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Descriptive epidemiology of the burden of human monkeypox in Nigeria: a retrospective review 2017-2021

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Abstract

Introduction: *sporadic outbreak of human monkeypox (hMPX) has been reported in 20 non-endemic countries as of the first quarter of 2022. One of these cases was epidemiologically linked to an individual with a history of previous visits to Nigeria. The purpose of this study was to determine the burden of hMPX in Nigeria, determine its hotspots and epidemic threshold from 2017-2021.* ***Methods:*** *we reviewed reports on the outbreak of hMPX disease from the Nigerian centre for disease control (NCDC) between 2017-2021. We identified States affected, determined the number of confirmed monkeypox cases, and conducted a Geospatial analysis with Arc Geographical Information System (ArcGIS), to describe the Hotspots of hMPX outbreaks in*

Nigeria classified as (major/high, medium, minor/low) clusters based on disease burden in affected states. We calculated the epidemic threshold (EPT) of outbreaks based on cumulative sum, (CUSUM) statistics, (C1-C3) for October 2017-2021. The epidemic threshold was based on the formula; EPT equals (=) Mean(α) + 3 standard deviations(δ) of seven past surveillance points of the year under consideration skipping over the two surveillance points before the month under consideration. ***Results:*** *in 2017, 88 confirmed cases of hMPX were reported in Nigeria in 15 States, River State accounts for 25(28%) of cases, Bayelsa State 19 (22%) was identified as major hotspots for hMPX, 13 States reported minor clusters of 44 cases, individuals aged 21-30 years 34(39%), were at higher risk. In 2018, 49 confirmed cases of hMPX were reported in Nigeria in 13 States, River State accounts for 14 (29%) of cases, Bayelsa State 11 (21%) were major hotspots for hMPX, 11 States reported minor clusters of 24 cases, individuals aged 31-40 years 17 (35%) were at higher risk. In 2019, 47 confirmed cases of hMPX were reported in Nigeria in 11 States, Lagos State accounts for 15(32%) of cases, Delta State, 10 (21%) were major hotspots for hMPX, Rivers and Bayelsa State accounts for 7(15%) and 7(15%) of cases were medium clusters of hMPX, 7 other States reported minor clusters of 8 cases, individual aged 31-40 years 22 (47%) were most affected. In 2020, 8 confirmed cases of hMPX were reported in Nigeria in 5 States Lagos State with 4 (50%) of cases, was a major hotspot for hMPX, four other States accounted for minor clusters of four cases, individual aged 21-30 and 31-40 years 4 (50%), 4 (50%) respectively were most affected. In 2021, 34 confirmed cases of hMPX were reported in Nigeria in 9 States, Delta State accounts for 9 (27%) of cases, Lagos State, 6 (18%), and Bayelsa 6 (18%) were the major hotspots. Rivers and Edo State with 5 (15%) and 4 (12%) of cases were medium clusters, four other states had minor clusters of four cases, individuals aged 31-40 years, 13(38%) were at high risk. The epidemic threshold for hMPX was (12, 8, 1, and 4) respectively.*

Conclusion: *monkeypox is endemic in Nigeria, 226 confirmed Human Monkeypox (hMPX) cases were reported with 8 fatalities across 20 States. Young adults aged 21-30 years are at a higher risk of infection. The disease is clustered in two geopolitical zones (South-west/South-south) of Nigeria. The observed hMPX cases were higher than the epidemic threshold in 2020 and 2021 such may have contributed to the sustained sporadic outbreak of monkeypox reported as of the first quarter of 2022, the risk factors included consumption of giant rats/monkeys, occupational hazard amongst health care workers, individual who frequent crowded social gathering. Consequently, improved screening for hMPX at the border post, and enhanced in-country surveillance may ensure early detection, and prevent the spread of hMPX. Furthermore, training of health care workers on increased risk perception of hMPX may reduce occupational hazards. These measures should be complemented with public enlightenment of high-risk populations.*

Introduction

Monkeypox (MPX) is a viral zoonosis which belongs to the family Poxviridae, [1-4]. An outbreak of monkeypox was first reported among clusters of monkeys kept for research purposes at the State Serum Institute in Copenhagen (Denmark) in 1958 [2,5,6]. The MPX viruses are classified into two clades (group), the Central African (more transmissible and causes severe morbidity) and the West African clade [4,7,8]. The disease is endemic in West Africa and the Congo [4,6]. The natural reservoirs of MPX are presently unknown, however, a putative zoonotic link has been established with individuals in contact with animal sentinels, rope squirrels, Gambian pouched rats and non-human primates susceptible to monkeypox viruses [4,6]. Furthermore, person-to-person transmission has been documented through contact with bodily fluids, fomites, and contaminated material from infected persons [9]. In affected individuals, clinical symptoms include fever, headache, muscle

pains, and pustular rashes similar to smallpox lesions, except for its marked lymphadenopathy [2,4,6]. Monkeypox lesions are self-limiting with morbidity of 2-4 weeks and a case fatality of 3-6% [4]. At present, management of hMPX cases are supportive with symptomatic treatment. Studies conducted in the United Kingdom with Tecovirimat has shown are promises with reports of shortened hospital stay, although patients were found to shed virus in urine [6,10], furthermore, individual with prior smallpox vaccination are seroprotective with an 85% chance of preventing an outbreak of human monkeypox [3,6]. After 39 years of hiatus sporadic outbreak of hMPX was reported in Nigeria in 2017, since then a few international spreads of hMPX has been epidemiologically linked to a few individuals with a history of a previous visit to Nigeria en route Israel and the United Kingdom in 2018, Singapore in 2019, United States of America, and the UK in 2021 [5,11-15]. As of the first quarter of 2022, the World Health Organisation (WHO) has reported about 257 monkeypox cases in 20 non-endemic countries [16]. The purpose of this study was to describe the burden of human Monkeypox in Nigeria, identify the hotspots of outbreaks of MPX in Nigeria, and determine the epidemic threshold of the outbreak of human monkeypox in Nigeria to provide the information necessary for public health actions.

Methods

Study area: Nigeria is a country located in West Africa, bordered by the Republic of Niger to the north, Chad to the northeast, Cameroon to the east and the Republic of Benin to the west. There are 36 States in Nigeria, with the Federal Capital Territory, (FCT). Nigeria´s population is estimated at over 200 m [17].

Study design: we reviewed reports on the outbreaks of human monkeypox in Nigeria from the Nigeria centre for disease control (NCDC) between 2017-2021. We identified affected States, determined the number of confirmed human monkeypox cases, and conducted a Geospatial analysis with Arc Geographical information system (ArcGIS), to describe the Hotspots of monkeypox outbreaks in Nigeria classified as (major/high, medium, minor/low) clusters based on disease burden in affected states, and calculated the epidemic threshold (EPT) of hMPX outbreaks based on cumulative sum, (CUSUM) statistics, (C1-C3) for October 2017-2021. The epidemic threshold was based on the formula; EPT equals (=) Mean(α) + 3 standard deviations(δ) of seven past surveillance points of the year under consideration, skipping over the two most recent surveillance months before the month under consideration.

Results

In 2017, 88 confirmed cases of Human monkeypox (hMPX) were reported in Nigeria in 15 States, River State accounts for 25(28%) of cases, Bayelsa State 19(22%) was identified as a major hotspot for hMPX (Table 1), (Figure 1), 13 other States reported minor clusters of 44 cases, individuals within the age range, 21-30 years 34(39%) (Table 2), were most affected. In 2018, 49 confirmed cases of hMPX were reported in Nigeria in 13 States, River State accounts for 14(29%) of cases, Bayelsa State 11(21%) were identified as major hotspots for hMPX (Figure 2), 11 States accounted for minor clusters of 24 cases, individuals within the age range, 31-40 years 17(35%) were most affected. In 2019, 47 confirmed cases of hMPX were reported in Nigeria in 11 States, Lagos State with 15(32%) of cases and Delta State, 10(21%) were the major hotspot for hMPX (Figure 3). Furthermore, Rivers and Bayelsa State with 7 (15%) and 7 (15%) of cases were medium clusters of hMPX while 7 States accounted for minor clusters of 8 cases, individual within the age range 31-40 years 22 (47%) were most affected. In 2020, 8 confirmed cases of hMPX were reported in Nigeria in 5 States, Lagos State with 4 (50%) of cases, was identified as a major hotspot for hMPX (Figure 4) four states had minor clusters of 4 cases, individuals within the age

range, 21-30 and 31-40 years 4 (50%), 4 (50%) were most affected. In 2021, 34 confirmed cases of hMPX were reported in Nigeria, in 9 States, Delta State accounts for 9 (27%) of cases, Lagos State, 6 (18%), and Bayelsa State 6 (18%) were a major hotspot for hMPX (Figure 5), Rivers and Edo State with 5 (15%) and 4 (12%) of cases were medium clusters of hMPX while 4 States accounted for minor clusters of 4 cases, individual within the age range 31-40 years 13 (38%) were most affected. The epidemic threshold for outbreak of human monkeypox from 2017-2021, was (12, 8, 1, and 4) (Table 3) respectively.

Discussion

Nigeria reported 226 confirmed Human Monkeypox (hMPX) cases from 2017 to 2021, and 8 fatalities across 20 states, young adults, 21-30 years of age were at a higher risk of infection [18]. Human monkeypox outbreaks were clustered in two geopolitical zones, the South-south and South-western regions of Nigeria. Rivers and Bayelsa States, were identified as a major hotspot of Human monkeypox, they accounted for 52 (23%) and 43(19%) of total confirmed hMPX cases during the period. Similarly, Lagos and Delta States, were identified as a medium cluster of hMPX in Nigeria (Figure 6), with 30(13%), and 29 (12%) of total confirmed cases The risk factors for hMPX outbreaks in Nigeria are diverse, it cut across occupational hazard amongst health workers, consumption of giant rats, monkeys, individual who frequent overcrowded social gathering. Chieloka *et al*. [2], in his study identified the consumption of giant rats and monkeys as a risk factor in the outbreak of Human monkeypox in Mkpat enin Local government area (LGA) of Akwa Ibom State, Nigeria in 2019, although there was a high-risk perception on the risk associated with suspected human monkeypox cases by health workers at Mkpat enin LGA, workers job apathy which borders on managements may be responsible for the increased disease incidence during the period. Furthermore, he posited that there was a weak association with the spread of infection by confirmed human monkeypox cases to individuals in contact with them {(OR=0.333, (0.0673, 1.6516), Fisher' exact 0.1756}, these findings were in tandem with Heymann *et al*. [9] who concluded that Human Monkeypox outbreaks were sporadic with few humans to human infection not exceeding two generations. Similarly, Owoicho *et al*. [19], identified the demography of unmarried young adults who attends overcrowded social gathering as a risk factor in the outbreak of hMPX in Bayelsa state, Nigeria in 2017. Mauldin *et al*. [11] linked the outbreak of monkeypox to occupational hazards amongst health care workers and consumption of bush meat, and improper disposal of suspected monkeypox-infected rodents by subjects were responsible for an outbreak of human monkeypox in Ebonyi and Rivers states, in 2018. As of the first quarter of 2022, an outbreak of Human monkeypox has been reported in 20 hMPX non-endemic countries [16]. Nigeria may have inadvertently, played a role in a few international spreads of Human monkeypox as individuals with a history of previous visit to Nigeria en route United kingdoms, United States, of America, Israel and Singapore [11,13-15], were epidemiologically linked to an outbreak of human monkeypox. The epidemic threshold (EPT) of hMPX from 2017-2021, was (12, 8, 1, and 4) respectively. In 2017, an outbreak of hMPX occurred within four surveillance months as such EPT could not be determined, however, from 2018 through 2019 the observed hMPX cases were below the Epidemic threshold, this may be attributed to control measures and policy instituted by one health tripartite subsector to control outbreak of hMPX. In 2020 through 2021 the observed hMPX cases exceeded the epidemic threshold; such may have contributed to the international spread of the virus and the sustained sporadic outbreak currently being reported in Nigeria as of the first quarter of 2022.

Conclusion

Monkeypox is endemic in Nigeria (Figure 7), 226 confirmed Human Monkeypox (hMPX) cases were

reported with 8 fatalities across 20 States Young adults aged 21-30 years are at a higher risk of infection. The disease is clustered in two geopolitical zones (south-west/south) in Nigeria. The observed hMPX cases were higher than the epidemic threshold in 2020 and 2021 such may have contributed to the sustained sporadic outbreak of monkeypox being reported as of the first quarter of 2022, the risk factors include consumption of giant rats/monkeys, occupational hazard amongst health care workers, individual who frequent crowded social gathering. Consequently, improved screening for hMPX at the border post, and enhanced in country surveillance may ensure early disease detection, to prevent the spread of hMPX. Furthermore, training of health care workers on increased risk perception of hMPX may reduce occupational hazards. These measures should be complemented with public enlightenment of high risk populations to reduce disease outbreaks.

What is known about this topic

- *The resurgence of human monkeypox was first reported in Nigeria in 2017 after a 39 years full in cases;*
- *Consumption of wild games is a risk factor for human monkeypox.*

What this study adds

- *Human monkeypox cases are clustered in two Geopolitical zones in Nigeria (South-south, South-west);*
- *Young adults 21-30 years of age are at a higher risk of infection.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Dr Okoli Solomon Chieloka wrote this manuscript, Dr Isa Mohammed Bammani, and Lateefat Kikelomo Amao read the manuscript and made suggestions. All the authors have read and agreed to the final manuscript.

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Tables and figures

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Table 3: epidemic threshold of human monkeypox october from 2017-2021

Figure 1: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2017

Figure 2: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2018

Figure 3: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2019

Figure 4: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2020

Figure 5: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2021

Figure 6: map of Nigeria showing cumulative burden of human monkeypox cases 2017-2021

Figure 7: trends of confirmed human monkeypox cases in Nigeria 2017-2021

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Table 1: distribution of confirmed human monkeypox cases from 2017-2021						
States	**2017**	**2018**	**2019**	**2020**	**2021**	**2017 to 2021**
Rivers	25	14	7	1	5	52
Bayelsa	19	11	7	0	6	43
Lagos	4	1	15	4	6	30
Delta	3	6	10	1	9	29
Cross River	9	3	1	0	1	14
Imo	5	2	1	0	0	8
Akwa Ibom	6	0	1	0	0	7
Oyo	1	3	2	0	0	6
Edo	4	1	1	0	4	7
FCT, Abuja	5	0	0	0	1	10
Enugu	1	2	1	0	0	6
Abia	1	2	0	0	0	4
Plateau	0	2	0	1	0	3
Nasarawa	1	1	0	0	0	3
Benue	2	0	0	0	0	2
Anambra	0	1	1	0	0	2
Ekiti	2	0	0	0	0	2
Ebonyi	0	0	0	1	0	1
Niger	0	0	0	0	1	1
Ogun	0	0	0	0	1	1

Table 2: age distribution of confirmed monkeypox cases September 2017 - December 2021					
Age group(yrs)	**2017**	**2018**	**2019**	**2020**	**2021**
0-10	7	5	1	0	1
11-20	12	4	1	0	4
21-30	34	13	13	4	10
31-40	26	17	22	4	13
41-50	9	10	9	0	5
51-61	0	0	1	0	1
Total	88	49	47	8	34

Table 3: epidemic threshold of Human Monkeypox October from 2017-2021					
Epidemic-months	**2017**	**2018**	**2019**	**2020**	**2021**
January	0	0	2	1	2
February	0	7	3	1	1
March	0	7	5	0	2
April	0	5	10	0	0
May	0	6	4	0	3
June	0	4	3	0	4
July	0	5	5	0	5
August	0	0	3	0	7
September	2	1	2	0	2
October	31	5	4	2	2
November	39	4	5	4	1
December	16	5	1	0	5
EPT=α + 3(δ) of 7 past surveillance points before October		12	8	1	4

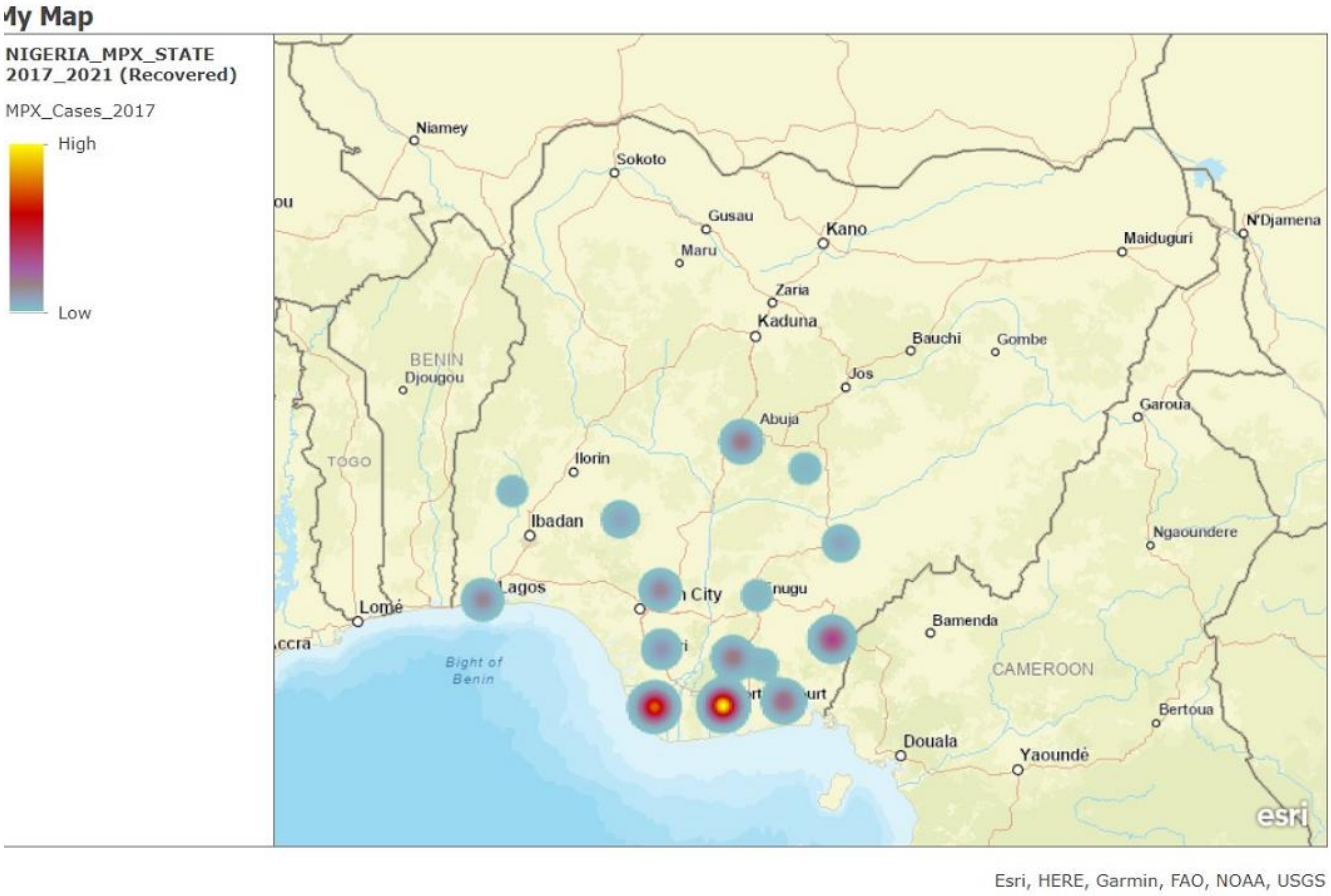

Figure 1: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2017

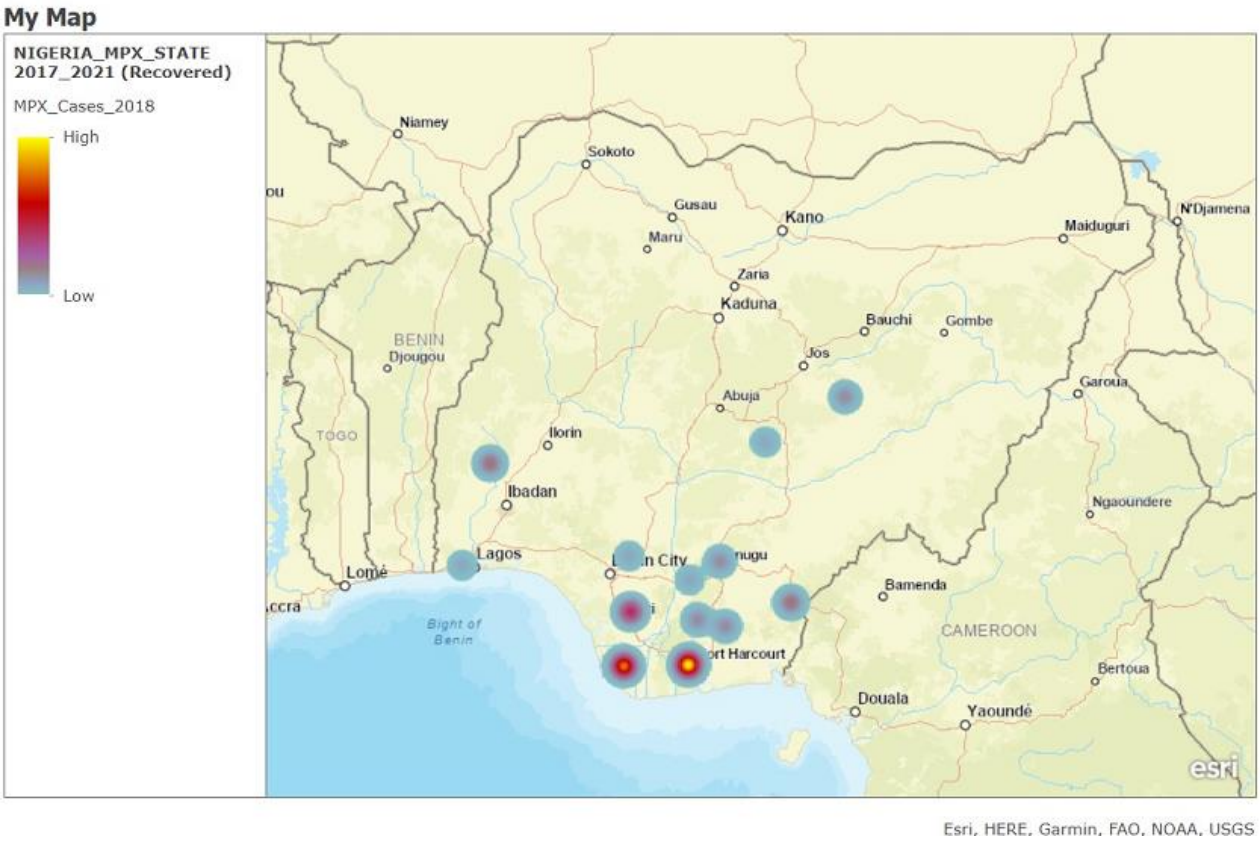

Figure 2: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2018

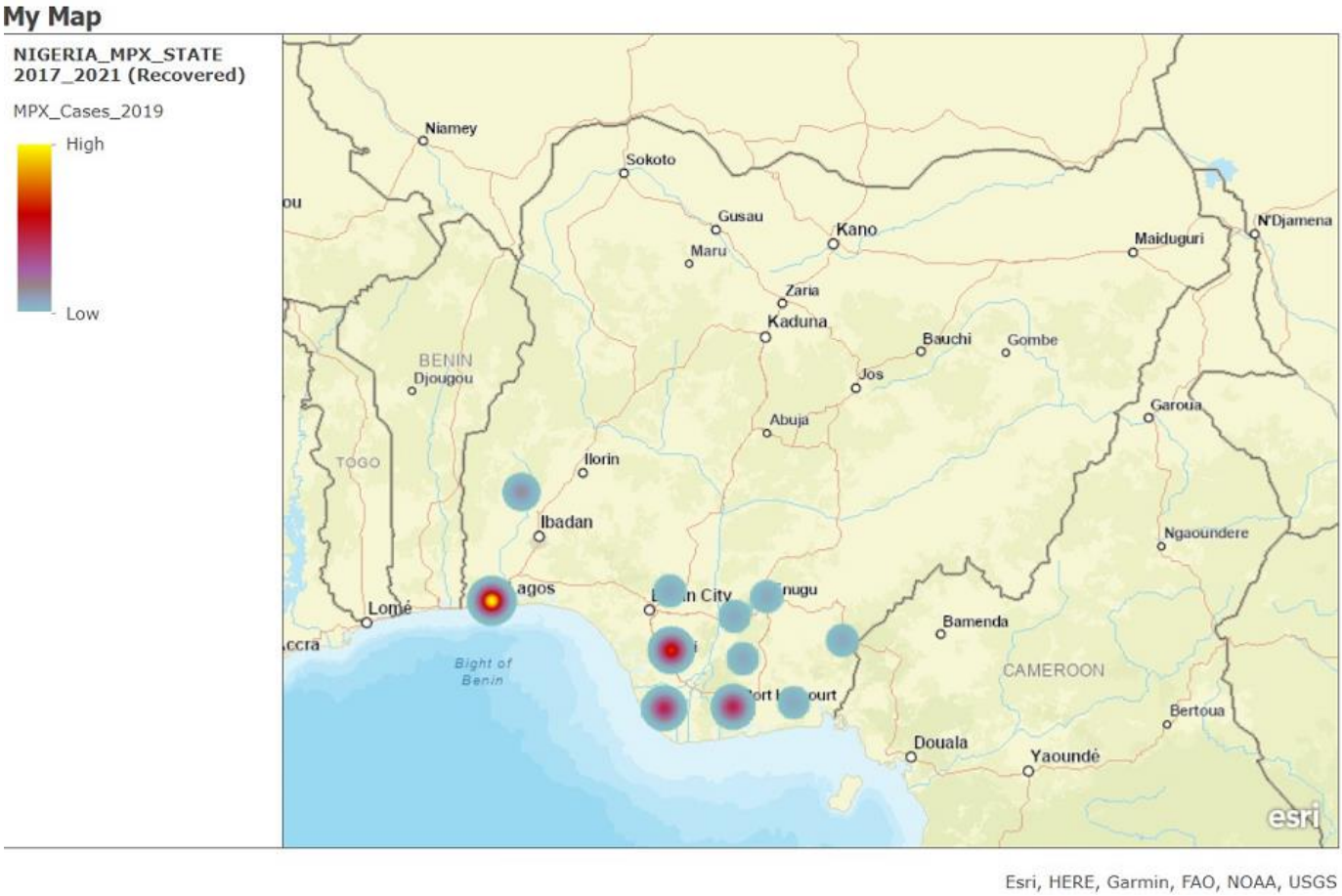

Figure 3: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2019

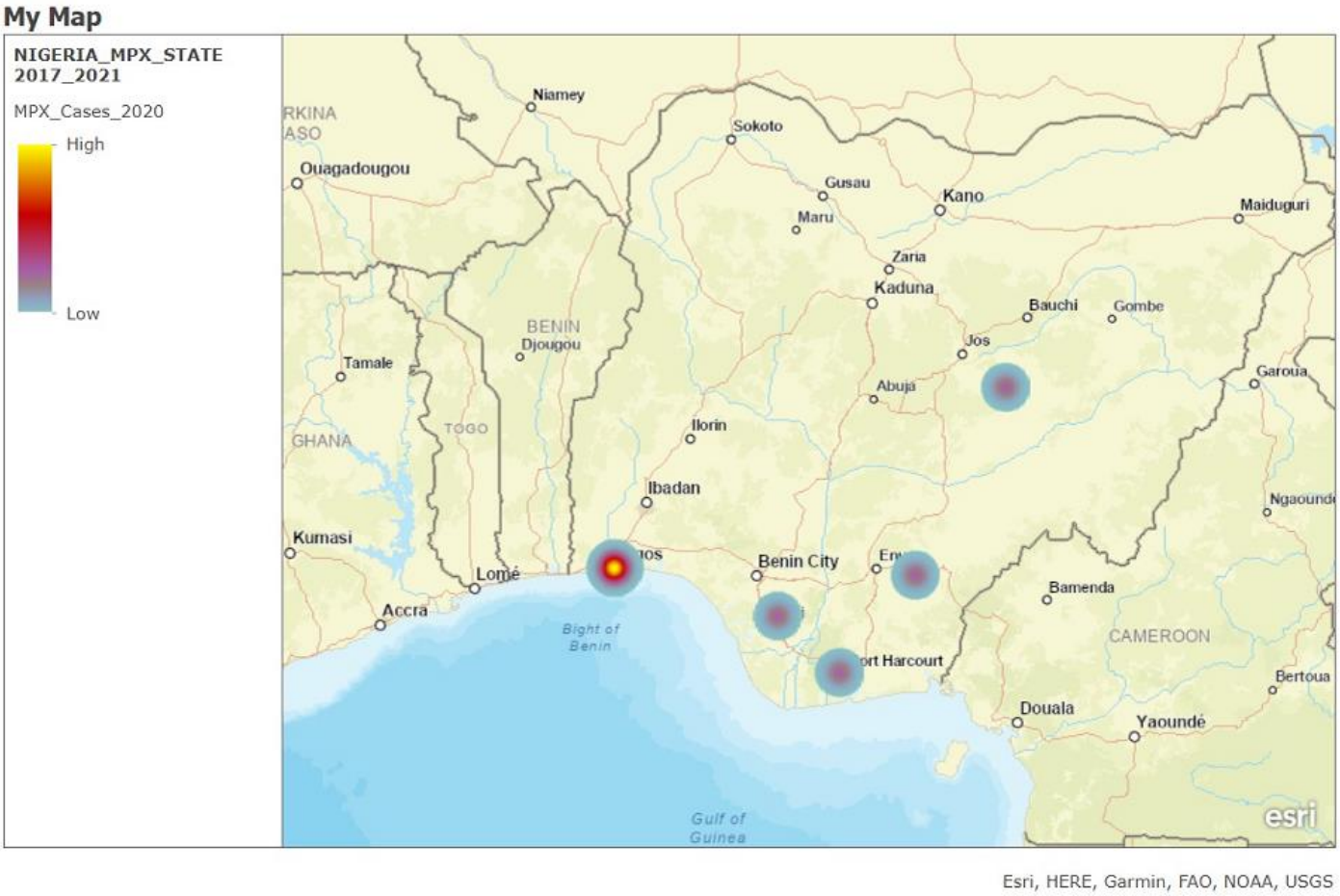

Figure 4: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2020

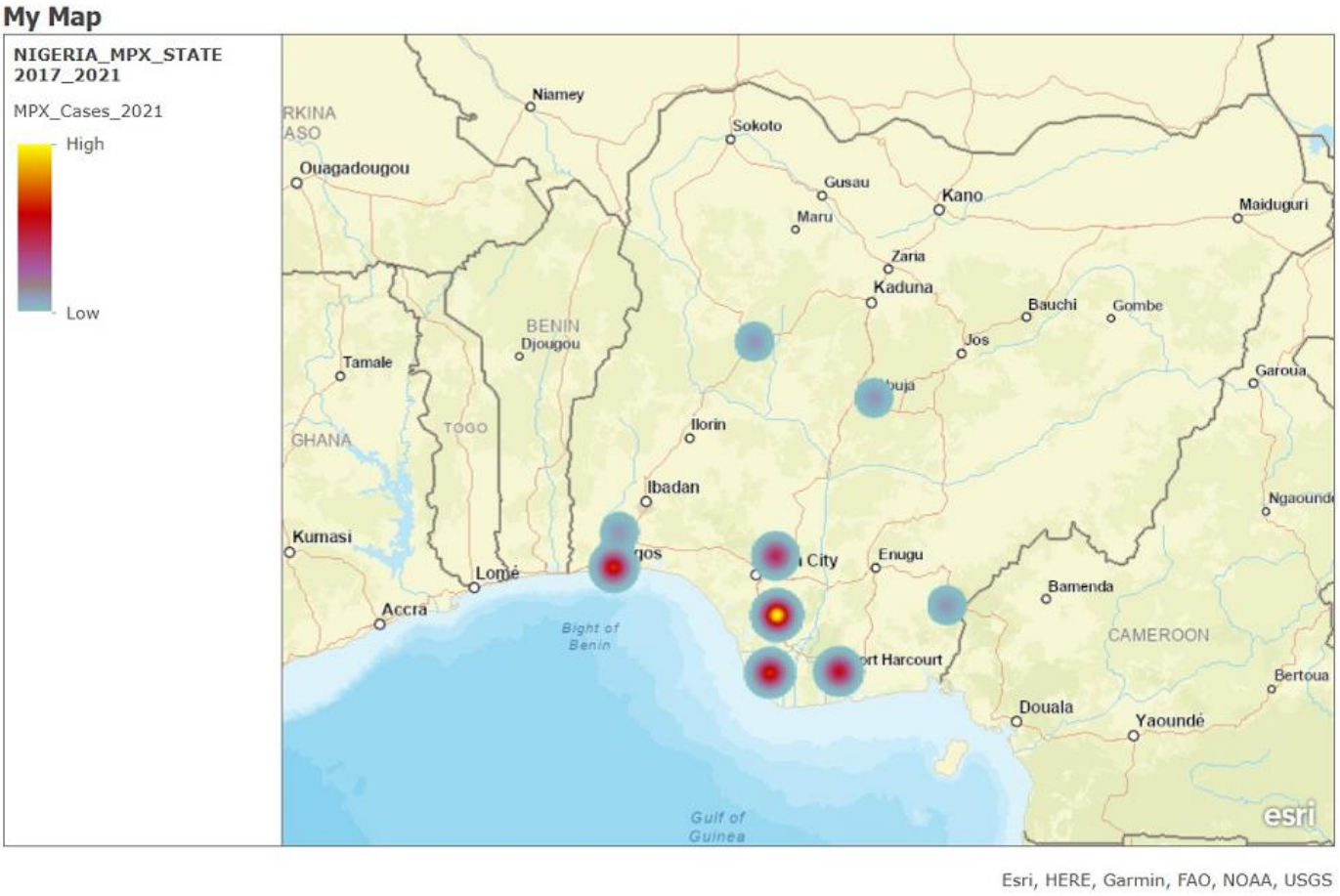

Figure 5: map of Nigeria showing hotspot of confirmed human monkeypox cases in 2021

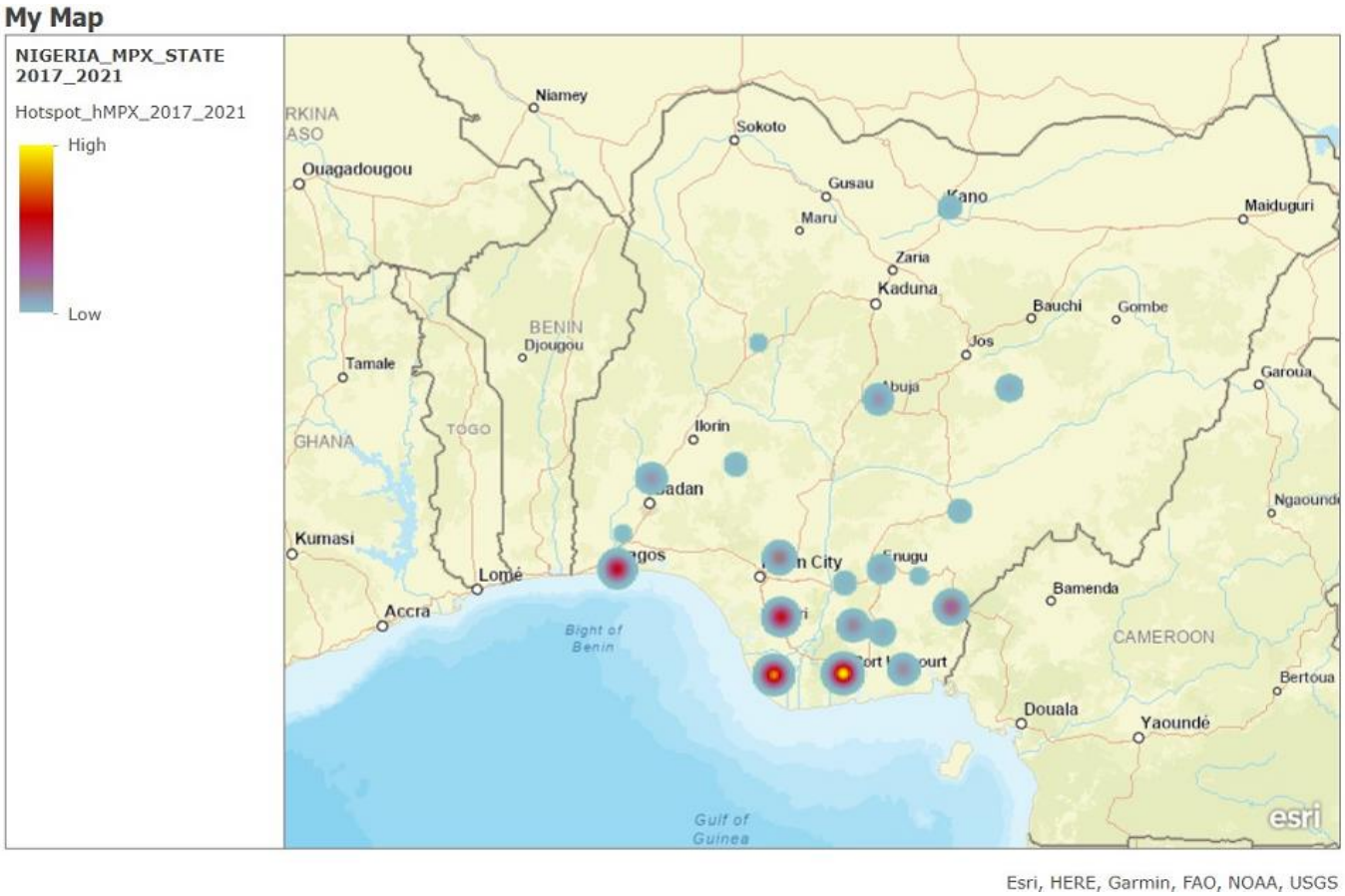

Figure 6: map of Nigeria showing cumulative burden of human monkeypox cases 2017-2021

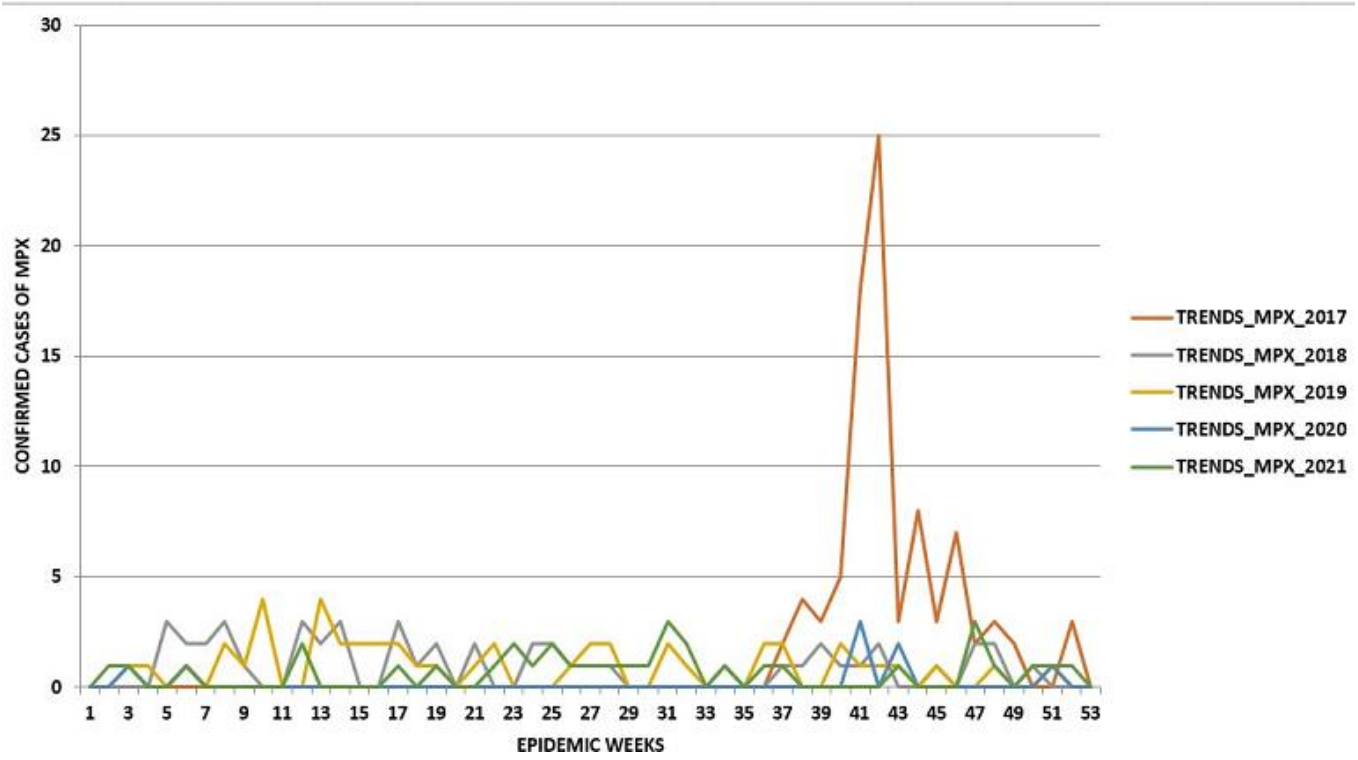

Figure 7: trends of confirmed human monkeypox cases in Nigeria 2017-2021