

Temporal and Spatial Epidemiology of Monkeypox (Mpox) in Plateau State of Nigeria

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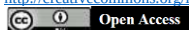
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ABSTRACT

The re-appearance of the monkeypox virus has become a global concern, especially for the World Health Organisation (WHO), which is responsible for promoting health, keeping the world safe, and serving the vulnerable. This necessitated the need for the Public Health Emergency Operation Centre (PHEOC), with support from the WHO office, to investigate the cumulative incidence of Monkeypox in Plateau State, the route of transmission and enabling factors in the state. The research will apply surveillance data gathered from the Ministry of Health (MOH) in the 17 LGAs with reported cases. Statistical analysis will be done using SPSS version 23.0. The findings revealed that only 16 cases were reported in the LGAs: Jos-North, Jos-South, Bassa, Shendam, Mangu and Pankshin. The source of the disease transmission was the use of second-hand clothes and people moving from one area to another. Thus, appropriate recommendations were proffered.

Introduction

Monkeypox is a rare viral illness that predominantly impacts humans and animals in Africa, although recent findings have been noted in additional areas (Mandja et al., 2019). The virus is transmitted from animals to humans and then spreads from person to person, presenting clinically as a vesiculopustular rash (varicella) accompanied by a fever akin to other prevalent illnesses. Monkeypox was first identified in Equateur Province of Zaire, now known as the Democratic Republic of the Congo, in 1970, with multiple cases documented across Central and Western Africa (Ladnyi et al., 1972; McCollum et al., 2016; Kantele et al, 2016; Hoff et al, 2017; Durski, et al, 2018). Increased incidence in numerous regions of the world prompted spatial epidemiology studies of Monkeypox, referred to in this study as *Mpox*. It is a zoonotic orthopoxvirus that manifests symptoms akin to human smallpox, with lymphadenopathy serving as the distinguishing characteristic. After an initial feverish prodrome, a maculopapular eruption with lesions on the palms and soles generally manifests. The ailment may persist for as long as four weeks, until the scabs detach and a fresh layer of skin develops. Complications include secondary bacterial infections, respiratory distress, bronchopneumonia, gastrointestinal involvement, dehydration, encephalitis, and ocular infections that may lead to permanent corneal scarring. Currently, there is no targeted therapy for monkeypox infection, and individuals receive supportive care and symptomatic treatment. The mortality rate for individuals unvaccinated against smallpox, which offers cross-immunity, is 11%. Human transmission occurs by respiratory droplets and contact with lesions harbouring the virus.

The recent noticeable rise in human monkeypox cases over an extensive region, the likelihood of additional transmission, and the lack of reliable monitoring have heightened apprehension about this emerging zoonotic disease. In November 2017, the World Health Organisation (WHO) and the Centres

for Disease Control and Prevention (CDC) convened an informal consultation regarding monkeypox, engaging researchers, global health stakeholders, health ministries, and orthopoxvirus specialists to evaluate and deliberate on human monkeypox in African nations with recent cases, while also pinpointing areas for enhancement in surveillance and response (Durski et al, 2018). The standard, according to the Centres for Disease Control and Prevention (CDC), is to use a negative-pressure room, along with droplet and airborne precautions when feasible, in medical environments.

From 2016 onwards, monkeypox instances have been documented and verified in the Central African Republic (19 instances), the Democratic Republic of the Congo (over 1,000 instances annually), Liberia (2 cases), Nigeria (more than 80 instances), the Republic of the Congo (88 instances), and Sierra Leone; an outbreak has also been reported among captive chimpanzees in Cameroon. Nigeria is suffering the greatest reported outbreak of human monkeypox in West Africa, with 80 confirmed cases. In October 2018, a traveller from Nigeria to Israel was diagnosed with the disease (Erez et al, 2018). In May 2019, a Nigerian guy who flew to Singapore was diagnosed with the disease (Yong.*et al.*,2020). In May 2021, following a trip to Nigeria, a family returned to the United Kingdom, where three family members contracted the *mpox* virus (Hobson *et al.*, 2021). The progressive emergence of symptoms in each family member could suggest human-to-human transfer. In July 2021, an individual travelling from Nigeria to Texas acquired the illness (Rao et al., 2021). In November 2021, an individual journeying from Nigeria to Maryland acquired the illness (Costello et al., 2021). As of May 2022, a case of human *mpox* in a man who returned to Massachusetts from Canada and outbreaks of human *mpox* in the United Kingdom are being examined.

Recent research has revealed that viral loads are high in bodily fluids such as urine, saliva, sperm, and faeces, as well as in swabs taken from the oropharynx and rectum, indicating that sexual transmission is a major factor in disease transmission. The emergence of cases is a worldwide health security risk (Wang et al., 2022). As an animal-transmitted virus, Plateau State is home to both wild and domestic animals due to the geomorphic nature of its habitat, which poses a mathematical danger of *Mpox* spreading. In numerous types of public health and epidemiological research, the spatial distribution of illness incidence and its association with putative risk factors play a crucial role. The technological breakthroughs and increasingly powerful and flexible spatial statistical techniques developed in this field can tackle more complex health issues than before. Therefore, surveillance of the geographical epidemiology of *Mpox* in Plateau State is required. The study investigates the incidence, root-to-human transmission, high-risk locations, and causative factors underlying regional heterogeneity.

Methods of the Research

Plateau State is situated in Nigeria's North Central Region, positioned between latitudes 8.371° N and 10.301° N, and longitudes 7.401° E and 8.401° E. In 1979, Plateau State was delineated from Benue-Plateau State. The state is bordered to the north by Bauchi State, to the east by Taraba State, to the south by Nassarawa State, and to the west by Kaduna State. The state's land expanse measures 26,901 square kilometres (Timothy, 2006). Plateau State is located in the central highlands of Nigeria (Refer to Figure 1). A multitude of traits draws a substantial populace and facilitates various economic endeavours. The plentiful availability of land makes agricultural production an essential element of the rural economy. Observations of the crops cultivated in several Local Government Areas underscore the significance of agriculture to the economy of Plateau State. The present Local Government Areas of Plateau State are Barkin Ladi, Bassa, Bokokos, Jos East, Jos North, Jos South, Kanam, Kanke, Langtang North, Langtang South, Mangu, Mikang, Pankshin, Qu'an-Pan, Riyom, Shendam, and Wase.

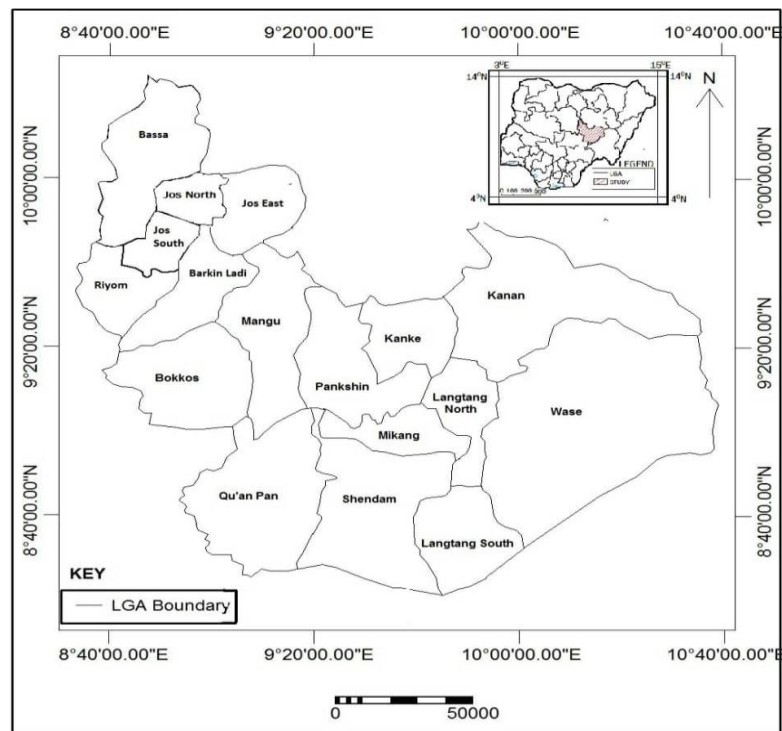


Figure 1: Study Area (Plateau State showing 17 LGAs)

The research method that will be used for this study will be a descriptive study. All confirmed cases will be used for the study. Interviewer-administered questionnaires will be used to collect data from confirmed cases of the disease using Google Sheets. Data collected will be cleaned and analysed using SPSS version 23.0; findings will be presented using tables and charts, and appropriate summary and chart statistics will be used where appropriate. Factor Analysis (FA) is an investigative method utilised on a collection of observable variables aimed at identifying latent factors (subsets of variables) that produced the observed variables. Typically, the objective of factor analysis is to facilitate data interpretation. Cluster analysis refers to a collection of multivariate methodologies aimed at recognising analogous entities based on their inherent properties. The elements consist of several shared factors in addition to a distinctive factor.

. The factor model is represented as:

$$X_i = A_{i1}F_1 + A_{i2}F_2 + A_{i3}F_3 + \dots + A_{im}F_m + V_iU_i$$

where

X_i = i th standardised variable

A_{ij} = standardised mult.Reg.coef. of $vari$ on common factor j

F_j = common factor j

V_i = standardised regcoeff of $vari$ on unique factor i

U_i = the unique factor for variable i

m = number of common factors

The underlying factors were addressed based on the responses of persons confirmed with Mpox in the study.

Results and Discussion

The results of monitoring 101 suspected cases of Monkeypox (*Mpox*) in Plateau State revealed that 52.5% of the suspects were male, 47.5% were female, and 27.8% of the suspects were between the ages of 0 and 9 years old. Other age groups include 22.1% between the ages of 10 to 19 years, 24.7% between the ages of 30 to 39 years, 22.1% between the ages of 10 to 19 years, 7.9% between the ages of 50 to 59 years, 2.9% between the ages of 40 to 49 and 60 to 69 years, and 1.9% between the ages of 70 and beyond. The marital status revealed that 57.6% of the respondents were single, followed by 31.6% who were married and 10.8% who declined to state their marital status, which we presumed to be children who do not comprehend the concept of marriage. Over 75.2% of the probable Monkeypox cases had invalid educational credentials. However, the report reveals that 11.9% had secondary school education, 6.9% had tertiary education, and only 2% had primary school education. 72.3% of the

suspected cases of persons' occupation had invalid results, with 8.9% showing pupils/students, 5.9% being farmers, 5.9% being housewives, 3% being business persons, and only 2% being children. Berom, Chawe, Fulani, Igala, Irigwe, Jhar, Lemoire, Ngas, and Taroh made up the majority of 73.3% of the population. 21.8% of the population was Hausa and 4.9% was Yoruba, as seen in Table 1

Table 1: Socio-demographic Details of Suspected Cases of Monkeypox in Plateau State

Sex	Frequency	Percentage
Male	53	52.5
Female	48	47.5
Age Group		
0-9	28	27.8
10-19	23	22.1
20-29	9	8.9
30-39	25	24.7
40-49	3	2.9
50-59	8	7.9
60-69	3	2.9
70-Above	2	1.9
Marital Status		
Single	58	57.6
Married	32	31.6
Prefer not to say	11	10.8
Education Attainment		
No education	4	4
Primary	2	2
Secondary	12	11.9
Tertiary	7	6.9
Invalid	76	75.2
Occupation		
Business	3	3.0
Child	2	2.0
Farmer	6	5.9
Healthcare Workers	2	2.0
Housewife	6	5.9
Pupil/student	9	8.9
Invalid	73	72.3
Ethnic group		
Hausa	22	21.8
Igbo	0	0
Yoruba	5	4.9
Others	74	73.3

Table 2 provides a summary of the symptoms of *Persons* who may have monkeypox. Of those *Persons*, 48.5% had suspected cases of monkeypox, 20.8% did not have cases of monkeypox, and 18.8% had confirmed cases, while 11.9% had not yet been categorised as cases. Only 66.3% of *Persons* did not show any symptoms of bumps, while 33.7% of *Persons* in the region where the surveillance was conducted did show symptoms of bumps. Of those who did show symptoms of mumps, 37.6% had fever, 5% had headache, 4% had rash, 2% had conjunctivitis, 2% had cough, 2% had rash lesions, 2% had muscle pain, and 2% had vesicular-pustular rash. 45.5% of suspected persons were not hospitalised and did not appear to be sick, while only 8.9% were admitted to a medical facility. The study identified the different kinds of quarantine that some suspected persons were subjected to in Table 2. According to the findings, 15.8% of suspected *Persons* were not subjected to any kind of quarantine, 13.9% were

quarantined in their own homes, 3% had an unknown area of quarantine, 2% were quarantined in hospitals and other places, and 1% were quarantined in institutions, with 62.4% of respondents being invalid.

Table 2: Symptoms of Suspected Persons with Monkeypox in Plateau State

Description	Frequency	Percentage
Confirmed Case	19	18.8
Not case	21	20.8
Not Yet Classified	12	11.9
Suspected Case	49	48.5
Total	101	100
Symptomatic		
Yes	34	33.7
No	67	66.3
Type of Symptoms		
All rash lesion	2	2.0
Chills or Sweat	1	1.0
Conjunctivitis	2	2.0
Cough	2	2.0
Fever	38	37.6
Headache	5	5.0
Muscle Pain	2	2.0
Rash itches	4	4.0
Vesiculopustula rash	2	2.0
Hospitalized		
No	46	45.5
Yes	9	8.9
Invalid	46	45.5
Type Quarantine		
Home	14	13.9
Hospital	2	2.0
Institutional	1	1
None	16	15.8
Other	2	2.0
Unknown	3	3.0
Invalid	63	62.4

Barkin Ladi, Bassa, Bokokos, Jos-East, Jos-North, Jos-South, Mangu, Pankshin, Shendam, and Wasa were the nine local government areas (LGAs) in the state that raised suspicions regarding the presence of Mpox viruses. As a result, surveillance was carried out in all of the state's MOHs to look for signs and symptoms of the virus. The state has a total of 17 LGAs. The Local Government Areas (LGAs) that were found to have confirmed cases of *Mpox* are presented in Figure 2. In the state of Plateau, the local government area of Jos-North has the highest number of confirmed cases, with a total of eight *Persons* having tested positive for the disease. In addition, three *Persons* have tested positive in Mangu LGA, two *Persons* have tested positive in both Jos-South and Shendam LGA, and only one person has tested positive in both Pankshin and Bassa LGA. This indicates that Jos-North has a rather high number of *Persons* infected with *Mpox*.

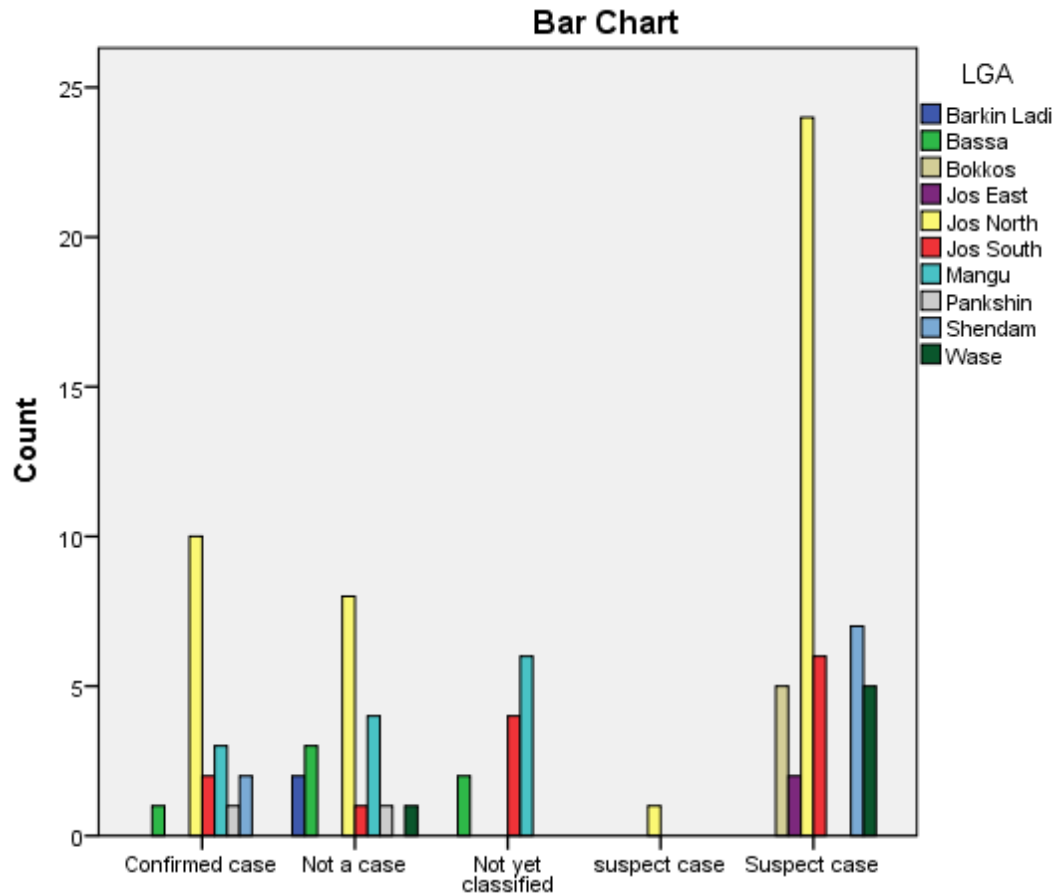


Figure 2: Confirmed Cases of *Mpox* in Local Government Areas (LGAs) of Plateau State

The monkeypox virus may transmit between individuals via close or direct contact with skin lesions, through substantial respiratory droplets, and potentially through infected surfaces. During the surveillance period, a total of 16 Persons with confirmed cases were interviewed to explore the root transmission of the monkeypox virus, which was found to occur either from animal to human or from human to human. 94.7 percent of the confirmed cases did not have scratches or bites from their animals or any other animals, and 84.2% did not travel in the last 21 days prior to the onset of mumps symptoms; 63.2% of the confirmed cases raised animals in their households; 66.7% of the confirmed cases never related with animals; 63.2% of the confirmed cases raised animals in their households; 66.7% of the confirmed cases never related with animals; 94.7 percent of the confirmed cases did not have contact with animal 94.7% of respondents said they had not noticed any blisters, rashes, or bumps on fellow workers, and 68.4% of respondents said they do not eat bush meat. Patronage of second-hand clothing for the family among persons confirmed with *Mpox* was 84.2%, which appears to be the major route of transmission of the virus in the region. The confirmed cases of persons with *Mpox* virus did not report discomfort, redness, or bumps in family, friends, and associates. Additionally, no one reported having cuddling or intercourse with his or her partner who has rashes/bumps on the body. Finally, 84.2% of persons diagnosed with mumps have not been in an environment that contained animals within the past two weeks.

Table 3: Root Transmission of Monkeypox to persons in the region

Description	Frequency	Percentage
Travelled in the last 21 days prior to date of onset of symptoms		
Yes	3	15.8
No	16	84.2
Raise Animals in households		
Yes	12	63.2
No	7	36.8
Interact with animals		
very frequently	1	5.6
Frequently	2	11.1
not Frequently	3	16.7
Never	12	66.7
Had scratches or bites from animal in last two weeks		
Yes	1	5.3
No	18	94.7
Contact with animal's blood or bodily fluid		
Yes	2	10.5
No	17	89.5
Seen sores, rashes or bumps on associate		
Yes	1	5.3
No	18	94.7
Consume bush meat		
Very Often	1	5.3
Often	1	5.3
Not Often	4	21.1
Not at all	13	68.4
Detect discomfort, redness, bumps on family, friends and associates		
Yes	4	21.1
No	15	78.9
Intimate cuddling or intercourse with partner that has rash/bumps in the body		
Yes	1	5.3
No	16	84.2
I can't recall	2	10.5
Patronise secondhand clothing for your family		
Yes	16	84.2
No	3	15.8
I can't recall	0	0
Been to an animal-filled environment in the last two weeks		
Yes	3	15.8
No	16	84.2

Jos-North has the most confirmed instances of *Mpox* virus, according to table 3 above, and because it is the state capital of Plateau, the influx of individuals from both inside and outside the LGA makes it a high-risk area. Jos-North LGA is notable for its abundance of secondhand clothing markets. This, however, suggests that underlying transmission of *Mpox* is not different with other LGAs such as Bassa, Jos-south, Pankshin and Shendam.

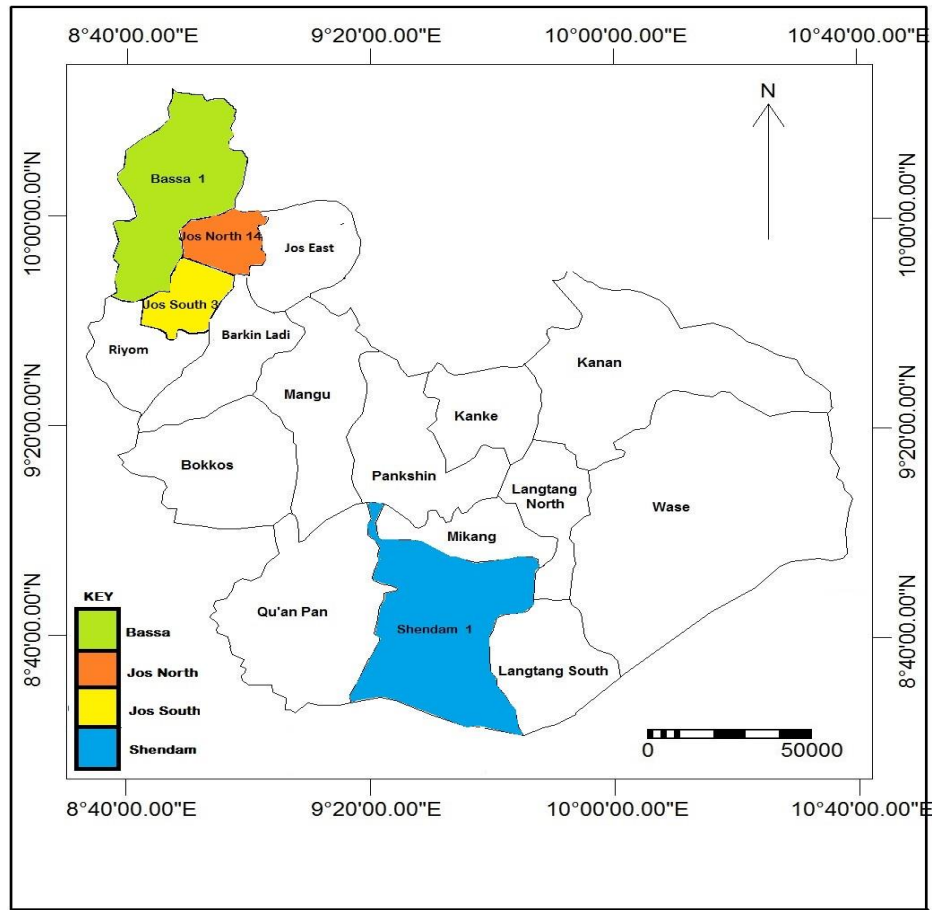


Figure 3: Density of *Mpox* in the LGAs of Plateau State

As indicated in Figure 3, LGAs with confirmed cases of *Mpox* show clusters among Jos-North, Jos-South, and Bassa, while Pankshin and Shendam have links. This, however, confirms that transmission is possible within the LGAs in Plateau State. Necessary measures should be considered to avoid spreading the virus in the state according to W.H.O standards.

Component Score Coefficient Matrix

	Component		
	1	2	3
Travelled last 3 weeks	.916	-.253	-.235
Raise animal in the household	.489	.597	-.330
Interact or play with animal as pet	.959	-.092	-.086
Animal scratched or bitten	.752	-.039	.644
Direct contact with animal's blood or bodily fluid	.752	-.039	.644
Seen rashes, sores or bumps on animal's skin	.916	-.253	-.235
Consume bushmeat	.922	.007	.046
Friend, family or associate has discomfort, redness or bumps	.852	-.155	-.297
Intimate cuddling or intercourse with someone with rashes	.665	.576	.299
Patronize secondhand clothings	.351	.839	-.189
Visited animals environment two week before been infected	.916	-.253	-.235
Eigen value	6.945	1.620	1.326
% of Variance	42.377	27.359	69.736
% Cumulative	42.377	69.736	89.919

Extraction Method: Principal Component Analysis.
Rotation Method: Equamax with Kaiser Normalisation.

The factor analysis disclosed the consolidated factors. A rotation technique utilising Varimax with Kaiser Normalisation was employed to accomplish this. The outcome achieved convergence in 11 rounds, therefore condensing the factors into 3 separate components. The three elements produced the fundamental factors that influence the population shifts from rural to urban areas. These collectively accounted for 89.9% of the cumulative variance. This indicates that these three fundamental characteristics accounted for roughly 89% of the overall variance in the primary transmission of Mpox, with 11% attributable to other influences.

The above table shows the results of factor analysis for root transmission of Mpox with 3 components extracted.

Component I have an eigenvalue of 6.945 and accounts for 42.377% of the total variance. It has significant loadings on six variables: X1(travel last 3 week), X3(Interact with animals), X4 (Animal Scratched or bite), X6(Seen rashes, sores or bumps on animal's skin), X7(Consume Bush meat) and X8(Urban population imbalance), X9(Friend, family or associate is discomfort, redness or bumps seen) and X11(visited animals' environment two week before been infected). All these variables increase the risk of people contracting the Mpox virus.

Component II, with an eigenvalue of 1.620, shows 27.359 of the total variance. It loads significantly on variables. The variable is X10 (Patronise second-hand clothing). The underlying factor for the root transmission here used is second-hand clothings

Component III with an eigenvalue of 1.326 reveals 69.736 of the total variance; the load is significant on the variables with loadings of X4(Animal scratched or bitten) and X5 (contact with animal's blood or bodily fluid). This shows that contact with animal blood or bodily fluids can infect a person with Mpox. All assumed root transmission routes show significant potential to infect people with the virus; however, people should avoid those factors in the endemic period of Mpox in the world

Conclusion

The apparent increase in human monkeypox cases across geographic locations globally has generated great concern among international organisations that are saddled with the responsibility for protecting the environment from infectious diseases. To avoid the widespread spread of such transmissible diseases, providing surveillance in all areas suspected of having signs or symptoms of Mpox mandated this research in the region. Plateau State was put on surveillance, like all other states in Nigeria. This, however, revealed about 16 confirmed cases of Mpox out of 101 suspected cases recorded in 6 LGAs: Jos-North, Jos-South, Bassa, Pankshin, Mangu, and Shendam, with the highest number in Jos-North. The major root of transmission was spatially indicated through the use of second-hand clothing, according to confirmed Mpox cases, which might be insufficient to justify the claim in other areas. However, all assumed root transmissions are based on the analysis, which explains 89% of the cumulative variance. Proper surveillance should be a continuous process in Plateau State. Medical personnel should be taught to spot and treat Mpox. There is a need for sensitively targeted health promotion that backs up increased testing and education efforts among vulnerable populations. Engaging communities at the outset of developing public health measures is essential to ensure their appropriateness and avoid stigmatisation, preventing messaging that might push the pandemic into secrecy. The duration of infectious viral shedding following the healing of lesions is uncertain. To mitigate the epidemic and address informational deficiencies, the world must collaborate. Swift case detection is crucial for containment without extensive treatment or preventive measures. Monkeypox, like many other ailments, can manifest in diverse ways, which is characteristic of therapeutic practice.

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