

Monkey Pox Data: Visualization and Prediction of the Observed Number of Affected People in Nigeria

Okorodudu Franklin Ovuolelolo*

Department of Computer Science, Faculty of Sciences, Delta State University, Abraka, Nigeria

Email: okoroblackx4@yahoo.co.uk

ORCID iD: <https://orcid.org/0000-0002-7445-5978>

*Corresponding Author

Onyeacholem Ifeanyi Joshua

ICT Directorate, Delta State University, Abraka, Nigeria

Email: ifeanyionyeacholem@yahoo.co.uk

ORCID iD: <https://orcid.org/0009-0008-1684-8352>

Gracious C. Omede

Department of Computer Science, Faculty of Sciences, Delta State University, Abraka, Nigeria

Email: ashimmmm1@gmail.com

ORCID iD: <https://orcid.org/0009-0000-2870-1149>

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Abstract: Information and communication technology (ICT) is the bedrock of information dissemination and a driving force for better economic planning to achieve its goals and get success stored securely and confidentially. Monkeypox (MPX) epidemic outbreaks affect human beings as a whole and can be a cause of serious illness and death. This epidemic continues to challenge medical systems worldwide in many aspects, including sharp increases in demands for hospital beds and critical shortages in medical equipment, while many healthcare workers have themselves been infected. Thus, the capacity for immediate clinical decisions and effective usage of healthcare resources is crucial. Therefore, this research has developed an effective screening system that will enable quick and efficient diagnosis of Monkeypox (MPX) and can mitigate the burden on healthcare systems. This system would be handy in sharing much-needed expert knowledge in the diagnosis of Monkeypox (MPX) symptoms since it would be used by medical officers, clinical officers, and nurses in the absence of specialists. It could be used to collect medical data, which in this case is the symptoms presented by the patients; it can also be useful in training general practitioners, physicians, inexperienced nurses, and paramedics to guarantee suitable and accurate decision-making in the diagnosis and management of Monkeypox (MPX). The methodology adopted is the machine learning algorithms for analysis and training of our dataset, to ascertain the level at which this epidemic has caused harm to lives, a linear relationship between an independent and dependent variable is provided by the linear regression technique, and Python programming was used to visualize and predict clinical outcomes.

Index Terms: Monkey-pox, Visualizing, Predicting, Clinical, Fluid, Dataset

1. Introduction

Monkeypox virus is an Orthopoxvirus, a genus that includes camelpox, cowpox, vaccinia, and variola viruses. The virus is the foremost Orthopoxvirus affecting human populations since smallpox eradication, as confirmed by the World Health Organization in 1980. Clinical recognition, diagnosis, and prevention still remain challenges in the resource-poor endemic areas where monkeypox is found. In [1] Since May 13, 2022, many cases of Monkey Pox Virus (MPX) have been reported from several non-endemic countries in Europe, North America, and Australia, posing an unexpected and concerning public health hazard given that the illness is unrelated to human or animal mobility. The number of cases reported is surprisingly high; there is no direct link between outbreaks and travels from endemic areas, and it is not clear whether the virus has developed more capacity for transmission between humans, as we know little of its general viral evolution and dynamics. According to [2] in addition, despite the general low mortality rate and the fact that no death has been reported during the current outbreak, many unusual aspects are creating public concern. Moreover, although,

in recent years, there have been cases reported in non-endemic areas, including the 2003 and 2021 outbreaks in the United States of America and Israel, the September 2018 outbreak in United Kingdom, and the May 2019 outbreak in Singapore, the current global epidemiology pattern has never been recorded before. In “Ref” [3] Nigeria, which is a sovereign nation in West Africa with inhabitants of about 200 million people and made up of 36 states and federal capital territory has recently been reported in some regions and states with Monkey Pox Virus (MPXV). The Nigeria Center for Disease Control (NCDC) reported several instances to WHO on October 27th, 2017, and the infections have been verified in Abuja, Enugu, Bayelsa, and Akwa Ibom. Delta, Nassarawa, Niger, Rivers, Abuja, Lagos, Imo, Enugu, Ekiti, Akwa Ibom, Bayelsa, and Cross River were among the suspected states. Many suspected instances were reported in 26 states in January 2019, with 17 states reporting verified cases. As of September 2019, the NCDC recorded MPXV cases in nine states: Oyo, Bayelsa, Lagos, Delta, Rivers, Enugu, Akwa Ibom, Anambra, and Cross River. Meanwhile, six additional states (Imo, FCT Abuja, Bauchi, Zamfara, Borno, and Plateau) reported MPXV cases in December 2019, bringing the total number of cases reported to 113 and cases that were confirmed to 45 between January and December 2019. Although there is not enough proof to imply that this illness is endemic in any area of Nigeria, outbreaks of the disease have occurred in various states in Southern Nigeria (Southwest, SouthSouth, and Southeast) throughout the years [4]. The ongoing efforts to strengthen surveillance at the national and sub-national levels, increased awareness from global news headlines, and our investments in risk communication and community engagement (RCCE) have all contributed to this year's observed increase in cases. The NCDC has said that they would continue to monitor the situation even as we continue to respond. Thus, the need to provides a secured movement within the country.

Poxviruses, unlike COVID-19, are members of the Poxviridae family, a vast and varied family of DNA with two strands of viruses that multiply in the nuclei of infected cells. When studied under electron microscopy, the poxviruses feature brick-shaped or oval nanostructures measuring 200–400 nm. Poxviruses' extensive host range and successful development are partly due to their manipulation and control of host immune responses. Because poxviruses have been identified in insects, reptiles, birds, and mammals, they are also known as old viruses. These viruses are thought to become visible "pox" before splitting vertebrates from invertebrates [5].

The study is aimed at using a machine learning algorithm to analyze the dataset, train, test, and prediction. The purpose of collecting data set on monkeypox in various states for affected and non affected persons and to use machine learning algorithms to ascertain the level at which this epidemic has caused harm to lives while using estimation parameter in least square method to predict for the next six years with an interval of two years per predictions. The motivation was based on inadequate health facilities and vaccines to cater for the affected persons, and the significant is to enable the government to be on alert for future occurrences for proper decision making.

2. Literature Review

The first signs of an MPX outbreak in the United Kingdom (U.K.) were seen on May 6, 2022. The epidemic was then attributed to a British person who had just visited Nigeria, a location with a high frequency of the ailment. Notably, this person had symptoms similar to those described on April 29, 2022. On May 4, the aforementioned individual came from the United Kingdom, carrying the first case of the pandemic [6]. As of May 21, 2022, 13 countries that typically do not experience this illness have officially confirmed 92 cases of the monkeypox virus (MPXV). The United Kingdom, Australia, Belgium, the Netherlands, Canada, France, Germany, Italy, Portugal, Spain, Sweden, and the United States are among these countries [7]. As of May 22, 2022, there have been recorded occurrences of breakouts in 15 different countries. According to United et al., the United Arab Emirates (UAE) is the first Arab government to register this incident formally. The United Arab Emirates (UAE) declared the first case of illness in the Arab world on May 24 [8]. There have been no reported cases of fatalities related to the aforementioned phenomena, according to available data [7]. It is worth noting that Belgium has tried to impose a mandatory 21-day quarantine period for people infected with MPX [9].

The first MPXV detection and isolation occurred in 1958 after observing vesicular disease in monkeys imported from Singapore to Denmark for research reasons. Previous research has found human cases of monkeypox (MPX) in eleven African countries since 1970 [7, 10]. The median age of those who suffer from this condition is 31 years old [1]. Outside of the African continent, just a few cases have been reported [10]. The virus was first found in patients with any clear relationship to West or Central Africa in the present pandemic [7]. The bulk of documented cases are men who identify as male, are homosexual or bisexual, and are between the ages of 20 and 50. It is crucial to highlight, however, that these incidents are not confined to this population [7]. Nonetheless, it is unclear whether sexual behaviours actively contribute to the spread of the disease or if their link is just accidental [11].

Monkeypox (MPX) is a viral zoonotic disease attributed to a DNA virus characterized by its double-stranded nature. This particular virus is classified under the orthopoxviral genus and the Poxviridae family, which is also home to the variola virus responsible for smallpox. The identification of the monkeypox virus occurred in 1959, after an outbreak of a sickness resembling pox in monkeys housed at a research facility situated in Copenhagen, Denmark. The first recorded case of human MPXV (Monkeypox virus) in medical history occurred on September 1, 1970, when a nine-month-old infant from the Democratic Republic of the Congo (formerly known as the Republic of the Congo) was admitted to Basankusu Hospital. The virus responsible for the boy's disease, which had symptoms similar to smallpox, was identified as a virus closely resembling MPXV. From October 1970 to May 1971, a total of six instances of human

Monkeypox Virus (MPXV) infection were documented in the countries of Liberia, Nigeria, and Sierra Leone [12]. The user's text is not sufficient to be rewritten academically. Between the years 1971 and 1978, a total of ten instances of Monkeypox Virus (MPXV) were documented in Nigeria. The first case, the index case, was recorded in 1971. Since then, several cases of monkeypox in humans have been verified, totaling in the hundreds. Among these cases, 11 have been reported in African nations. Monkeypox has been identified in many countries, including Israel, Singapore, the United Kingdom, and the United States [13].

The user provided a numerical reference without any accompanying text. The Epidemiology of Monkeypox Virus in Nigeria the first case of MPXV, a viral infection, was seen in a four-year-old child in Nigeria. Subsequently, the child's mother also had the same infection, becoming the second documented case. The individuals affected by the incident were inhabitants of IhieUmduru, located in the contemporary region of Abia. It was hypothesized that the mother contracted the infection by transmission from her child. Likewise, in 1978, a male individual aged 35 hailing from Omifunfun, located in the Oyo state of Nigeria, presented the third recorded Monkeypox Virus (MPXV) inside the country [14]. From 1971 to 1978, the verification rate of reported cases was found to be 30%, with no recorded instances of deaths. The user did not provide any text to rewrite. In September 2017, Nigeria saw a resurgence of the virus after almost four decades without any documented instances. As per the findings of the Niger Delta University Teaching Hospital (NDUTH), an 11-year-old male patient presenting with symptoms including fever, extensive rash, headache, general discomfort, and throat pain persisting for 11 days, was under suspicion of being afflicted with Monkeypox Virus (MPXV). From September to December 2017, 187 probable cases of the MPXV pandemic were documented throughout 23 states in Nigeria. Bayelsa, Rivers, Lagos, Cross River, and Akwa Ibom exhibited the largest number of suspected cases, with 40, 29, 21, 22, and 15 instances, respectively. In the year 2017, a total of 68 instances were officially documented, resulting in two deaths that were reported from two different states. Of the 23 states with suspected instances, nine states did not have any verified cases, whilst the other 14 states had confirmed cases ranging from one to twenty [15]. The user did not provide any text. The occurrence of a widespread outbreak of monkeypox across many countries in 2022. From January 1 to June 15, 2022, 2103 laboratory-confirmed occurrences were reported across 42 nations in five areas designated by the World Health Organization (WHO). Notably, just a single fatality was recorded during this period. However, this phenomenon does not consistently occur. Since May 2022, the predominant cases (98%) identified have consisted of individuals who identify as males and engage in sexual activity with other men (MSM), who have sought medical assistance in both general healthcare and sexual health clinics. At present, there are no available access points to regions characterized by endemicity. As of July 5, 2022, 5949 MPX cases have been identified in Europe via IHR methodology and the utilization of authorized public resources from 33 nations. The laboratory successfully confirmed 5265 out of the total 5266 cases that were submitted to the European Surveillance System (TESSy). Among these cases, 99 were identified as having West African ancestry based on available sequencing data. The first manifestation of a symptom was seen on April 17, 2022. Most cases consisted of males (5209/5230, 99.6%) and individuals in the age range of 30s and 40s (2214/5258, 42%). Out of the overall sample size of 917 individuals with documented HIV statuses, 364 individuals were identified as HIV positive, representing 40% of the population. A total of 2684 out of 2793 patients, accounting for 96.1%, exhibited a rash. In contrast, systemic symptoms, including fever, fatigue, muscle pain, vomiting, diarrhoea, chills, sore throat, or headache, were seen in 1931 out of 2793 patients, representing 69% of the sample. There were no recorded deaths in any of the occurrences. While there have been reported instances of medical staff being affected by specific illnesses, more study is being conducted to look at the possible connection between these illnesses and occupational exposure. The absence of epidemiological connections to specific endemic regions notwithstanding, the observed fast proliferation of MPX over many geographical areas suggests a prolonged presence of the virus. The age distribution of infected individuals in this epidemic sets it apart from prior outbreaks since many patients are in their thirties. This distinction extends to other demographic parameters such as sex/gender, risk factors, and method of transmission, with sexual transmission being especially likely. The clinical appearance of this condition is characterized by the presence of anogenital lesions and rashes, which exhibit a distinct pattern of sparing the face and limbs, thereby rendering it atypical and distinctive. The prevailing indications and manifestations included fever, lymphadenopathy, exanthema, asthenia, fatigue, and headache.

3. Transmission

The transmission of MPXV may occur via two primary modes: human-to-human transmission and zoonotic transmission, which occurs when the virus spreads from animals to humans. Transmission among individuals has been linked to the dispersion of respiratory particles, direct contact with bodily fluids, exposure to contaminated patient-related objects or environments, and contact with open wounds on infected individuals. The Congo Basin clade, also known as the Central Africa clade, is believed to exhibit more virulence than the West African clade due to its more significant proportion of human-to-human transmission. Zoonotic transmission occurs when an individual comes into proximity with or consumes any natural viral hosts. Moreover, zoonotic transmission might also occur via direct exposure to an infected animal's blood, body fluids, or mucocutaneous lesions. The transmission of illnesses from people to animals hasn't been shown satisfactorily.

Many works have been done by various researchers, [16], in their research used. to further understand the exportations in the time and geographic context of the epidemic, epidemiological and genetic data for exported and

Nigerian cases were studied together. “But” they did not inculcate the use of machine learning algorithm which gives a better visualization and prediction for good health care for its citizenry.

4. Materials and Methods

For the cause of this analysis and training of our dataset, we used machine learning algorithms (linear regression), a linear relationship between an independent and dependent variable is provided by the linear regression technique, which is used to forecast the course of future occurrences. Predictive analysis is done using this statistical technique in data science and machine learning.

Imported Python libraries using machine learning techniques for training and splitting of dataset

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import style
%matplotlib inline
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.impute import SimpleImputer
import seaborn as sns
from sklearn import datasets
from sklearn.model_selection import train_test_split
from sklearn import svm
from sklearn import metrics
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import accuracy_score
```

The table 1 and table 2 shows the data fed into the equation for analysis and training.

Table 1. showing the display the first 5 rows of data read into jupyter notebook(IDE) for analysis.

STATE	2017	2018	2019	2020	2021
Rivers	25	14	7	1	5
Bayelsa	19	1	7	0	6
Lagos	4	1	15	4	5
Delta	3	6	10	1	8
Cross_River	9	3	1	0	0

Table 2. Showing the display of the first 5 rows of data read into jupyter notebook(IDE) for analysis.

STATE	2017	2018	2019	2020	2021
Anambra	0	1	1	0	0
Ekiti	2	0	0	0	0
Ebonyi	0	0	0	1	0
Niger	0	0	0	0	1
Ogun	0	0	0	0	1

5. Maths Specification/Model

Table 3. Showing the predicted values for the next six years with an interval of two years

Years	Initial Total numbersof Affected persons	Prediction for an interval of the first 2 years	Prediction for an interval of 4 years	Prediction for an interval of 6 years
2017	88	0.6%	0.2%	-0.1%
2018	49	0.8%	0.7%	0.5%
2019	48	0.8%	0.7%	1.6%
2020	8	0.3%	0.6%	0.8%
2021	31	0.8%	0.6%	0.5%

$$Y = \beta_0\beta_1X_1+\beta_2X_2+E \quad (1)$$

$$\beta_0 = y/n - \beta_1 x/n_1 \quad (2)$$

$$\beta_1 = \frac{nxy - XY}{nX^2 - (x_1)^2} \quad (3)$$

Result Interpretation : From the above table, it is observed that there is every tendency that if proper measures are put in place, there will be a total eradication and reduction in a percentage growth in the spread of this epidemic.

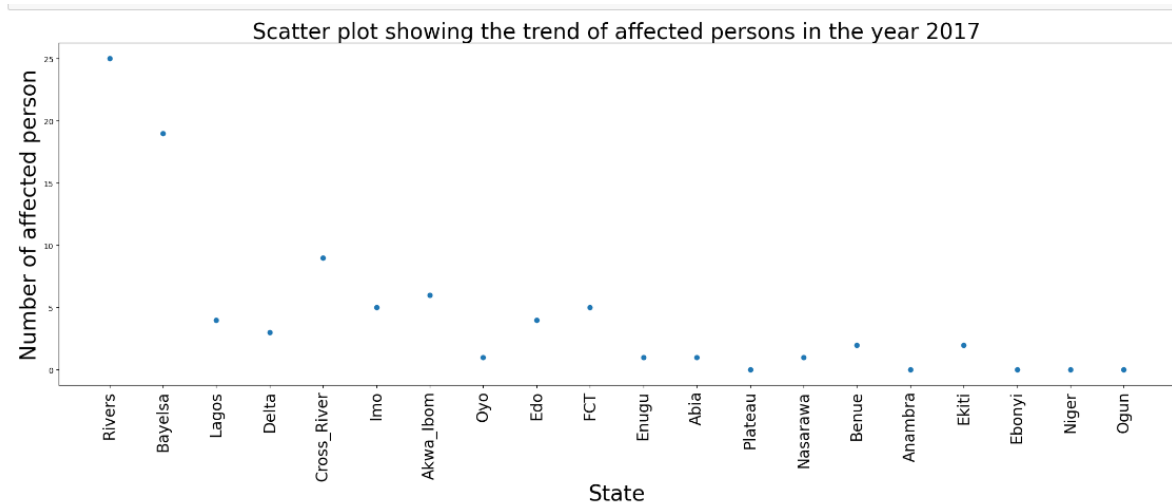


Fig. 1. Scatter plot showing the trend of affected persons in the year 2017

Fig.1. Interpretation: In 2017, there was a significant rise in the number of persons impacted. River state has the most affected people, followed by Bayelsa, Cross River, Akwa-Ibom, FCT, and Imo state.

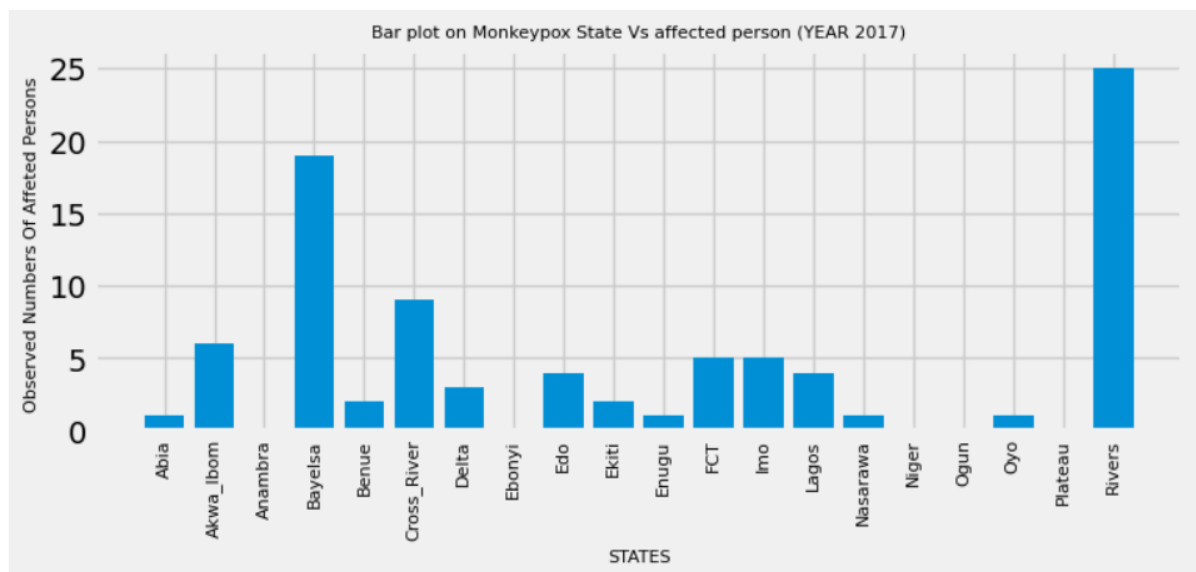


Fig. 2. Bar plot on monkeypox State vs affected person (The year 2017)

Interpretation of Fig.2.: According to the displayed bar plot, Rivers, Bayelsa, and Cross-Rivers states had the most significant prevalence of afflicted persons in 2017. In terms of impacted population, Akwa-Ibom comes close behind. This research shows that Niger Delta populations are more vulnerable to monkeypox infection. As a result, additional attention and preventative measures are required to restrict the spread of monkeypox within the area successfully. Furthermore, the National Center for Disease Control (NCDC) must concentrate on many more states, including the Federal Capital Territory (FCT), Edo, Ekiti, Benue, and Lagos.

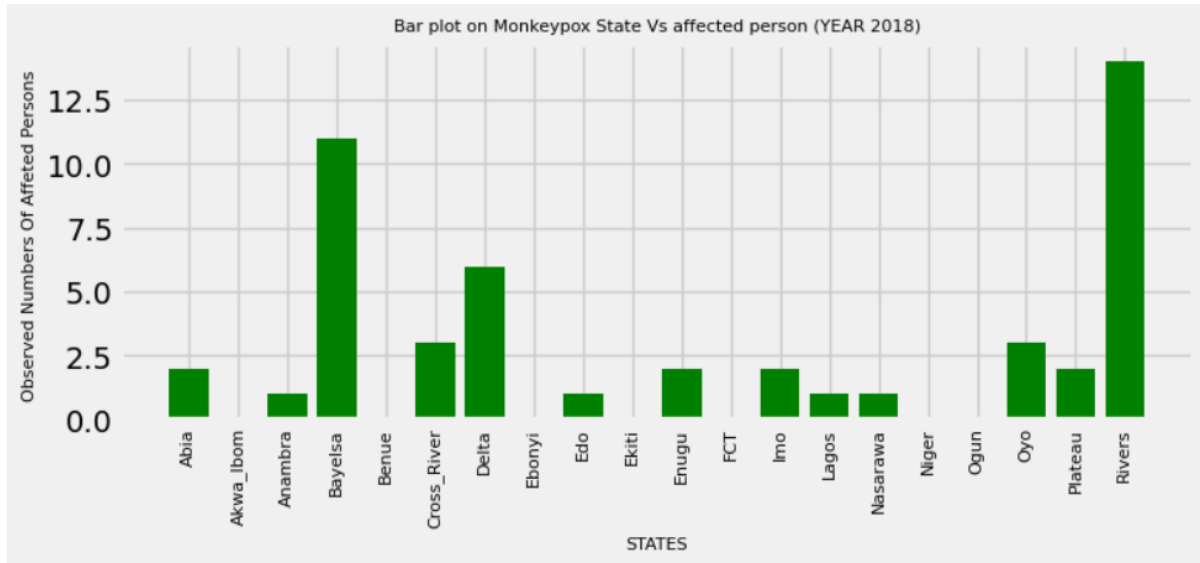


Fig. 3. Bar plot on Monkeypox State vs affected person (The year 2018)

Interpretation of result in Fig.3.: According to the plot above, Rivers, Bayelsa, Delta, Cross-Rivers, and Oyo states had the most people affected in 2018. This means that Delta and Oyo states, which had a lower frequency in 2017, are now experiencing an increase in the number of infected people. This pattern shows that these governments' preventative measures may have failed. If suitable precautions are not adopted swiftly, there is a risk of a further increase in disease transmission. Nonetheless, both Bayelsa and Rivers states have many registered voters.

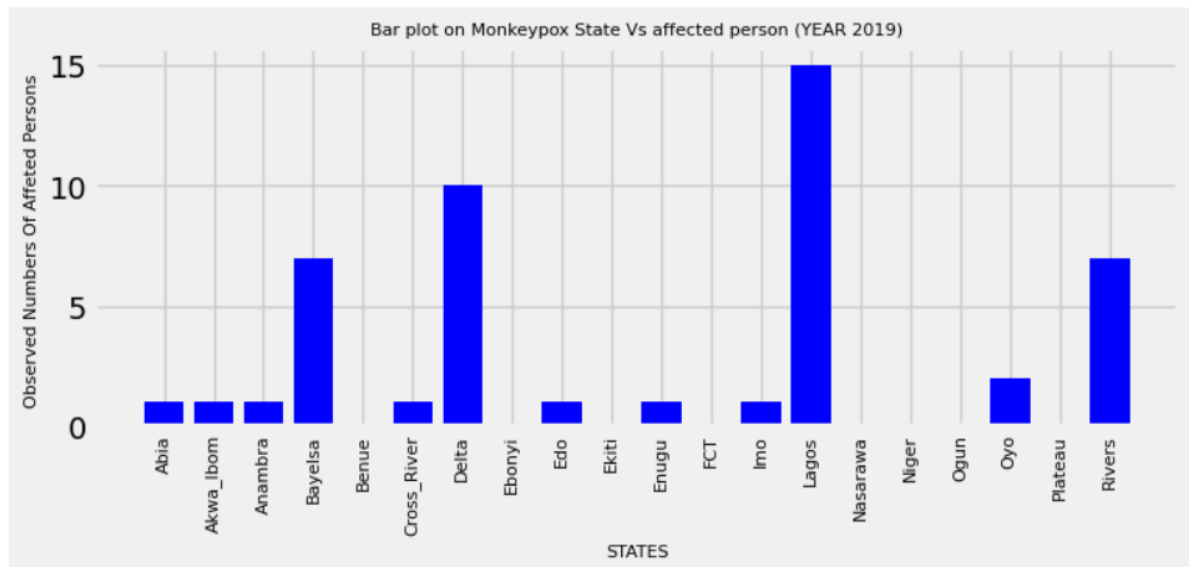


Fig. 4. Bar plot on Monkeypox State vs affected person (The year 2019)

Interpretation of Result Fig.4.: In 2019, the observed trend shows decreased registered persons in Bayelsa and Rivers states. This decrease implies that the authorities in these states have taken a cautious approach, implementing preventative measures that inhabitants have diligently observed. However, the number of people impacted increased occasionally in Lagos and Delta states.

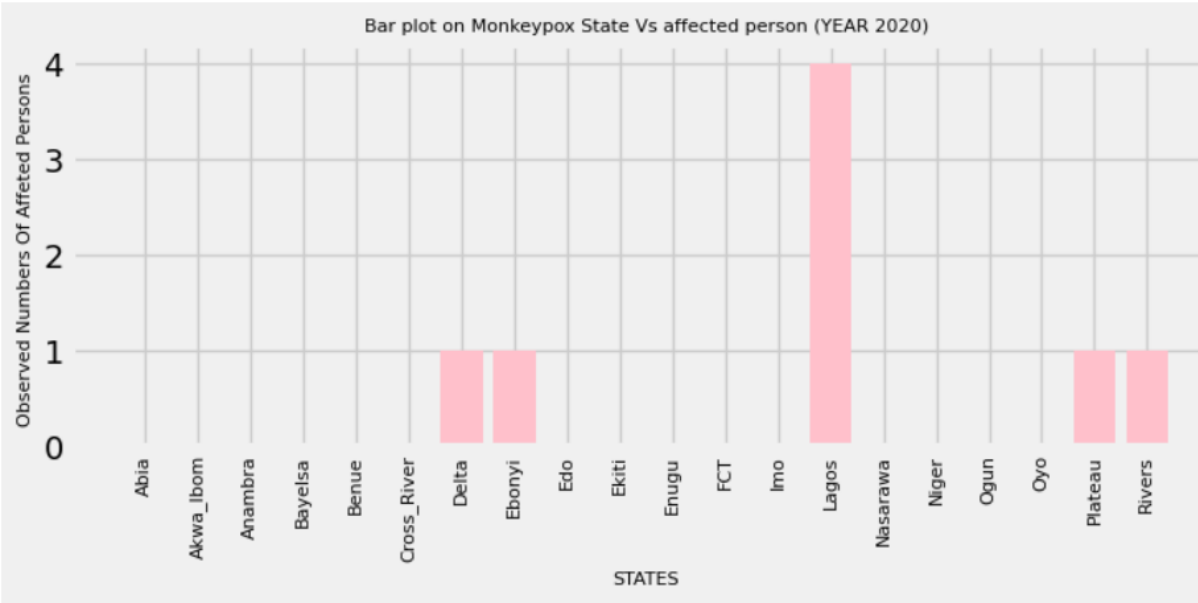


Fig. 5. Bar plot on Monkeypox State vs affected person (The year 2020)

Interpretation: Fig.5. depicts the growing number of afflicted persons in 2020. In order to alleviate this consistently increasing tendency, additional resources must be allocated to Lagos state. In comparison to Rivers, Delta, Plateau, and Ebonyi states, which are expected to have an equal number of people affected by the illnesses in 2020, the Federal Capital Territory (FCT), Akwa-Ibom, Edo, and Bayelsa states have made significant contributions to reducing the spread of these diseases. These states have successfully decreased the number of people impacted to zero (0).

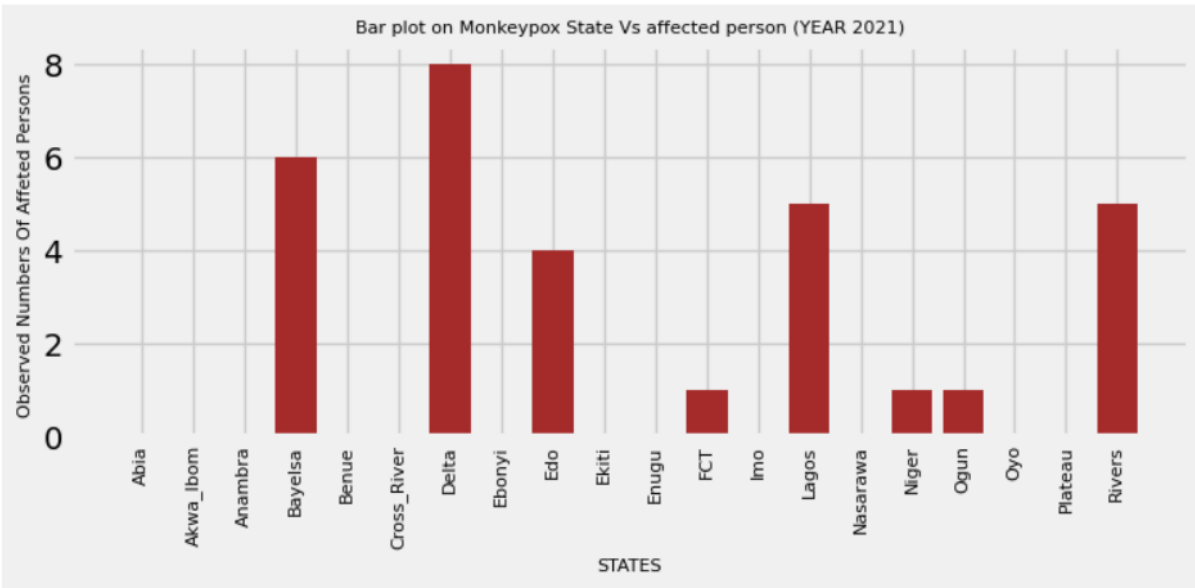


Fig. 6. Bar plot on Monkeypox State vs affected person (The year 2021)

Interpretation: Fig 6 depicts a projected growth in population size for the year 2021. Rivers, Bayelsa, Lagos, Delta, Edo, the Federal Capital Territory (FCT), Niger, and Ogun are projected to be impacted by this expansion. Some remain untouched, with an unknown number of people impacted. This finding suggests that jurisdictions with previously lower-case counts are seeing a dramatic increase in the registration of people afflicted by the illness.

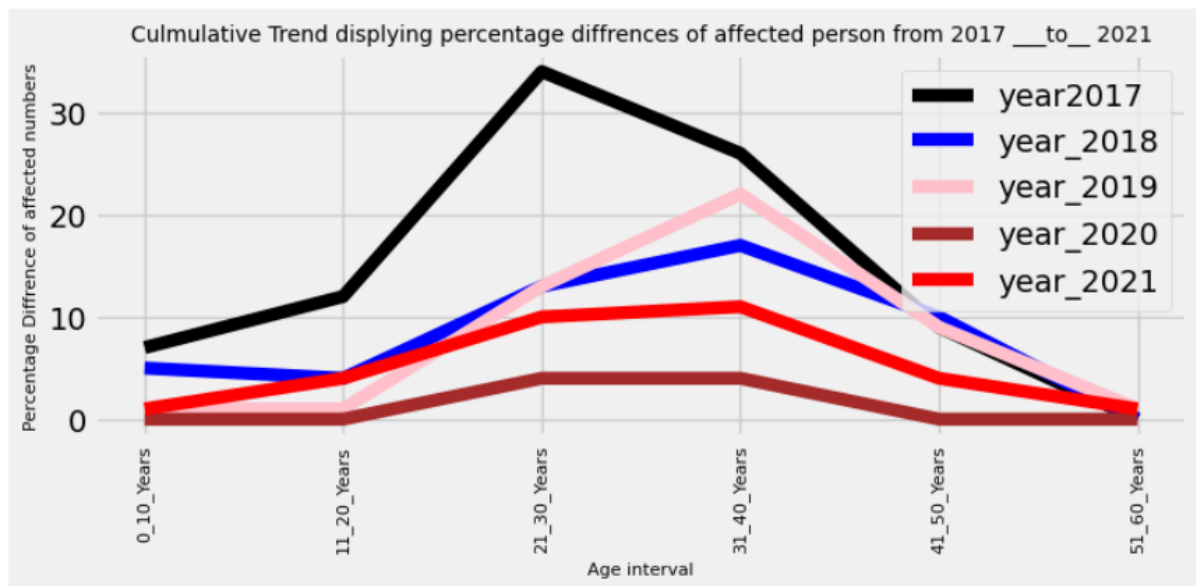


Fig.7. Cumulative Trend displaying percentage difference of affected persons from 2017-2021

Interpretation: Fig.7. above based on the statistics shown in the line chart, it is clear that a more significant number of people were affected in 2017. However, there was a decrease in the number of people impacted in 2018, followed by a rise in 2019. This variation resulted in a 22.5% percentage difference. In 2020, there was a significant improvement in attempts to reduce monkeypox transmission, resulting in a 4.9% decrease in reported cases. However, the incidence rate of people affected by this condition increased by 11.5% in 2021. What may be claimed in light of the situation? Based on the facts supplied, it is possible to conclude that there was a lack of effort and attention to guaranteeing a constant decrease in the number of afflicted persons. As a result, it is prudent to implement adequate safeguards and procedures to limit the spread. Failure to do so may cause the situation to deteriorate significantly.

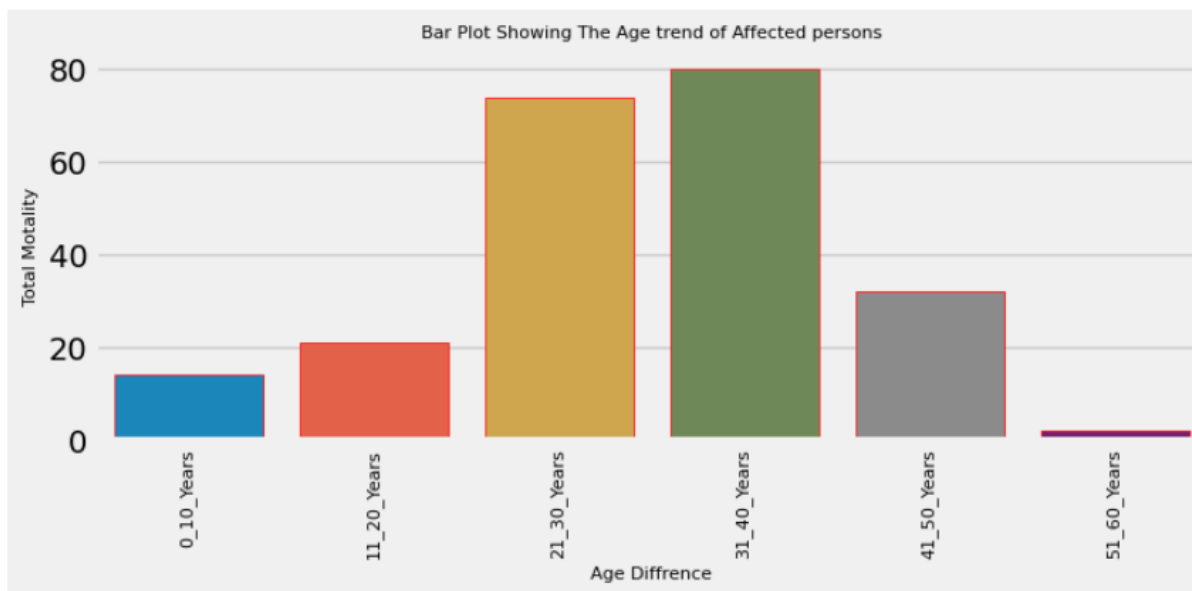


Fig. 8. Bar plot showing the age trend of affected persons

Interpretation: According to the bar plot in Fig.8., persons within the median age range are more susceptible to monkeypox, especially those between the ages of 31-40 and 21-30. As a result, it is prudent to target this group in attempts to halt the development of the illness. Individuals between 0 and 10 and 11 and 20 should also be constantly watched to avoid future spread. Notably, there is a return of monkeypox among adults aged 41-50, demonstrating a substantial relationship between age differences and the occurrence of this condition. Individuals under 50 tend to be the most vulnerable to monkeypox.

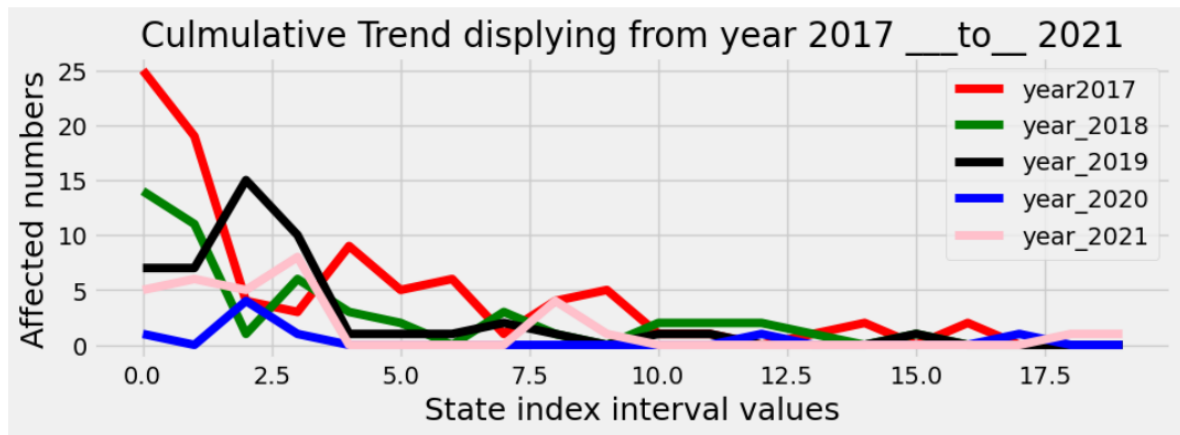


Fig. 9. Cumulative trend visualization showing from the year 2017 - 2021

Interpretation: The line chart in Fig.9. depicts the yearly cumulative trend in the documented number of afflicted persons. According to the statistics, there was a noticeable growth in the entire population in 2017, equivalent to a 25% increase. As a result, the population dropped by 10% in 2019 after dropping by 8% in 2018. In 2021, there was a 5% reduction, while in 2020, there was a 3% decrease.

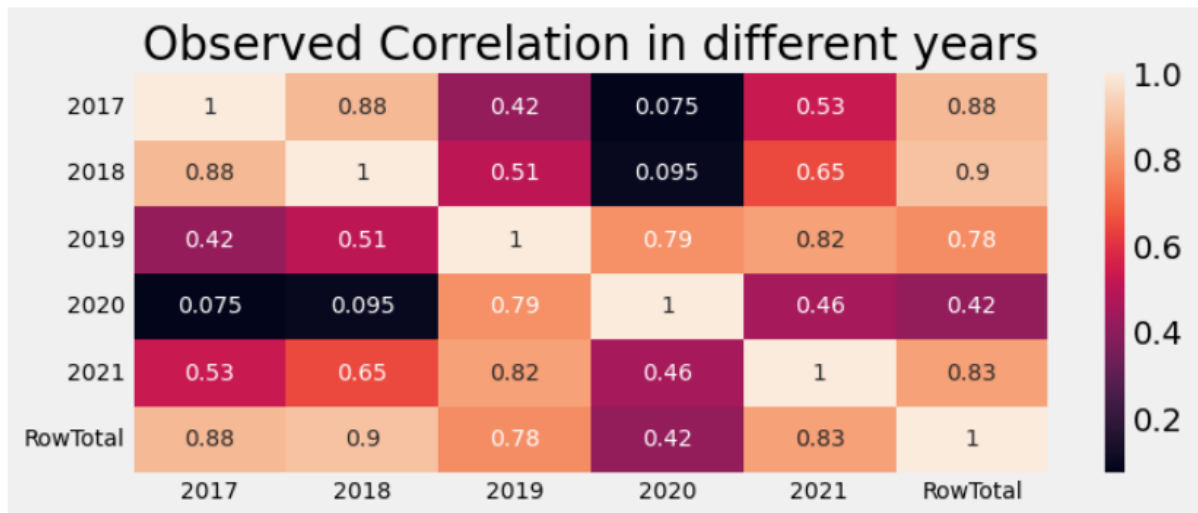


Fig. 10. heat map visualization showing the observed correlation concerning years

Interpretation: The heat map above depicts the relationship between age variations. The darker background's roots may be traced back to the years 2017 and 2019, indicating the existence of specific variables.

There is a close link between the population statistics reported in 2017 and 2019. When the primary diagonal is examined, it is clear that there is a strong connection, marked as 1, in the positive direction.

Table 4. Showing the descriptive statistics showing the 25th, 50th, and 75th percentile

Descriptive Statistical Measures	2017	2018	2019	2020	2021	Cumulative Row Totals
count	20.000000	20.000000	20.000000	20.000000	20.000000	20.000000
mean	4.400000	2.450000	2.400000	0.400000	1.550000	11.200000
std	6.564658	3.776311	4.096211	0.940325	2.523052	14.838073
min	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
25%	0.750000	0.000000	0.000000	0.000000	0.000000	2.000000
50%	2.000000	1.000000	1.000000	0.000000	0.000000	5.000000
75%	5.000000	2.250000	1.250000	0.250000	1.750000	10.750000
max	25.000000	14.000000	15.000000	4.000000	8.000000	52.000000

Interpretation: The caption provides descriptive and inferential statistics about the observed values. The count, mean, standard deviation, minimum, maximum, and 25th, 50th, and 75th percentiles are among the data included. According to the statistics, there was a significant rise in the number of persons infected during the initial phase of the

monkeypox pandemic in 2107, as seen by the comparative percentages of afflicted individuals in successive years, namely 2018, 2019, 2020, and 2021.

6. Conclusion

This system leverages machine learning models to predict Monkeypox disease based on symptom, offering valuable insights to healthcare professionals. The system's architecture, built on robust technologies such as python programming libraries, to ensure stability and scalability. Rigorous testing, performance evaluation, and training initiatives have been integral to the system's successful implementation, guaranteeing both functionality and proficiency.

However, this work has yielded a valuable tool that empowers users and healthcare professionals with predictive capabilities, enhancing our collective ability to combat the Monkeypox epidemic effectively. The system's successful implementation stands as a testament to meticulous planning, technical excellence, and a commitment to delivering a solution that addresses a pressing need.

Finally, increased awareness, diligent disease monitoring, quick detection, and practical information dissemination across healthcare facilities are critical in reducing the spread of an MPXV with pandemic potential.

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Authors' Profiles



Okorodudu Franklin Ovuolelolo is a lecturer with the Computer Science Department, Delta State University Abraka, with research interest in Artificial Intelligence, Modeling Simulations, E-Learning Using the Web, Machine learning, Data Modeling Concepts, he has several articles to his debut.



Onyecholem Ifeanyi Joshua just concluded is Master's Degree program with the Computer Science Department, Delta State University Abraka, with research interest in Machine learning and artificial intelligence.



Gracious C. Omede is a Lecturer with the Computer Science Department, Delta State University Abraka, with research interest in Systems Networks, Data Science and Software Engineering, he has also published several articles to his credit.

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