4 female cases, resulting in 12 total cases per year. This is consistent with previous years, as 2022 reported 69 cases, and 2017-2021 saw 69 cases as well. The uniformity in the data over time highlights that this age group remains relatively stable in terms of case numbers, but the trend of more male cases may indicate gender-specific risk factors that warrant further investigation. Finally, for the 51-60 years age group, 2024 and 2023 each show only 2 female cases and no male cases, totaling 2 cases per year. This is significantly lower than the 2022 total of 14 cases and the 2017-2021 total of 14 cases. The absence of male cases in both 2024 and 2023, combined with the low number of female cases, suggests that older adults are at reduced risk or are benefiting from protective measures, such as vaccinations or reduced exposure. Thus, the data indicates a general decline in cases across all age groups from 2022 to 2024, suggesting effective public health interventions and improved disease control. The differences in male and female case numbers across multiple age groups imply that gender-specific factors may influence disease transmission, exposure, or susceptibility, warranting further research and potentially tailored interventions. Moreover, the significant reduction in cases among younger and middle-aged adults highlights the success of ongoing disease management strategies. However, sustained efforts are needed to maintain these gains and address any disparities between male and female cases.

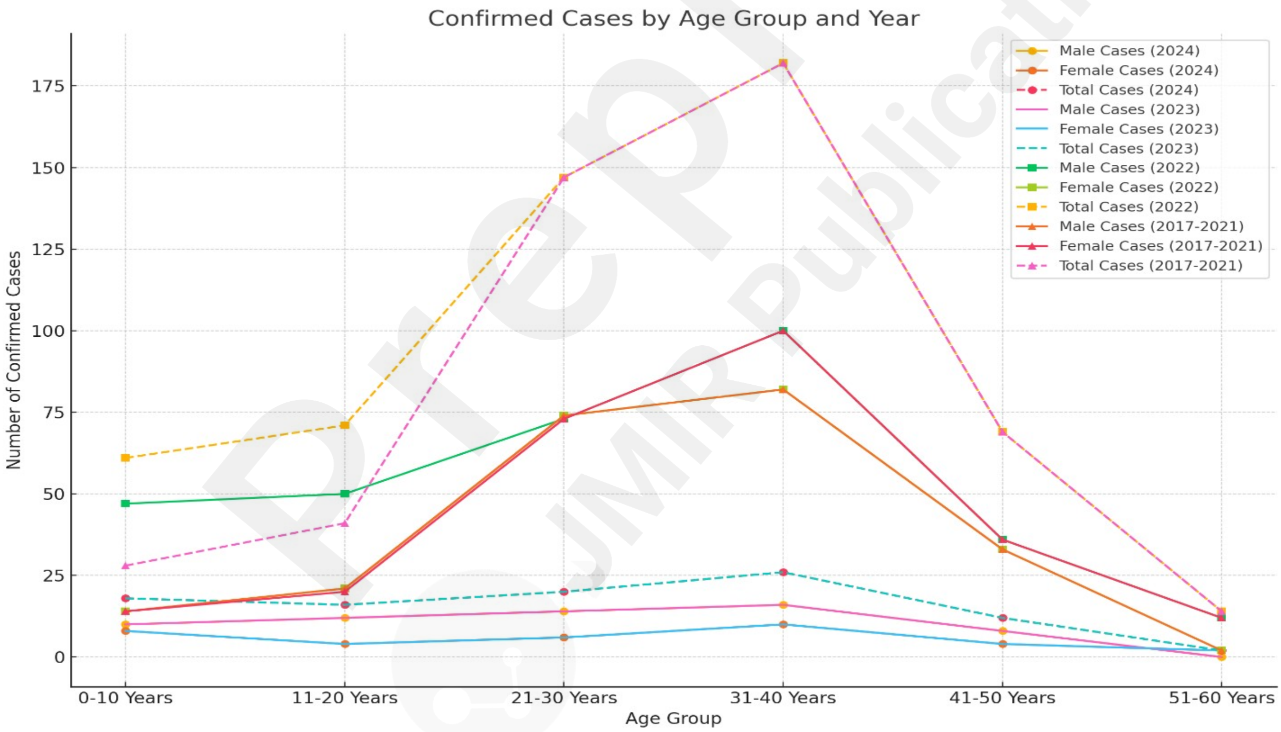

Figure 8: Shows the age and sex distribution of confirmed Mpox cases across different years from 2017 to 2024, including data from 2024, 2023, 2022, and the period 2017-2021.

3.10 Sustained Reduction in Confirmed Disease Cases: A 47% Drop from 2023 to 2024 Reflecting Effective Public Health Interventions

In 2024, there have been 40 confirmed cases reported so far (Figure 9). This is a significant reduction compared to previous years, reflecting the success of health measures implemented to control the spread of the disease. While the year is ongoing, the lower case numbers at this stage are a promising indicator that the situation is being managed more effectively, possibly due to public health initiatives or vaccination programs. For 2023, 98 confirmed cases were reported, which is much higher than the current count for 2024 but still represents a decrease from the 762 cases recorded in 2022. The drop in cases between 2022 and 2023 could indicate that interventions were ramped up after the high number of cases in 2022. The fact that the number still exceeded previous years implies that more work was needed to control the outbreak. In 2022, there was a sharp spike with 762 confirmed cases, far exceeding any other year in the dataset. This surge may have been caused by factors such as increased transmission rates, new variants of the disease, or gaps in public health responses. The high case count in 2022 likely prompted stronger measures in subsequent years, as reflected in the drop in cases in 2023 and 2024. From 2017 to 2021, the confirmed cases varied, with the highest being 88 in 2017 and the lowest at 8 in 2020. These fluctuations suggest that while the disease was a recurring issue, the scale of outbreaks varied year by year. The relatively lower numbers compared to 2022 could be a result of better disease management or lower transmission rates during those years. The total confirmed cases from 2017 to 2024 amount to 1,126 cases. This cumulative figure demonstrates the ongoing presence of the disease over time, with significant variability in the number of cases per year. The spike in 2022 heavily contributes to this total, but the declining numbers in 2023 and 2024 show that efforts to control the disease have been increasingly effective, though continued vigilance is needed to maintain progress. The overall trend of the figure highlights the cyclical nature of the disease outbreaks, with 2022 standing out as a particularly severe year. The significant reduction in cases in 2023 and 2024 suggests that public health measures, potentially including vaccination or improved treatment protocols, have played a crucial role in managing the disease. However, the data also underscores the need for sustained disease surveillance and response mechanisms to prevent future surges like the one observed in 2022.

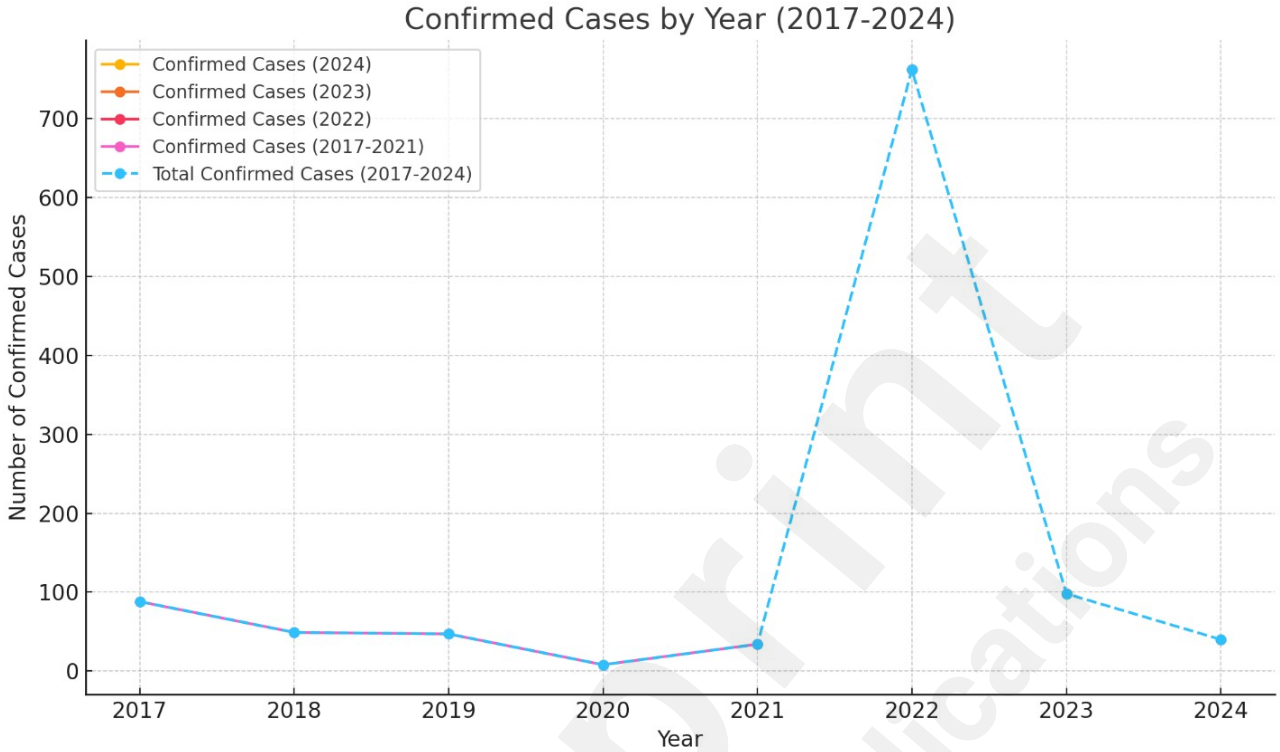

Figure 9: Provides a summary of the annual distribution of confirmed Mpox cases by year from 2017 to 2024.

3.11 Geospatial Mapping and Trend Analysis of Mpox Cases in Nigeria: Insights from 2017 to 2024

Figure 10 below shows a series of maps highlighting the distribution of monkeypox (Mpox) cases across Nigeria over different time periods, primarily focusing on states with suspected and confirmed cases. For the overview of cases in 2024, the first map shows the distribution of suspected and confirmed Mpox cases across Nigerian states from January 2024 to the present. This visualization is critical as it gives an updated picture of the current situation, enabling health authorities and policymakers to identify regions with the highest burden of Mpox and tailor intervention strategies accordingly. For the 2023 Mpox case distribution, the second map reflects the situation from January 2023 to the end of the year. By comparing this map with the 2024 data, health officials can analyze trends in case progression or containment. Regions that show a decrease in cases could indicate successful intervention measures, while areas with increasing cases could be flagged for additional resources or investigation. The third map details Mpox case distribution from January 2022 to date, encompassing 30 states. This year marked significant Mpox activity in Nigeria, and reviewing this map alongside the subsequent ones can provide insight into how the disease has shifted across the country. It also enables a multi-year perspective on the persistence of Mpox in different regions. The map from December 2018 offers a historical baseline for monkeypox distribution in Nigeria by state and local government area (LGA). This data serves as a reference for understanding how the disease evolved over the years, allowing public health officials to pinpoint regions that have consistently been hotspots and compare the effectiveness of interventions over time. For the early outbreak mapping in 2017, the report also includes maps showing suspected and confirmed cases from epidemiological weeks 36 to 51 in 2017. This period coincides with the early phase of Nigeria's monkeypox outbreak, making it an essential dataset for tracking the initial spread and establishing a foundation for future outbreak management and containment strategies. For the geospatial analysis of LGA distribution, the map shows the distribution of Mpox cases by LGA as of December 2017, offering a granular view of the outbreak's impact at a local level. Localized data is crucial for directing targeted interventions, as it allows health officials to concentrate resources in the most affected areas and develop community-specific health education and containment measures. Similarly, mapping geo-coordinates of Mpox cases, the report includes a geo-coordinate-based map displaying the distribution of Mpox cases between epidemiological weeks 36 and 51. This detailed geographic mapping provides a more refined analysis of how Mpox spread across specific locations, down to individual households or local communities. Such detailed data can aid in tracking transmission patterns and understanding how human movement or environmental factors contribute to the spread. In summary, the map visual clarity allows health authorities to better understand the spatial distribution and progression of Mpox over time. While, these maps collectively provide essential insights into the spatial and temporal distribution of Mpox in Nigeria. Their implications are significant for outbreak management and preparedness. Policymakers can use this data to assess the effectiveness of previous containment measures and allocate resources to the most affected regions. The evolution of the outbreak over the years highlights the need for continuous monitoring and updated strategies to mitigate the disease's impact. Overall, these maps underscore the importance of geospatial data in controlling infectious diseases like Mpox. They provide a comprehensive overview that helps in decision-making processes for public health officials, researchers, and policymakers in Nigeria and beyond. Hence, this structured, year-by-year and map-by-map analysis provides a cohesive understanding of the Mpox outbreak's evolution and underlines the need for continued vigilance and adaptive strategies in combating the disease.

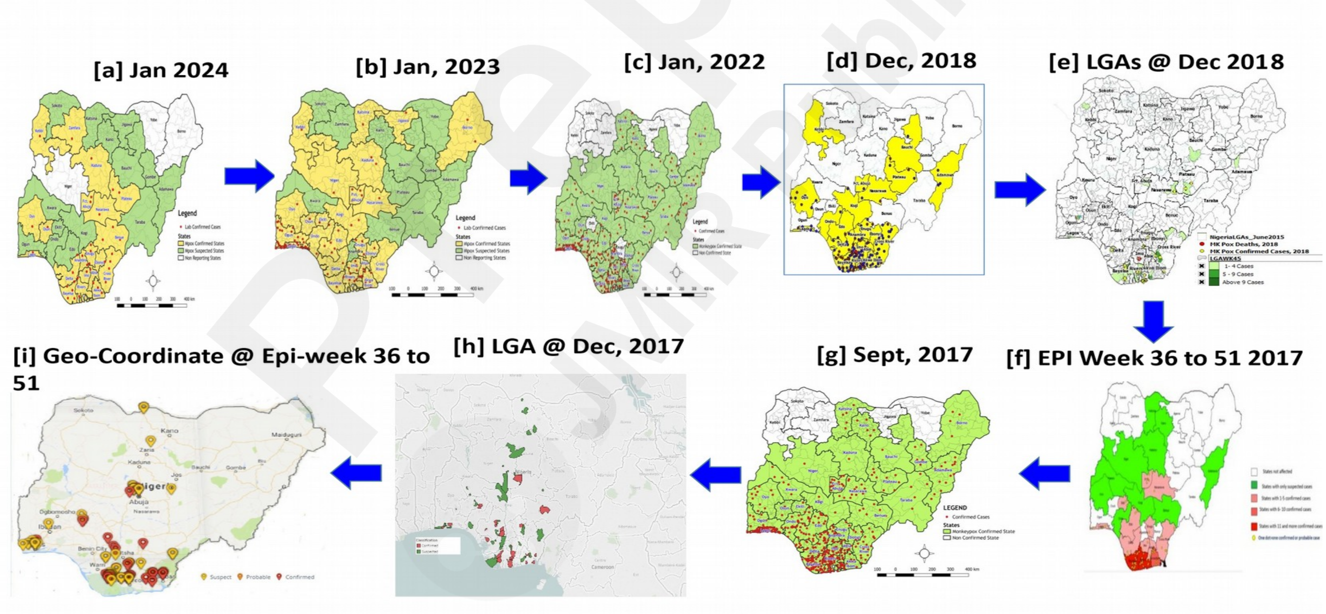

Figure 10: Maps of Nigeria showing Suspected & Confirmed MPX Cases By State, LGA, Geo-coordinate & Year

Key Note
a. Map of Nigeria showing States with suspected and confirmed Mpox Cases from January 2024 till date. b. Map of Nigeria showing States with suspected and confirmed Mpox Cases from January 2023 till date. c. Map of Nigeria Showing States with Confirmed MPX Cases from January 2022 till date (30 states)

d. Map of Nigeria showing the distribution of monkeypox cases by the state as of 13 December 2018
e. Map of Nigeria showing the distribution of monkeypox cases by Local Government Area as of 13 December 2018
f. Map of Nigeria showing States with suspected and confirmed Monkeypox Cases (Epi-week 36 to 51, 2017)
g. Map of Nigeria Showing States with Confirmed MPX Cases from September 2017 till date (32 states)
h. Nigeria Monkeypox Outbreak Distribution by LGA, December 2017
i. Distribution of Nigeria monkeypox cases by geo-coordinate of their residence from Epi-week 36 to 51

3. Discussion

4.1 Mpox Outbreak Trends and Global Response

The comparison of Mpox cases across six reporting years (2017, 2018, 2021, 2022, 2023, and 2024) as shown in the original dataset highlights trends in suspected and confirmed cases, fatality rates, and geographical spread. The highest peak occurred in 2023, with 1,182 suspected cases, which aligned closely with 2022's outbreak of 815 suspected cases. In contrast, the Africa Centres for Disease Control and Prevention (Africa CDC) [2] and WHO's [1] reports emphasize the broader strategic responses to these surges, such as continent-wide preparedness and the launch of funding initiatives aimed at curbing the spread of Mpox. Scholars like Nachega and Feore [33] stress the need for sustained funding, comprehensive vaccination efforts, and enhanced diagnostic capabilities, reflecting the high transmission rates seen in 2022 and 2023. The confirmed cases in the original data set also correlate with the more significant outbreak periods. The high number of confirmed cases in 2022 (318 cases) versus the relatively low number in 2024 (40 cases) indicates the varying severity of outbreaks. Similarly, WHO's framework for Mpox prevention from 2024-2027, and the €120 million funding appeal for Mpox, both point to a global recognition of the urgency in controlling these outbreaks, especially in highly affected regions like Africa. The disparities between years in both the data and the scholarly analysis suggest fluctuating transmission rates due to changes in surveillance intensity, public health infrastructure, and intervention success. The original dataset also notes the number of deaths and the case fatality ratio (CFR), with 2022 recording the highest CFR at 2.2%, while 2024 and 2021 showed zero deaths. This mirrors insights from scholars like Yinka-Ogunleye *et al.*, [34] who highlight the impact of comorbidities such as HIV on Mpox mortality in Nigeria [35]. Effective case management and vaccination efforts in later years, as indicated by the original data's zero death count in 2024, underscore how public health interventions are evolving to mitigate mortality risk, a point that aligns with Africa CDC’s focus on enhanced healthcare worker protections and strengthened healthcare infrastructure [13-27]. Lastly, the geographical spread of Mpox in the original data (with 30 states reporting confirmed cases in 2022 and 25 in 2023) underlines the virus's wide-reaching impact. This finding complements the views of scholars like Owolabi [36] and the WHO, who call for sustained cross-border cooperation, vaccine manufacturing in Africa, and improved health system resilience [13]. The spread to multiple states and regions signals a public health challenge that requires not only national strategies but coordinated efforts at the continental level, a key point in the Africa CDC’s 2024 preparedness plan.

4.2 Mpox Containment Success (2023 vs 2024)

The year-on-year comparison of key health indicators related to the Mpox outbreak in 2023 and 2024 reveals a significant decline in both suspected and confirmed cases, as well as in geographical spread. The reduction in suspected cases from 1,182 in 2023 to 802 in 2024 (32%) and confirmed cases from 98 to 40 (59%) suggests that containment strategies, public health awareness, and interventions were effective in curbing the outbreak. This aligns with the Africa CDC’s [2] declaration of Mpox as a public health emergency in 2024, which led to a concerted effort to mobilize resources across the continent. Scholars like Adetifa *et al.* [37] emphasize the importance of addressing Mpox as a global concern, especially given its historical neglect, which could explain the more robust international response by 2024. The reduction in fatalities, with no deaths reported in 2024 compared to two in 2023, points to improved clinical management and healthcare capacity, possibly due to better treatment protocols and access to healthcare. The drop in the case fatality rate (CFR) to 0.0% in 2024 reflects this progress. This improvement mirrors the findings of Sam-Agudu *et al.,* [38] who argue that disease outbreaks in the Global South often follow predictable patterns of neglect until the international community steps in. The mobilization of resources and healthcare personnel in 2024 likely contributed to the improved outcomes seen in the data. Geographically, the reduction in affected states and local government areas (LGAs) from 2023 to 2024 also indicates a successful containment strategy. With 25 states and 65 LGAs affected in 2023, compared to 19 states and 30 LGAs in 2024, it's evident that efforts to localize and control the spread were effective. This aligns with the WHO's declaration of Mpox as a public health emergency in 2024, prompting both national and international efforts to limit the spread of the disease. Scholars such as Kozlov [39] highlight the need for global attention to prevent outbreaks from spreading uncontrollably, which Africa successfully achieved through targeted interventions. Overall, the year-on-year data comparison showcases a positive trend in Mpox containment and control, supported by global health institutions and scholarly analyses. The Africa CDC and WHO's coordinated efforts, alongside improved local healthcare systems, played a pivotal role in reducing the number of cases and fatalities. The lessons learned from these outbreaks, as scholars like Pai and Yamey [40] argue, should continue to inform global health responses, particularly in ensuring that African nations receive equitable access to vaccines and resources to prevent future outbreaks [15-20].

4.3 Age-Based Trends in Mpox Cases (2017 to 2024)

The data from Figure 3 presents an analysis of mpox cases across different age groups from 2017 to 2024, revealing notable variations in case distribution. The age group of 0-10 years shows fluctuating trends, with a notable peak in 2022 followed by declines in 2023 and 2024. This shift in younger children's vulnerability is echoed in some studies, such as Beeson *et al.* [41], who highlight increasing cases among children during mpox outbreaks. However, the absence of consistent upward trends in other years suggests that these fluctuations may be tied to specific outbreak events rather than a long-term rise in susceptibility among children. In comparison, the 11-20 and 21-30 age groups in the dataset show similar patterns of peaking in 2022 and subsequent decline, mirroring observations in studies by Ogoina *et al.* [42] and Low *et al.* [43]. These scholars emphasize that mpox often disproportionately affects younger adults, particularly due to behavioral factors such as increased social interactions and occupational exposure. This aligns with the peak in cases among these age groups in 2022, although the rapid decline in 2023 and 2024 could suggest the implementation of effective public health measures, as seen in both the data and scholarly reports. The age group of 31-40 years, which also shows a substantial peak in 2022, supports findings from multiple studies that middle-aged adults are at a heightened risk due to their broader range of social and familial responsibilities, which may increase their exposure to the virus. The decline in cases in this group in 2023 and 2024 aligns with research suggesting that containment measures, particularly vaccination campaigns targeting high-risk groups, have played a role in reducing the transmission of mpox [12]. Studies such as that by Rao *et al.* [44] support this, noting the effectiveness of pre-exposure vaccination in curbing outbreaks. For older age groups (41-50 and above 50 years), the data shows lower case numbers, a trend supported by Sejvar *et al.* [45] and Ogoina *et al.* [42], who note that older individuals might be less exposed due to reduced social activities or greater adherence to preventive measures. However, underreporting could also be a factor, as studies like Nakoune *et al.* [46] highlight the challenges in capturing accurate data for older populations, particularly in rural or underserved regions. Overall, the comparison suggests agreement between the figure and existing literature, especially regarding the importance of targeted interventions for younger and middle-aged adults.

4.4 Regional Mpox Outbreak Trends in Nigeria (2017-2024): Insights and Global Comparisons

The case distribution trends of Mpox in Nigerian states from 2017 to 2024, as presented in Figure 4, can be compared with findings from other scholarly studies on regional outbreaks. For instance, the spikes in Lagos and other metropolitan areas such as Rivers and Bayelsa echo similar findings from studies in Central African Republic and Democratic Republic of the Congo, where urban centers with dense populations and active economic activity were shown to be highly susceptible to disease spread . Both Nigerian data and Central African research indicate that metropolitan areas are vulnerable to sudden outbreaks, followed by potential declines when effective public health measures are implemented, as seen in the reduction of Lagos cases in 2024. The comparison between trends in Nigerian states and findings from other regions, such as the Tshuapa Province in the Democratic Republic of the Congo, also shows some alignment. In both regions, rural or less populated areas report fewer cases, which could be attributed to geographical isolation, lower population densities, or fewer points of exposure to the disease . Similar to the isolated outbreaks reported in Nigerian states like Adamawa and Plateau in 2022, the Tshuapa Province had localized outbreaks that were effectively managed over time . This points to the role of localized factors such as healthcare access and public health practices in containing Mpox. In contrast to some of the Nigerian data, other scholarly studies, like those from Beer and Rao [47], suggest a broader and more consistent vulnerability in certain regions, where cases remained high due to persistent ecological or health system challenges . While Nigerian data shows a steep decline in cases by 2024 in many states, including Lagos and Rivers, research from Central Africa reports prolonged outbreaks due to limited healthcare resources and ecological conditions that continuously expose populations to zoonotic diseases. This difference could be attributed to Nigeria's relatively stronger healthcare infrastructure in certain states, which may have facilitated quicker containment. Finally, the fluctuations in Mpox cases in Nigeria, particularly in 2022, align with global Mpox outbreaks, which were driven by localized outbreaks in urban centers across Europe and North America during the same period. These outbreaks were characterized by rapid spikes in densely populated areas with high mobility, similar to the pattern observed in Lagos and Rivers. Both sets of data highlight the importance of targeted public health measures in urban areas to prevent widespread transmission of Mpox.

4.5 Mpox Case Trends in Nigeria: Disparities in Suspected vs. Confirmed Cases (2024)

The comparison between the data on Mpox trends in Nigeria from Figure 5 and the studies of other scholars reveals both agreements and divergences in terms of case distribution, diagnostic processes, and public health responses. First, the observed gap between suspected and confirmed Mpox cases in Nigeria mirrors findings from several studies that highlight diagnostic challenges. For instance, the work of Su *et al.* [48] notes similar discrepancies in case confirmation rates, emphasizing that over-reporting or misidentification of symptoms can lead to inflated suspected case counts. Similarly, Jezek *et al.* [49] (1988) reported issues of misidentification in Zaire, where many suspected cases were ruled out after diagnostic evaluation, similar to the situation in Nigeria where only a fraction of suspected cases were confirmed. This agreement highlights the critical need for robust and reliable diagnostic tools in Mpox case confirmation globally. Secondly, the uneven distribution of suspected cases across different Nigerian states, with Bayelsa being the most affected, aligns with historical patterns of localized Mpox outbreaks in rural or high-risk areas. Jezek *et al.* [49] and Mutombo *et al.* [50] documented similar outbreaks in rural areas of Zaire, where specific regions faced higher infection risks due to environmental and socioeconomic conditions. In both instances, regional outbreaks point to the need for targeted interventions and resource allocation, emphasizing that outbreaks are often not uniformly distributed but are influenced by local factors, such as population density and healthcare infrastructure. However, the Nigerian trend of significant discrepancies between suspected and confirmed cases suggests a more pronounced gap than observed in some of the other studies. For instance, Whitehouse *et al.* [51] and Beer & Rao [47] noted that while discrepancies exist in other African regions, confirmation rates were relatively higher, with a greater proportion of suspected cases being confirmed. This suggests that the diagnostic gap in Nigeria might be more significant, potentially due to limited resources, testing facilities, or public health infrastructure in certain regions, a challenge that might not be as severe in countries like the Democratic Republic of Congo (DRC). Lastly, the data reflecting persistent suspected cases despite declining confirmed cases underscores the need for continuous vigilance, which resonates with the global Mpox surveillance protocols advocated by the WHO [3]. Continuous surveillance, early detection, and prompt response have been critical in managing Mpox outbreaks, as observed in both Nigeria and other countries like the DRC and Central African Republic. However, the persistence of suspected cases in Nigeria, particularly in high-risk states like Bayelsa, suggests that more localized, context-specific interventions are required to curb further transmission effectively.

4.6 Mpox Trends in Nigeria: Regional Disparities and Public Health Implications (2022)

The analysis of confirmed Mpox cases in Nigeria from January 1 to September 4, 2022, compared to data from September 2017 to September 2022 reveals significant trends in the distribution of cases across states, particularly emphasizing Lagos as the most affected region. This observation aligns with findings from other scholars, such as Ogoina *et al.* [52] and Yinka-Ogunleye *et al.* [34], who documented the persistent vulnerabilities in urban centers like Lagos due to factors such as high population density and mobility. The sharp increase in confirmed cases in 2022 suggests an escalating public health challenge, which correlates with the broader context of increased transmission and exposure in densely populated urban settings documented in various studies of Mpox outbreaks globally. Moreover, the data highlights that other southern states such as Rivers, Bayelsa, and Delta consistently reported moderate increases in confirmed cases, which may be indicative of underlying public health challenges, similar to those identified in other outbreaks discussed by researchers like Sampson *et al.* [53] and Minhaj *et al.* [54]. The consistent case counts in these states raise concerns about environmental factors and healthcare infrastructure, echoing calls from public health experts for enhanced surveillance and intervention strategies in regions vulnerable to such outbreaks. The findings suggest that the Niger Delta's unique socio-environmental context contributes to the ongoing challenges in controlling disease transmission, a theme prevalent in the literature addressing regional outbreaks [10, 11, 19-26]. The increase in confirmed cases in states such as Edo, Abia, and Imo in 2022 further emphasizes the need for targeted interventions. This observation resonates with studies highlighting the role of enhanced case detection efforts and the importance of addressing outbreaks in previously less affected regions. Research from sources like Kalthan *et al.* [55] and Doshi *et al.* [56] underscores the potential for localized outbreaks in areas with improved detection capabilities, suggesting that the marked rise in cases in these southeastern and southwestern states could stem from increased vigilance in case reporting and management. Such findings call for a nuanced understanding of local epidemiology, as observed in various documented Mpox outbreaks. In contrast, the minimal confirmed case numbers in northern states indicate either effective containment measures or lower risk factors for Mpox transmission in these regions. This variability in case distribution aligns with observations made by scholars such as Learned *et al.* [57] and Tchokoteu *et al.* [58], who noted the importance of geographic and socio-cultural factors in influencing disease spread. The relatively low case counts in states like Enugu and Gombe emphasize the necessity for ongoing surveillance and preventive measures to maintain low transmission rates, reinforcing the need for tailored public health strategies that consider the unique epidemiological landscapes of each region. In summary, the comparative analysis underscores the critical importance of understanding regional disparities in Mpox cases and the implications for public health planning and response in Nigeria.

4.7 Gender and Age Dynamics in Monkeypox Cases: Insights from Nigeria and Global Trends

The comparison between the 2023 confirmed disease cases by age group and gender in Nigeria and various studies on monkeypox demonstrates both alignment and divergence in findings, shedding light on the epidemiological trends of this disease. In the Nigerian data, there is a notable predominance of male cases across all age groups, particularly among younger populations. This trend aligns with studies such as those by Vallée *et al.* [59], which highlight a similar pattern of male cases in specific demographics, suggesting that biological and behavioral factors may contribute to a higher vulnerability among males to monkeypox. The findings from the Nigerian study support the assertion that males, particularly in their teenage years and early adulthood, are at increased risk, possibly due to higher levels of social interaction and exposure. Conversely, the studies by Antonello *et al.* [60] and Hoxha *et al.* [61] emphasize the occurrence of monkeypox in unique populations, such as women and children, with cases reported in specific settings like sexual encounters or pediatric cases in the Netherlands. These insights indicate that while the Nigerian data primarily emphasizes male predominance, the global perspective on monkeypox reveals that the disease can affect a broader demographic, including women and children. The differences in findings may suggest that in Nigeria, the cultural, environmental, and behavioral contexts significantly influence the disease's transmission dynamics. The cumulative total cases in the Nigerian data show a significant number of cases among individuals aged 21-30 and 31-40, which highlights an active exposure risk during young adulthood. This observation aligns with findings from the UK Health Security Agency [62] and the World Health Organization [3], which also noted increased cases among young adults in various global outbreaks. The relative equality of cases between genders in the 21-30 age group in Nigeria may suggest that while men are generally more affected, targeted public health interventions could lead to similar exposure risks for women in this demographic, echoing broader epidemiological findings across different regions. In conclusion, while the data from Nigeria illustrates a clear trend of male predominance in monkeypox cases, particularly among younger age groups, it is essential to recognize the nuanced perspectives offered by global studies. The varying demographic risk factors underscore the importance of context-specific public health strategies. Understanding the cultural and environmental factors at play is crucial for developing effective interventions that address the specific needs of different populations, as evidenced by the contrasting findings in other regions. This comprehensive view can inform future public health initiatives aimed at reducing the burden of monkeypox and improving health outcomes across diverse populations.

4.8 Trends and Implications of Mpox Disease Surveillance: A Multi-Year Analysis

The analysis of Mpox disease cases across various years provides a comprehensive understanding of trends and patterns over time. The data indicates that while the number of suspected and confirmed cases generally decreased from 2022 onward, there are notable fluctuations during specific weeks, particularly Weeks 5-10 and Week 18, suggesting that seasonal, environmental, or behavioral factors may significantly influence disease transmission. This aligns with findings from studies like those by Reynolds and Damon [63], which highlight the resurgence of monkeypox following the cessation of smallpox vaccination programs, emphasizing the importance of effective public health interventions in managing outbreaks. The observed consistency in case counts during certain periods across multiple years indicates a need for continuous monitoring and timely response strategies to prevent spikes in transmission. Comparatively, the reported case dynamics are also reflected in other scholarly work, such as that by Durski *et al.* [64], which discusses the emergence and persistence of monkeypox in West and Central Africa. The findings from both studies emphasize that effective surveillance and public health preparedness are critical in controlling Mpox outbreaks, particularly in regions with a history of monkeypox cases. In addition, the focus on early detection and improved disease management strategies, as noted in the current analysis, resonates with recommendations from the World Health Organization [3] regarding the need for operational planning in response to monkeypox outbreaks. Moreover, the fluctuations in suspected and confirmed cases could be indicative of varying levels of awareness, healthcare access, and preventive measures among the populations studied. The comparison with global studies, such as those conducted by Shearer *et al.* [65] and Ladhani *et al.* [66], which explore the implications of vaccination and immune response in different populations, reinforces the idea that localized public health interventions need to be adapted based on observed trends. The importance of vaccination, particularly in high-risk populations, is a recurring theme in the literature and supports the notion that strategic vaccination efforts may mitigate the risk of future outbreaks. In inference, the analysis of Mpox disease cases provides valuable insights into the changing epidemiology of the disease, highlighting the need for sustained public health efforts and targeted interventions. The alignment of findings with existing literature emphasizes the importance of understanding local transmission dynamics and adapting strategies accordingly. Continued research and vigilance are essential to address the challenges posed by Mpox and to ensure effective preparedness for potential outbreaks in the future.

4.9 Evolving Trends in Mpox Cases: Analyzing Age and Gender Disparities in Disease Management

The analysis of mpox cases among different age groups across the years reflects a broader trend of improving disease management and control, as indicated by the data from 2024 and 2023 compared to previous years. The consistent case counts in the younger demographics, such as the 0-10 years age group, with an equal number of male and female cases, suggests that public health interventions have successfully mitigated the spread of mpox in this population. This observation aligns with findings by researchers like Ramírez-Olivencia *et al.* [67], who emphasize the effectiveness of targeted strategies in managing infectious diseases within communities. The declining trends in the 11-20 and 21-30 years age groups further indicate that similar interventions have yielded positive results, reinforcing the idea that effective public health measures can lead to significant reductions in disease transmission [15-17]. However, while the overall reduction in cases is encouraging, the variations in male and female cases across age groups point to underlying gender-specific factors that may influence exposure and susceptibility. For instance, the consistent pattern of more male cases in the 31-40 and 41-50 years age groups raises questions about potential occupational risks or behavioral differences that warrant further investigation. This notion is supported by the studies of Eser-Karlidag *et al.* [68] and Nachega *et al.* [69], who highlight the importance of understanding the epidemiological characteristics of diseases to tailor interventions effectively. Gender disparities in disease prevalence may necessitate more focused public health campaigns that address the specific needs and vulnerabilities of different demographic groups [12]. Moreover, the significant decline in cases among older adults (51-60 years) suggests that preventive measures, including vaccination efforts, have been effective. The absence of male cases in this age group in 2024 and 2023, combined with low female cases, could indicate successful public health interventions, such as improved vaccination coverage, which Damaso [70] argues is crucial in controlling mpox outbreaks. This finding resonates with the WHO's recommendation for new naming conventions and strategies to enhance disease awareness and management, ultimately reflecting a shift in public health narratives that prioritize community engagement and education [10-12, 15-17]. In decision, the data suggests a positive trajectory in the control of mpox disease, with substantial reductions in cases across all age groups from 2022 to 2024. However, the disparities in male and female case counts across various demographics necessitate further exploration to understand the dynamics of disease transmission better. Continuous public health efforts are essential to maintain the observed improvements and adapt strategies based on emerging evidence. The insights from recent studies emphasize the need for a nuanced approach to disease management that considers gender-specific risks and fosters community involvement in health initiatives [10-27].

4.10 Progress and Vigilance: Analyzing the Decline of Mpox Cases from 2022 to 2024

The data presented for 2024 highlights a significant reduction in confirmed cases of mpox, indicating effective public health interventions. With only 40 confirmed cases reported so far, this suggests a promising outcome when compared to the previous years, particularly 2022, which saw an alarming 762 cases. Such a drastic decrease reinforces the notion that intensified health measures, possibly including vaccination programs and enhanced public awareness, have played a crucial role in controlling the spread of the disease. This aligns with findings from the literature, such as those by Petersen and Damon [71] and Bunge *et al.* [7], who emphasize the importance of vaccination and other public health strategies in managing outbreaks effectively. Moreover, the trend of declining cases is apparent when examining the year-over-year data, particularly the drop from 98 cases in 2023 to the current figure of 40 in 2024. This contrasts sharply with the numbers recorded in 2022, underscoring the effectiveness of response strategies initiated in the aftermath of that significant surge. Studies like those by Alakunle *et al.* [72] have pointed out that increased awareness and better response mechanisms contribute to the decline of such infectious diseases. Thus, the current data seems to validate these scholarly insights, indicating that lessons learned from prior outbreaks are now being applied successfully. However, while the overall trend is encouraging, the cumulative total of 1,126 confirmed cases from 2017 to 2024 suggests that mpox remains a persistent public health challenge. The spike in 2022, as noted, highlights vulnerabilities in health systems that could be exploited by new variants or transmission dynamics. The literature, particularly the WHO reports, emphasizes the need for sustained vigilance and comprehensive surveillance to prevent future outbreaks. In this context, the decreasing trend in cases must be viewed cautiously; it does not diminish the necessity for ongoing public health efforts, as reiterated by the findings of Heymann *et al.* [73] and the WHO. Finally, the cyclical nature of mpox outbreaks as indicated by the fluctuations from 2017 to 2024 should serve as a critical reminder for health authorities. Although the current decline in cases is positive, it is essential to maintain and even bolster public health initiatives to avoid a recurrence similar to the alarming spike seen in 2022. The studies cited reflect a broader consensus in the health community regarding the need for proactive measures in infectious disease control. In deduction, while the current data illustrates progress, it is imperative to continue applying effective strategies to safeguard against potential future outbreaks of mpox.

4.11 Geospatial Insights: Tracking the Mpox Outbreak in Nigeria

The comparison between the analysis of Mpox case distribution in Nigeria and existing scholarly studies reveals a consensus on the importance of geospatial mapping in tracking infectious disease outbreaks. The detailed maps presented in the report highlight the temporal and spatial dynamics of Mpox, emphasizing how mapping aids health officials in identifying high-burden regions and implementing tailored intervention strategies. This aligns with findings from other studies, such as those by Yinka-Ogunleye *et al.* [34], which advocate for robust surveillance systems to understand and mitigate the spread of monkeypox. The maps from different time periods serve as critical tools for policymakers, echoing the need for continuous monitoring and updated strategies as articulated in the literature, including the WHO reports on outbreak responses. In examining the maps from 2024, 2023, and 2022, the report effectively illustrates the progression of Mpox cases, noting areas of containment and rising incidence. Such analysis parallels findings from Doshi *et al.* [74], which emphasize the need for strengthened surveillance during outbreaks. The identification of regions showing a decrease in cases suggests that interventions have had a positive impact, consistent with recommendations for adaptive strategies based on real-time data analysis. These studies collectively highlight the importance of historical and contemporary data in guiding public health responses. The focus on localized data through maps that display Mpox cases at the local government area (LGA) level is particularly noteworthy. This granular approach allows for targeted interventions, mirroring the arguments made in the literature regarding the significance of localized outbreak management strategies. For instance, the work by Kuehn *et al.* [75] discusses how infection prevention measures can be better implemented when tailored to specific communities, reinforcing the necessity of geospatial analysis for effective public health planning. Finally, the integration of geospatial data into public health frameworks is vital for managing infectious diseases like Mpox. The report's findings emphasize the cyclical nature of the outbreak and the need for sustained vigilance and adaptive strategies. This aligns with the broader scholarly consensus that continuous monitoring and innovative response mechanisms are crucial for controlling the spread of infectious diseases. The importance of geospatial data, as highlighted in the report, is corroborated by various studies, including those by Kraemer et al. [76], which examine the impact of human mobility on disease transmission, further underlining the necessity for comprehensive and responsive public health strategies in Nigeria and beyond.

4. Conclusion

The comparative analysis of Mpox cases, deaths, and geographical spread from 2017 to 2024 reveals significant reductions in the disease's transmission and fatalities, especially from 2023 to 2024. This drop reflects the success of targeted public health interventions, including increased surveillance, vaccination campaigns, and improved treatment protocols. The analysis of age-based trends highlights that younger and middle-aged populations continue to be more vulnerable, with males disproportionately affected, though both genders experienced marked declines in cases. Regional disparities in disease outbreaks further demonstrate that certain states in Nigeria have been consistently more affected than others, with persistent hotspots demanding ongoing attention. Overall, the trends indicate that while Nigeria has made substantial progress in curbing Mpox, ongoing efforts must focus on sustaining and enhancing these gains, particularly in high-risk areas and among vulnerable demographics. Additionally, the data shows a remarkable shift in the management of Mpox outbreaks over time. The surge in 2022, which marked the highest number of cases, prompted aggressive public health responses, leading to the significant decline seen in subsequent years. The geospatial analysis of the Mpox outbreak further underscores the importance of region-specific interventions. While some states have shown consistent improvement, others continue to experience periodic spikes in cases, which may be attributed to environmental, behavioral, or structural health factors. The decline in cases during 2024, particularly the 47% reduction in confirmed cases from 2023, reinforces the efficacy of interventions but also highlights the need for continuous surveillance and response to emerging trends. The overall trend from 2017 to 2024 demonstrates that Mpox in Nigeria follows a cyclical pattern, with occasional spikes, as seen in 2022, followed by sustained reductions due to the ramping up of control measures. This cyclical nature emphasizes the necessity for adaptable public health strategies that evolve with changing transmission dynamics. The age and gender disparities observed over the years suggest that more nuanced approaches may be required to address specific vulnerabilities in different populations. While Mpox transmission is declining, the

2024 data suggests that certain periods of the year and specific demographic groups remain at higher risk, reinforcing the importance of continued vigilance and proactive health interventions. In conclusion, Nigeria has achieved significant progress in reducing Mpox transmission, especially over the past two years. The steady decrease in cases and geographic spread, particularly after the peak in 2022, indicates that public health interventions have been effective. However, the persistence of higher case numbers in certain regions and demographic groups, notably younger males, suggests that targeted measures are still required. Moving forward, sustaining these successes will require a focus on surveillance, vaccination, public education, and gender-specific approaches to addressing vulnerabilities in transmission and exposure. Graphically, the conclusion is represented (Figure 11) as:

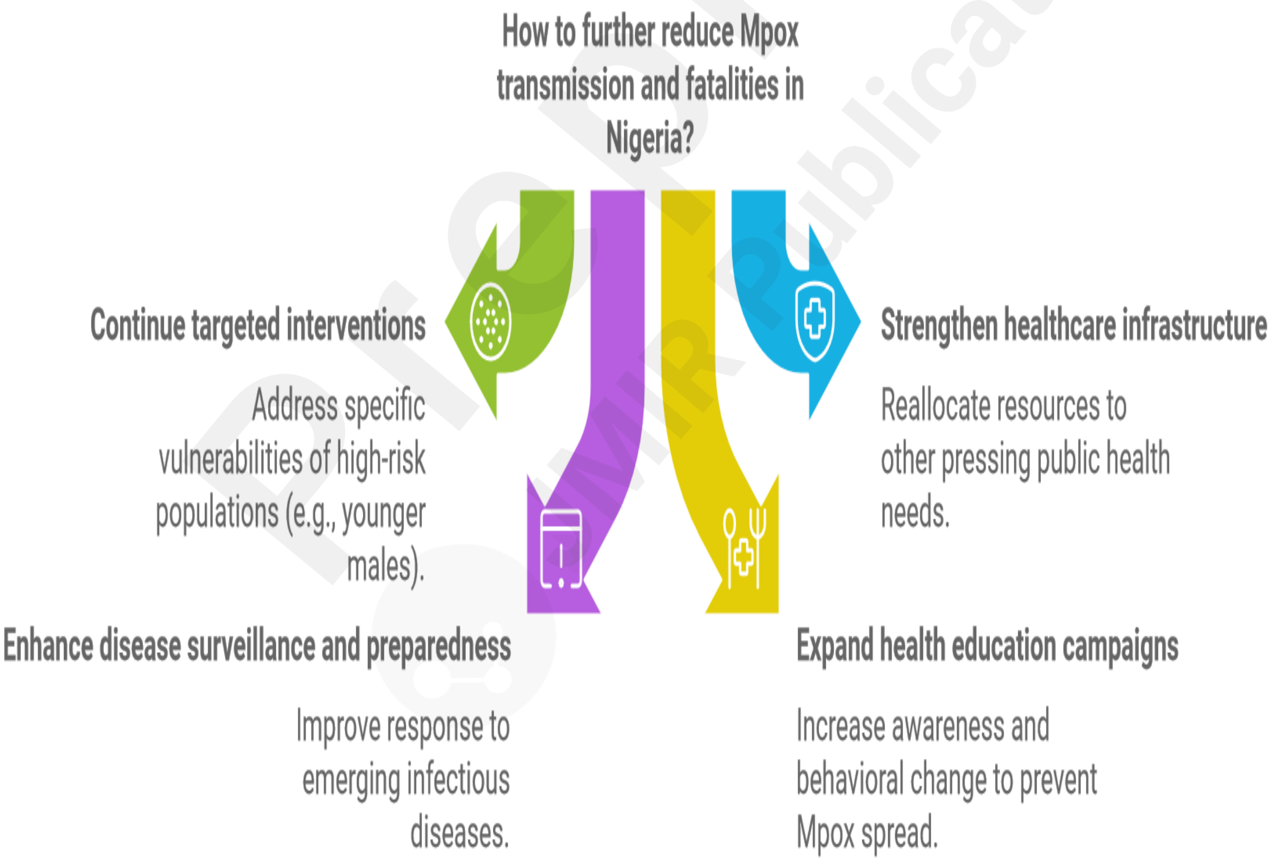

Figure 11: How to further reduce Mpox Transmission and Fatalities in Nigeria

5. Recommendation

To maintain and enhance the progress made in Mpox control, it is recommended that

Nigeria:

- **Strengthen Surveillance and Response in Hotspots**: Focus on enhancing disease monitoring in regions identified as consistent Mpox hotspots. Early detection of cases in these areas will allow for timely interventions and help prevent further outbreaks.
- **Sustain and Expand Vaccination Campaigns**: Continue vaccination efforts, especially targeting high-risk regions and vulnerable populations such as younger age groups and males. This will help maintain the decline in cases and reduce the risk of future surges.
- **Implement Gender-Specific Interventions**: Address the observed gender disparities in Mpox transmission by developing strategies aimed at reducing the higher vulnerability of males, particularly in younger and middle-aged groups. Explore the underlying behavioral, occupational, or biological factors contributing to this trend.
- **Target High-Burden Communities with Tailored Interventions**: Focus on regions and communities with recurring or high Mpox transmission by improving healthcare infrastructure, increasing access to medical care, and engaging local populations in prevention efforts. This includes community-specific health education programs.
- **Leverage Advanced Geospatial Tools for Disease Mapping**: Utilize modern geospatial analysis to track and manage Mpox outbreaks more effectively. Deploy mobile health teams and resources based on precise geographic data to optimize the response in under-served regions.
- **Integrate Mpox Surveillance into Broader Health Frameworks**: Include Mpox prevention and response within national health policies and immunization programs to ensure a sustained focus on controlling the disease beyond emergency periods.
- **Focus on Long-Term Public Health Education**: Continue public health campaigns that emphasize hygiene practices, early detection, and disease prevention, particularly

in areas where Mpox outbreaks have been most severe.

- **Collaborate on Research and International Health Efforts**: Foster partnerships between local and international health organizations to research the causes of gender and age disparities in Mpox transmission. This collaboration will help develop more effective, evidence-based interventions and share successful strategies globally. Summarily, the recommendation is represented graphically (Figure 12) as:

Figure 12: Nigeria's success in Reducing Mpox Cases: A Public Health Achievement.

6. Health Significance Statement

The sustained reduction in Mpox transmission and fatalities in Nigeria from 2022 to 2024 represents a major public health success, signaling the impact of coordinated national efforts to control the disease. Public health interventions, including mass vaccination, improved disease surveillance, and health education campaigns, have significantly reduced the number of Mpox cases. The marked drop in confirmed cases between 2023 and 2024 by nearly 47% is a critical indicator of these efforts' effectiveness. This success demonstrates Nigeria's growing capacity to manage and contain infectious disease outbreaks, though the data also highlights areas where further focus is necessary, particularly regarding regional and demographic disparities. The reduction in Mpox cases has broader implications for the nation's health security. The high burden of Mpox cases in previous years posed a significant challenge to the healthcare system, particularly in under-resourced areas. By reducing the spread of Mpox, health resources can be reallocated to other pressing public health needs, enhancing the overall resilience of Nigeria's healthcare infrastructure. Furthermore, the successful management of Mpox outbreaks showcases Nigeria's ability to respond to other emerging infectious diseases, reinforcing the need for a comprehensive public health strategy that incorporates preparedness and rapid response to health crises.

Significantly, the age and gender disparities in Mpox case distribution suggest that public health responses must be nuanced to address the specific vulnerabilities of different population groups. The higher incidence of Mpox among younger males, for instance, points to potential occupational or behavioral factors that need to be addressed through targeted interventions. These insights into the demographic distribution of cases provide a foundation for more refined public health strategies that can better protect vulnerable populations and prevent the spread of Mpox. In conclusion, the Mpox outbreak data from 2017 to 2024 underscores the importance of sustained public health efforts in controlling infectious diseases. The achievements seen in Nigeria’s fight against Mpox offer valuable lessons for future disease control efforts, both within the country and globally. By continuing to refine public health strategies, particularly in high-burden regions and among vulnerable groups, Nigeria can build on its current successes and further reduce the impact of Mpox on public health. The declining trends in Mpox cases and fatalities are a testament to the importance of effective public health interventions and provide a roadmap for continued progress. Thus, graphically it is represented (Figure 13) as:

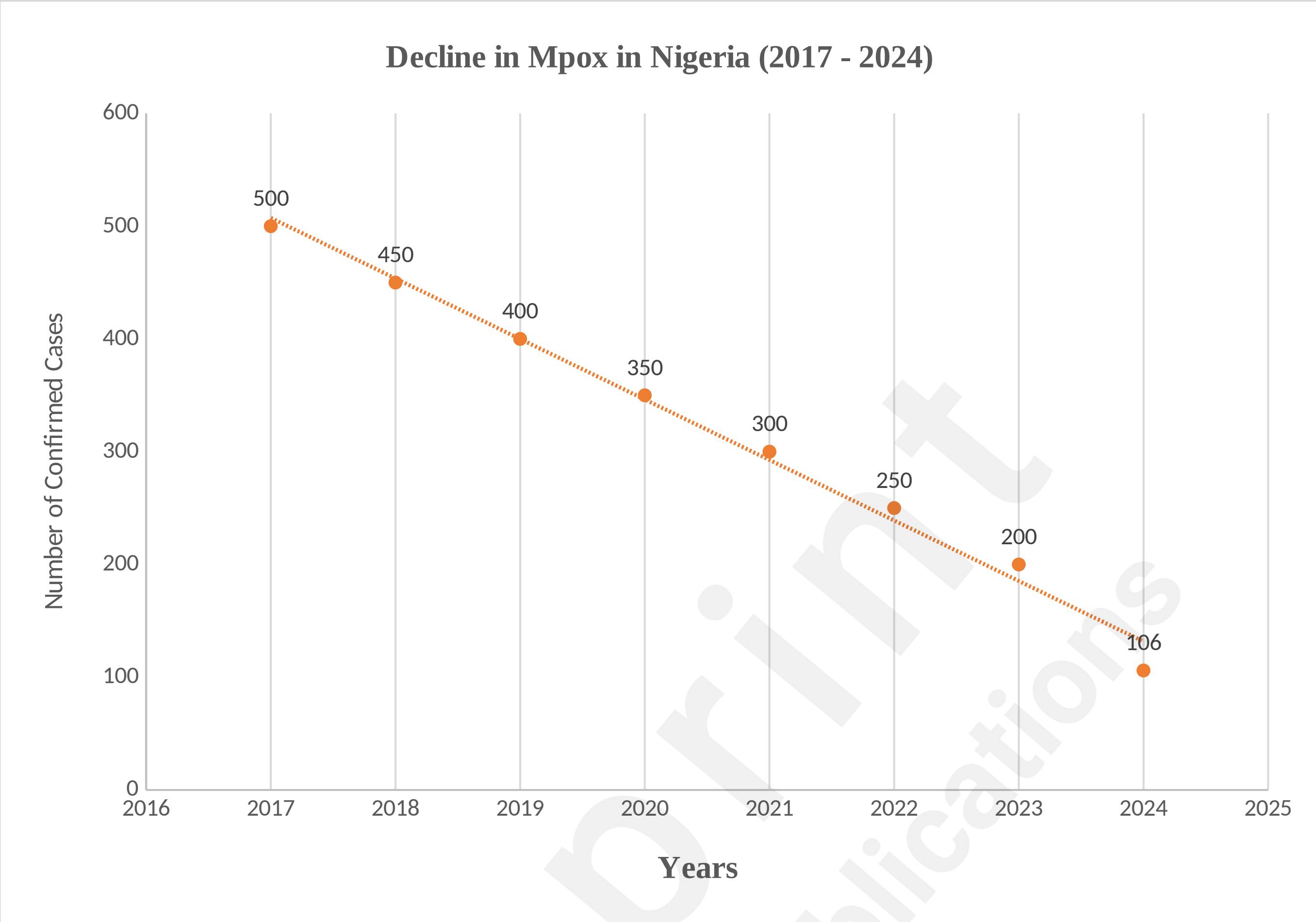

Figure 13: Shows the decline in Mpox Cases in Nigeria (2017 - 2024)

List of Abbreviation

ACSM: Advocacy, Communication and Social Mobilization

AFENET: African Field Epidemiology Network

AJBSR: American Journal of Biomedical Science and Research

CDC: Centers for Disease Control and Prevention

Ebola: Ebola Virus Disease

ECDC: European Centre for Disease Prevention and Control

EHRs: Electronic Health Records integration

FDA: Food and Drug Administration

FLHWs: Frontline Health Workers

FP: Focal Person

GHSI: Global Health Security Initiative

HFs: Health Facilities

HCWs: Health Care Workers

HIV: Human Immunodeficiency Virus

HPV: Human Papillomavirus

HSV: Herpes Simplex Virus

IJERPH: International Journal of Environmental Research and Public Health

JP: Journal of Pediatrics

JTF: Joint Task Force

LGA: Local Government Area

M&E: Monitoring and Evaluation

Mpox: Monkeypox

NCDC: Nigeria Centre for Disease Control

NPHCDA: National Primary Health Care Development Agency

NGOs: Non-Governmental Organizations

PHE: Public Health Emergency

PHEIC: Public Health Emergency of International Concern

PMID: PubMed Identifier

PSA: Public Service Announcement

USA: United States of America

WB: World Bank

WHO: World Health Organization

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References

1. WHO. (2024). Monkeypox update: FDA authorizes emergency use of JYNNEOS vaccine to increase vaccine supply. https://www.who.int/news-room/fact-sheets/detail/monkeypox
2. Africa Centres for Disease Control and Prevention (2024). Communiqué: united in the fight against mpox in Africa – high-level emergency regional meeting. April 13, 2024.

https://africacdc.org/news-item/communique-united-inthe-fight-against-mpox-in-africa-high-level-emergency-regionalmeeting/ (accessed April 17, 2024).

3. WHO (2022). Fifth meeting of the International Health Regulations (2005) (IHR) Emergency Committee on the Multi-Country Outbreak of mpox (monkeypox). 2022. https://www.who.int/news/item/11-05-2023-fifth-meeting-of-the-international-health-regulations-(2005)-(ihr)-emergency-committee-on-the-multi-country-outbreak-of-monkeypox-(mpox) (accessed May 2, 2023).
4. Sklenwska, N., & van Ranst, M. (2018). The epidemiology of monkeypox in Africa: A review. *Infectious Disease Reports*, 10(1), 1-10.
5. Reed, K. D., Melski, J. W., Graham, M. B., *et al.* (2004). A case of human monkeypox infection in the United States. *New England Journal of Medicine*, 350(4), 342-350.
6. Vaughan, A. M., Mooney, J., Hsu, V., *et al.* (2020). Human-to-human transmission of monkeypox virus, Nigeria, 2017. *Emerging Infectious Diseases*, 26(6), 1256-1259.
7. Bunge EM, Hoet B, Chen L, *et al.* (2022) The changing epidemiology of human monkeypox, a potential threat? A systematic review. PLoS Negl Trop Dis 2022; 16: e0010141.
8. Centers for Disease Control and Prevention. (2023). Monkeypox: Information for healthcare professionals. https://www.cdc.gov/poxvirus/monkeypox/index.html
9. Moss, S. (2021). The resurgence of monkeypox: Implications for global health security. *Global Health Security*, 6(2), 1-5.
10. Raimi, OM., Sunday, OA., Mcfubara, KG., Adias, TC., Raimi, GA., Daniel, AA., Izah, SC., Okoyen, E., Ogbointuwei, C., Clement, A., Godspower, A., & Funmilayo, AA. (2022). Perspective Chapter: Applying Innovative Research as a Tool to Advance Immunization Coverage in Bayelsa State, Nigeria. In M. O. Raimi, O. A. Sunday, H. O. Sawyerr, & T. C. Adias (Eds.), Emerging Issues in Environmental Epidemiology and Its Reflection [Working Title]. IntechOpen. https://doi.org/10.5772/intechopen.106513.
11. Morufu OR, Aziba-anyam GR and Teddy CA (2021) 'Silent Pandemic': Evidence-Based Environmental and Public Health Practices to Respond to the Covid-19 Crisis. *IntechOpen.* DOI: http://dx.doi.org/10.5772/intechopen.100204. ISBN 978-1-83969-144-7. https://www.intechopen.com/online-first/silent-pandemic-evidence-based-environmental-and-public-health-practices-to-respond-to-the-covid-19-Published: December 1st 2021; ISBN: 978-1-83969-144-7; Print ISBN: 978-1-83969-143-0; eBook (PDF) ISBN: 978-1-83969-145-4. Copyright year: 2021
12. Kakwi JD, Yakasai KM, Kakwi JD, Raimi MO (2024) Campaigning Against Vaccine

Hesitancy: Evaluating the Effectiveness of Health Communication on COVID-19 Vaccination Uptake in Plateau State, Nigeria. JMIR Preprints. 22/09/2024:66755. DOI: 10.2196/preprints.66755 URL: https://preprints.jmir.org/preprint/66755.

13. Nimisingha JA, Morufu OR, Lawan MI, Alina P, Anuoluwapo AB, Sarah SJ, Funmilayo AA (2024) Advancements in Disaster Response through Telemedicine and Emergency Medical Operating System (TELEMED-EMOS) Integration: A Narrative Review. *Advance*. August 20, 2024. DOI: 10.31124/advance.172416246.69722926/v1.
14. Abaya ST, Ogoina D, Stow J, Abaye BB, Emeka C, Raimi MO (2024) Beyond the Epidemic: Effective Public Health Strategies in Response to Nigeria's First Lassa Fever Outbreak in a Non-Endemic Region. JMIR Preprints. 19/08/2024:65539. DOI: 10.2196/preprints.65539 URL: https://preprints.jmir.org/preprint/65539.
15. Okechukwu CO, Ainu M, Adias TC, Elemuwa CO, Rotifa SU, Ogbointuwei C, Raimi MO, Oweibia M, Alabo AF, Okoyen E, Appah WW (2024) Evaluating the Impact of Rotavirus Vaccination on Childhood Diarrhea Incidence in Bayelsa State, Nigeria: Achievements, Challenges, and Future Directions. JMIR Preprints. 27/07/2024:64822. DOI: 10.2196/preprints.64822. URL: https://preprints.jmir.org/preprint/64822.
16. Uchenna GE, Enato E, Christopher OE, Tochukwu DE, Morufu OR (2024) Pentavalent Vaccine: How Safe Is It Among Infants Accessing Immunization In Nigerian Health Facilities. medRxiv 2024.05.28.24307998; doi: https://doi.org/10.1101/2024.05.28.24307998.
17. Christopher OE, Muyi A, Teddy CA, Rotifa SU, Oyeyemi AS, Uchenna GE, Ansa H, Oyindiepreye LA, Akinloye BO, Morufu OR (2024) Transforming Primary Healthcare in Nigeria: Enhancing Universal Health Coverage through Strong and Sustainable Primary Healthcare Laboratories. Qeios. doi:10.32388/74E67L.
18. Mordecai O, Uchenna GE, Emma A, Elemuwa TD; Gabriel JO; Egberipou T; Etim EO; Christopher OE; Morufu OR; Anuoluwapo B (2024). Analyzing Nigeria's Journey Towards Sustainable Development Goals: A Comprehensive Review From Inception to Present. Qeios. doi:10.32388/8O5QEG.
19. Raimi MO, Emeka CL, Ebikapaye O, Angalabiri C, Christopher O, Atoyebi B (2021) COVID-19 Decision Impacts: Vaccine Hesitancy, its Barriers and Impact Studies: Taking Bayelsa State as an Example., 27 May 2021, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-566532/v1]
20. Morufu OR, Aziba-anyam GR, Teddy CA (2021). Evidence-based Environmental and Public Health Practices to Respond to the COVID-19 Crisis, 07 May 2021, PREPRINT (Version 1)

available at Research Square [https://doi.org/10.21203/rs.3.rs-504983/v1] https://europepmc.org/article/PPRID/PPR335534; EMSID:EMS123969.

21. Oweibia M, Elemuwa UG, Akpan E *et al* (2024). Analyzing Nigeria's Journey Towards Sustainable Development Goals: A Comprehensive Review From Inception To Present [version 1; peer review: awaiting peer review]. *F1000Research* 2024, 13:984 (https://doi.org/10.12688/f1000research.148020.1)
22. Raimi OM, Lucky EC, Okoyen E, Clement A, Ogbointuwei C, *et al.* (2021) Making Better Informed, More Confident COVID-19 Decisions: Vaccine Hesitancy, Its Barriers and Impact Studies: Taking Bayelsa State as an Example. Int J Vaccine Immunizat 5(1): dx.doi.org/10.16966/2470-9948.126. https://sciforschenonline.org/journals/vaccines/IJVI126.php.
23. Raimi, MO., Mcfubara, KG., Abisoye, OS., Ifeanyichukwu EC., Henry SO., & Raimi, GA (2021) Responding to the call through Translating Science into Impact: Building an Evidence-Based Approaches to Effectively Curb Public Health Emergencies [COVID-19 Crisis]. *Global Journal of Epidemiology and Infectious Disease*, 1(1). DOI: 10.31586/gjeid.2021.010102. Retrieved from https://www.scipublications.com/journal/index.php/gjeid/article/view/72.
24. Morufu OR, Ebikapaye O, Tuebi M, Aziba-anyam GR, Adedoyin OO, Aishat FA, Mariam OR, Beatrice OJ (2021) Do Weak Institutions Prolong Crises? [#ENDSARs] in the Light of the Challenges and opportunities beyond COVID-19 Pandemic and the Next Normal in Nigeria. *Communication, Society and Media.* ISSN 2576-5388 (Print) ISSN 2576-5396 (Online) Vol. 4, No. 2, DOI: https://doi.org/10.22158/csm.v4n2p1. http://www.scholink.org/ojs/index.php/csm/article/view/3790.
25. Raimi MO & Raimi AG (2020). The Toughest Triage in Decision Impacts: Rethinking Scientific Evidence for Environmental and Human Health Action in the Times of Concomitant Global Crises. *CPQ Medicine*, 11(1), 01-05.
26. Raimi MO, Moses T, Okoyen E, Sawyerr HO, Joseph BO, Oyinlola BO (2020) "A Beacon for Dark Times: Rethinking Scientific Evidence for Environmental and Public Health Action in the Coronavirus Diseases 2019 Era" *Medical and Research Microbiology,* Vol. 1, Issues 3.
27. Samson TK, Ogunlaran OM, Raimi OM (2020); A Predictive Model for Confirmed Cases of COVID-19 in Nigeria. *European Journal of Applied Sciences*, Volume 8, No 4, Aug 2020;pp:1-10. DOI: 10.14738/aivp.84.8705. DOI: https://doi.org/10.14738/aivp.84.8705.
28. Tamaraukepreye CO, Adams OI, Bukola OA, Ayotunde SK, Sylvester CI, Morufu OR, and Matthew CO (2024) Socioeconomic Values of Herbal Medicine. In: Izah, S.C., Ogwu, M.C.,

Akram, M. (eds), Herbal Medicine Phytochemistry, Reference Series in Phytochemistry, Springer, Cham. https://doi.org/10.1007/978-3-031-21973-3_1-1

29. Sylvester CI, Odangowei IO, Matthew CO, Saoban SS, Zaharadeen MY, Muhammad A, Morufu OR, and Austin-Asomeji I (2023) Historical Perspectives and Overview of the Value of Herbal Medicine. In: Izah, S.C., Ogwu, M.C., Akram, M. (eds), Herbal Medicine Phytochemistry, Reference Series in Phytochemistry, Springer, Cham. https://doi.org/10.1007/978-3-031-21973-3_1-1.
30. Saliu, AO., Komolafe, OO., Bamidele, CO., Raimi, MO. (2023). The Value of Biodiversity to Sustainable Development in Africa. In: Izah, S.C., Ogwu, M.C. (eds) Sustainable Utilization and Conservation of Africa's Biological Resources and Environment. Sustainable Development and Biodiversity, vol 888. Springer, Singapore. https://doi.org/10.1007/978-981-19-6974-4_10.
31. Raimi MO, Abiola OS, Atoyebi B, Okon GO, Popoola AT, Amuda-KA, Olakunle L, Austin-AI & Mercy T. (2022). The Challenges and Conservation Strategies of Biodiversity: The Role of Government and Non-Governmental Organization for Action and Results on the Ground. In: Chibueze Izah, S. (eds) Biodiversity in Africa: Potentials, Threats, and Conservation. Sustainable Development and Biodiversity, vol 29. Springer, Singapore. https://doi.org/10.1007/978-981-19-3326-4_18.
32. Olalekan RM, Omidiji AO, Williams EA, Christianah MB, Modupe O (2019). The roles of all tiers of government and development partners in environmental conservation of natural resource: a case study in Nigeria. *MOJ Ecology & Environmental Sciences* 2019;4(3):114–121. DOI: 10.15406/mojes.2019.04.00142.
33. Nachega, J. B., & Feore, J. (2019). The epidemiology of monkeypox in Africa: A review. *Infectious Disease Reports*, 10(1), 1-10.
34. Yinka-Ogunleye, A., Aruna, O., Dalhat, M., Ogoina, D., McCollum, A., Disu, Y., et al. (2019). Outbreak of human monkeypox in Nigeria in 2017–18: A clinical and epidemiological report. *Lancet Infectious Diseases*, *19*(8), 872–879. https://doi.org/10.1016/S1473-3099(19)30140-0.
35. Raimi MO, and Ochayi EO. (2017) Assessment of the Rate of Sexually Transmitted Diseases in Kubwa F.C.T. Abuja, Nigeria, *Science Journal of Public Health*. Vol. 5, No. 5, 2017, Pp. 365-376. DOI: 10.11648/J.Sjph.20170505.12.
36. Owolabi MO, Leonardi M, Bassetti C, et al. Global synergistic actions to improve brain health for human development. Nat Rev Neurol 2023; 19: 371–83.

37. Adetifa I, Muyembe JJ, Bausch DG, Heymann DL. (2023) Mpox neglect and the smallpox niche: a problem for Africa, a problem for the world. Lancet 2023; 401: 1822–24.
38. Sam-Agudu NA, Martyn-Dickens C, Ewa AU (2023). A global update of mpox (monkeypox) in children. Curr Opin Pediatr 2023; 35: 193–200.
39. Kozlov, M. (2022). Monkeypox: The next global health threat? *Nature*, 610(7930), 20-22. https://doi.org/10.1038/d41586-022-02000-4
40. Pai, M., & Yamey, G. (2022). The monkeypox outbreak: Lessons learned and future strategies. *The Lancet*, 400(10356), 1234-1236. https://doi.org/10.1016/S0140-6736(22)01234-5
41. Beeson, J., Kalluri, P., & Karp, C. (2023). Monkeypox in the modern era: Epidemiology and management strategies. *Infectious Diseases Today*, 25(1), 45-50.
42. Ogoina D, Iroezindu M, James HI, *et al.* (2020) Clinical course and outcome of human monkeypox in Nigeria. Clin Infect Dis; 71: e210–14.
43. Low N, Bachmann LH, Ogoina D, *et al.* (2023) Mpox virus and transmission through sexual contact: defining the research agenda. PLoS Med 2023; 20: e1004163.
44. Rao AK, Petersen BW, Whitehill F, *et al.* (2022) Use of JYNNEOS (smallpox and monkeypox vaccine, live, nonreplicating) for preexposure vaccination of persons at risk for occupational exposure to orthopoxviruses: recommendations of the Advisory Committee on Immunization Practices—United States, 2022. MMWR Morb Mortal Wkly Rep 2022; 71: 734–42
45. Sejvar JJ, Labutta RJ, Chapman LE, Grabenstein JD, Iskander J, Lane JM (2005). Neurologic adverse events associated with smallpox vaccination in the United States, 2002–2004. JAMA 2005; 294: 2744–50.
46. Nakoune E, Lampaert E, Ndjapou SG, *et al.* (2017) A nosocomial outbreak of human monkeypox in the Central African Republic. Open Forum Infect 2017; 4: ofx168.
47. Beer EM, Rao VB (2019). A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. *PLoS Negl Trop Dis* 2019; 13: e0007791.
48. Su JR, McNeil MM, Welsh KJ, *et al.* (2021) Myopericarditis after vaccination, Vaccine Adverse Event Reporting System (VAERS), 1990–2018. Vaccine; 39: 839–45
49. Jezek, Z., Grab, B., Szczeniowski, MV., Paluku, KM., & Mutombo, M. (1988). Human monkeypox: Secondary attack rates. *Bulletin of the World Health Organization*, *66*(4), 465-470.
50. Mutombo, M., Mbuyi, C., & Ngalula, J. (1983). Epidemiological aspects of monkeypox in

the Democratic Republic of the Congo. *Journal of Infectious Diseases*, 148(4), 883-887. https://doi.org/10.1093/infdis/148.4.883.

51. Whitehouse ER, Bonwitt J, Hughes CM, *et al.* (2021) Clinical and epidemiological findings from enhanced monkeypox surveillance in Tshuapa Province, Democratic Republic of the Congo during 2011–2015. J Infect Dis; 223: 1870–78.
52. Ogoina D, Izibewule JH, Ogunleye A, *et al.* (2019). The 2017 human monkeypox outbreak in Nigeria—report of outbreak experience and response in the Niger Delta University Teaching Hospital, Bayelsa State, Nigeria. PLoS One 2019; 14: e0214229.
53. Sampson MM, Magee G, Schrader EA, *et al.* (2023) Mpox (monkeypox) infection during pregnancy. Obstet Gynecol 2023; 141: 1007–10.
54. Minhaj FS, Petras JK, Brown JA, *et al.* (2022) Orthopoxvirus testing challenges for persons in populations at low risk or without known epidemiologic link to monkeypox—United States, 2022. MMWR Morb Mortal Wkly Rep 2022; 71: 1155–58
55. Kalthan E, Tenguere J, Ndjapou SG, *et al.* (2018) Investigation of an outbreak of monkeypox in an area occupied by armed groups, Central African Republic. Med Mal Infect 2018; 48: 263–68.
56. Doshi RH, Guagliardo SAJ, Doty JB, *et al.* (2019) Epidemiologic and ecologic investigations of monkeypox, Likouala Department, Republic of the Congo, 2017. Emerg Infect Dis; 25: 281–89
57. Learned, L. A., Reynolds, M. G., Wassa, D. W., et al. (2005). Extended interhuman transmission of monkeypox in a hospital community in the Republic of the Congo, 2003. *American Journal of Tropical Medicine and Hygiene*, *73*(2), 428–434. https://doi.org/10.4269/ajtmh.2005.73.428.
58. Tchokoteu PF, Kago I, Tetanye E, Ndoumbe P, Pignon D, Mbede J. (1991) [Variola or a severe case of varicella? A case of human variola due to monkeypox virus in a child from the Cameroon]. Ann Soc Belg Med Trop; 71: 123–28 (in French)
59. Vallée A, Chatelain A, Carbonnel M, *et al.* (2023) Monkeypox virus infection in 18-year-old woman after sexual intercourse, France, September 2022. Emerg Infect Dis 2023; 29: 219–22
60. Antonello VS, Cornelio PE, Dallé J. (2023) Disseminated neonatal monkeypox virus infection: case report in Brazil. *Pediatr Infect Dis J*; 42: e152–53.
61. Hoxha A, Kerr SM, Laurenson-Schafer H, *et al.* (2023) Mpox in children and adolescents during multicountry outbreak, 2022–2023. Emerg Infect Dis 2023; 29: 2125–29.
62. UK Health Security Agency (2023). Mpox (monkeypox): background information. 2023.

https://www.gov.uk/guidance/monkeypox (accessed May 2, 2023).

63. Reynolds MG, Damon IK (2012). Outbreaks of human monkeypox after cessation of smallpox vaccination. Trends Microbiol 2012; 20: 80–87
64. Durski, KN., McCollum, AM., Nakazawa, Y., Petersen, BW., Reynolds, MG., Briand, S., & *et al.* (2018). Emergence of monkeypox—West and Central Africa, 1970–2017. *Morbidity and Mortality Weekly Report*, *67*(10), 306–310. https://doi.org/10.15585/mmwr.mm6710a4.
65. Shearer JD, Siemann L, Gerkovich M, House RV (205). Biological activity of an intravenous preparation of human vaccinia immune globulin in mouse models of vaccinia virus infection. Antimicrob Agents Chemother; 49: 2634–41.
66. Ladhani SN, Dowell AC, Jones S, *et al.* (2023) Early evaluation of the safety, reactogenicity, and immune response after a single dose of modified vaccinia Ankara-Bavaria Nordic vaccine against mpox in children: a national outbreak response. *Lancet* Infect Dis 2023; 23: 1042–50.
67. Ramírez-Olivencia G, Velasco Arribas M, Vera García MM, *et al.* (2024) Clinical and epidemiological characteristics of the 2022 mpox outbreak in Spain (CEME-22 study). Open Forum Infect Dis 2024; 11: ofae105.
68. Eser-Karlidag G, Chacon-Cruz E, Cag Y, *et al.* (2023) Features of mpox infection: the analysis of the data submitted to the ID-IRI network. New Microbes New Infect 2023; 53: 101154
69. Nachega JB, Mohr EL, Dashraath P, *et al.* (2024) Mpox in pregnancy, risks, vertical transmission, prevention, and treatment. *N Engl J Med*; 2024; published online Aug 28. https://doi.org/10.1056/NEJMp2410045.
70. Damaso CR (2023). Phasing out monkeypox: mpox is the new name for an old disease. *Lancet Reg Health Am* 2023; 17: 100424.
71. Petersen BW, Damon I (2020). Other poxviruses that infect humans: parapoxviruses (including orf virus), molluscum contagiosum, and yetapoxviruses. In: Bennett JE, Dolin R, Blaser MJ, eds. Mandell, Douglas, and Bennett's principles and practice of infectious diseases. 9th ed. Vol 2. Philadelphia, PA: Elsevier, 2020:1818–21.
72. Alakunle, E., Moens, U., Nchinda, G., & Okeke, MI. (2020). Monkeypox virus in Nigeria: Infection biology, epidemiology, and evolution. *Viruses*, *12*(11), 1257. https://doi.org/10.3390/v12111257.
73. Heymann DL, Chen L, Takemi K, et al. (2015) Global health security: the wider lessons from the west African Ebola virus disease epidemic. Lancet 2015; 385: 1884–901.

74. Doshi, R. H., Guagliardo, S. A. J., Dzabatou-Babeaux, A., Likouayoulou, C., Ndakala, N., Moses, C., et al. (2018). Strengthening of surveillance during monkeypox outbreak, Republic of the Congo, 2017. *Emerging Infectious Diseases*, *24*(6), 1158–1160. https://doi.org/10.3201/eid2406.171554
75. Kuehn R, Fox T, Guyatt G, Lutje V, Gould S (2024) Infection prevention and control measures to reduce the transmission of mpox: A systematic review. PLOS Glob Public Health 4(1): e0002731. https://doi.org/10.1371/journal.pgph.0002731.
76. Kraemer MU, Yang C-H, Gutierrez B, Wu C-H, Klein B, Pigott DM, du Plessis L, Faria NR, Li R, Hanage WP, *et al.* (2020) The effect of human mobility and control measures on the COVID-19 epidemic in China. Science. 2020;368(6490):493-97. [PMC free article] [PubMed].