



Trend Analysis of Lassa fever in Bauchi State

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ABSTRACT

Lassa fever (LF) is an acute viral hemorrhagic fever endemic and its impact has ravaged most of West African countries with Nigeria inclusive. The occurrence of the diseases has a periodic pattern in Nigeria exhibiting mostly period of November to March of every year which is directly proportional to the climatic conditions. This study was conducted to determine the trends of Lassa fever in Bauchi state and a look for an increased effort by all stake holders. This is because all hands must be on deck. The study uses secondary data from the surveillance indicators from the National Lassa Fever Technical Working Group at the Nigeria Centre for Disease Control in conjunction with Abubakar Tafawa Balewa University Teaching Hospital, Bauchi. Data on total reported case, tested negative and mortality was collected and used. Findings showed that there is steady increase in magnitude of Lassa fever in Bauchi state with a transmission rate found to be periodic and time dependent, driven by climatic factors such as rainfall, humidity. It poses a serious public health was dared by the defiance, and as such there is need set a benchmark for proactive plans to tackle the menace. For the level of awareness about the disease, there is much that is at the dark side of the disease about the environmental connections to the disease. The treatment centers of Lassa fever should be isolated entity apart from the major facilities for more inward treatment to enhance proactiveness in dealing with the disease. The State government in conjunction with the State Primary Health Care Development Agency should organize training, workshops and seminars of health care workers using the Standard Operating Procedures and use of well defined guidelines on preventive practices procured by NCDC.

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INTRODUCTION

Lassa Fever virus, also known as the Lassa hemorrhagic fever (LHF), is an acute viral hemorrhagic illness cause by Lassa virus (LASV) that last for 2-21 days in humans and generated recurrent outbreaks in Western Africa (Richmond & Baglolle, 2003). The virus is endemic to much of sub-Saharan West Africa with regular widespread outbreaks (Gibb et al., 2017). The LHF risk areas approximately cover 80% of Sierra Leon and Liberia, 50% of Guinea, 40% of Nigeria, 30% of Benin, Cote d'Ivoire and Togo and 10% of Ghana (Fitchet-Calvet, 2009; Akhmetzhanov et al., 2019). In 2018, an unusually large increase in LASV cases occurred in Nigeria, which led the WHO to declare it an outbreak, classified it as a

grade 2 public health emergency (Katherine et al., 2018). The Nigerian Center for Disease Control (NCDC) had reported 431 laboratory-confirmed cases in patients from 21 states in 2018 alone, including 37 health care workers, with an estimated case fatality rate of 25% (Kolawole et al., 2019). In recent years 2019 and 2020, Nigeria has carried the major burden of reported disease.

Generally, LASV transmission occurs through direct contact with rat urine, faeces, and saliva or through contact with excretion- or secretion-infected materials, the use of rodents as a food source in some areas provides a further avenue of exposure (Carey et al., 1972). Furthermore, LASV can transmit between humans via direct contact with



infected bodily fluids such as blood, urine, and faeces (Akhmetzhanov et al., 2019). Epidemiological modelling studies found that 20% of hospitalized LF cases were infected by other people, with high levels of transmission due to super-spreaders (Chowell et al., 2016).

The current strategies for preventing LASV infection focus on avoiding direct and indirect contact with *Mastomys* rodent secretions, excretions and improved hygiene in health facilities (Fisher-Hock et al., 1995). However, these measures have proven challenging to implement effectively, and are unlikely to result in effective control in the foreseeable future (Hamblion et al., 2018). Several promising studies support a LASV vaccine, although vaccine candidates have not yet undergone clinical trials (Demby et al., 2004; Saez et al., 2018).

Trend of Lassa Fever

The overall regional and global risk is considered low due to minimal cross-border transmission from Nigeria to neighbouring countries. Lassa fever is known to be endemic in West African countries, primarily in Sierra Leone, Guinea, Liberia and Nigeria (WHO, 2022). Lassa fever is endemic in West African countries of Sierra-Leone, Nigeria, Guinea, and Liberia with about 300,000 - 400,000 cases occur annually with approximately 5,000 deaths (Ogbu et al., 2007). Its severity was reported in Central African Republic, Democratic Republic of the Congo, Mali and Senegal (McCormick et al., 1987; Tomori et al., 1988; Ogbu et al., 2007).

In Nigeria, Lassa outbreak is said to have spread over 18 states (Anambra, Bauchi, Benue, Nasarawa, Ebonyi, Edo, Ekiti, Federal Capital Territory, Delta, Kogi, Gombe, Ondo, Plateau, Rivers, Taraba, Osun, Lagos and Imo) of the countries affecting over one thousand and eighty-one (1081) people while three hundred and seventeen (317) were classified as confirmed, eight (8) as probable and seventy-two (72) (WHO 2018).

In January 2022 alone, 211 laboratory confirmed Lassa fever cases including 40 deaths (case fatality ratio: 19%) have been cumulatively reported in 14 of the 36 Nigerian states and the Federal Capital Territory across the country with three states account for 82% of confirmed cases: Ondo (63), Edo (57) and Bauchi (53). Other states affected are Benue (11), Ebonyi (5), Oyo (5), Taraba (5), Kogi (4), Enugu (2), Kaduna (2), Cross Rivers (1), Delta (1), Katsina (1) and Plateau (1).

According to Lassa Fever Situation Report, in August 2022, there are 894 confirmed cases from 25 states and 101 local government areas. Of all confirmed cases, 70% are from Ondo (31%), Edo (26%), and Bauchi (13%) with a total of 168 deaths having case fatality rate (CFR) of 18.8%, which is lower than the CFR for the same period in 2021 (23.3%). The predominant age group affected is 21-30 years. There is an increase in the number of suspected cases when compared to that reported for the same period in 2021.

Characteristic	Suspected cases	Confirmed cases	Probable cases	Deaths (confirmed cases)
2019	5,057	833	19	174
2020	6,791	1,189	14	244
2021	2,872	365	3	83
2022	6,471	899	37	169

Source: Statista, 2022

World Health Organization (2022) stated that the peak of Lassa fever cases in humans typically occurs in the dry season (December – April) and follows the reproduction cycle of the *Mastomys* rats in the wet season (May – November). Given that 90 - 95% of human infections are due to indirect

exposure (through food or household items contaminated by infected rats' excreta) or direct contact with infected *Mastomys* rats, the very high density and high circulation of Lassa fever virus in the rat population poses a risk for further human infection during the dry season (WHO, 2022).

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There is an insufficient enormity, amplitude and the degrees of the risk factors associated with the disease is considerable and substantial that affect the early warning, rapid responses and the control of the diseases. By these aforementioned, this research aimed to determine the trend of Lassa fever infection and a look for an increased effort by all stakeholders in Bauchi State from 2019 to date.

Data Collection

Lassa fever surveillance in Bauchi state follows a hierarchical channels through the 'Integrated Disease Surveillance and Response' (IDSR), a strategy adopted by countries in the WHO African Region for implementing comprehensive public health surveillance and response systems for priority diseases, conditions and events at all levels of health systems. Information flows from the health facilities, through the ward focal persons to the Local Government Areas (LGA) Disease Surveillance and Notification Officers (DSNOs), to the State DSNOs who is in the Ministry of Health, Hospital Management Board and Bauchi State Primary Healthcare Development Agency, and then to the Federal Ministry of Health (Nigeria Centre for Disease Control) through the State Epidemiologists at various locations in the state where it is tagged as Lassa epicentre.

Source of Data and Scope

The study used secondary data. Reported cases of Lassa fever from IDSR records from 2018 - 2021 was conducted. IDSR weekly epidemiological data line list for the years under review was obtained from the Planning, Research and Statistics Unit of Abubakar Tafawa Balewa Teaching Hospital (ATBUTH) in conjunction with the Surveillance and Epidemiology Department of the Nigeria Centre for Disease Control (NCDC). The variables reported were Lassa fever classifications based on laboratory diagnosis (reported, suspected, confirmed and death).

Data Management

The collected data was subjected to data cleaning and preliminary analyses, classifications and sorting based on geographical, chronological, quantitative and qualitative characteristics; like total reported cases, number of cases, locations and laboratory results (positive or negative), recovery, deaths and so on. We examined the data for validity and reliability. Data was collected and analyze using SPSS V23. The analysis was based at 5% level of significance.

Ethical Considerations

Approval was received from the Administrative Unit of ATBUTH and Surveillance and Epidemiology Department of Nigeria Centre for Disease Control (NCDC).

RESULT AND DISCUSSION

Descriptive Statistics

Table 1: Descriptive

Item	Variable	Frequency	Percentage (%)	Total
Gender	Male	277	71.8	100%
	Female	109	21.2	
Age	18 – 30 years	216	56.0	100%
	31 – 40 years	107	27.7	
	41 – 50 years	13	12.9	
	51 years and above	3	3.4	
Location	Urban	176	45.6	100%
	Rural	210	54.4	

Source: Author's Computation using SPSS, 2022

From the table above, result showed that the population proportions that were mostly affected by Lassa fever were male representing 71.8% while female were 21.2%. Lassa fever affect those with younger age as seen from the result those between the age group of 18 – 30 years (56%), followed by those between 31 – 40 years of age (27.7%). Between 41 – 50 years were 13, representing 12.9% while the least affected were those aged more than 50 years (3.4%). This is in line with the Lassa Fever Situation Report on Epi-Week 42: 17 – 23 October, 2022 which has it

as the predominant age group affected is 21 - 30 years; median age is 30 years and the male – to – female ratio for confirmed cases is 1:0.8

The distribution by location shows that most of those affected with Lassa fever are from rural areas (54.4%) while 176 patients representing (45.6%) were from urban areas. It was observed by Nwonwu et al., (2018) that a greater proportion of people live in the rural communities where poverty prevails, and standards of living are low, and the emergence of highly contagious diseases (like Lassa fever) fever is common.

Table 2: Lassa fever Tested Negative and Mortality in Bauchi State

Quarter	2018		2019		2020		2021	
	Negative	Death	Negative	Death	Negative	Death	Negative	Death
I	1	0	22	7	19	8	25	11
	3	1	11	6	16	5	23	6
	3	2	10	1	6	2	15	3
II	2	2	1	0	2	2	11	2
	1	1	0	0	2	1	8	2
III	1	0	1	0	0	0	5	3
	3	1	2	2	0	0	12	1
	4	1	2	1	1	0	13	1
IV	7	1	1	0	1	0	12	0
	9	3	0	0	3	1	2	0
	5	1	1	0	4	3	5	0
	22	13	37	12	4	2	15	1

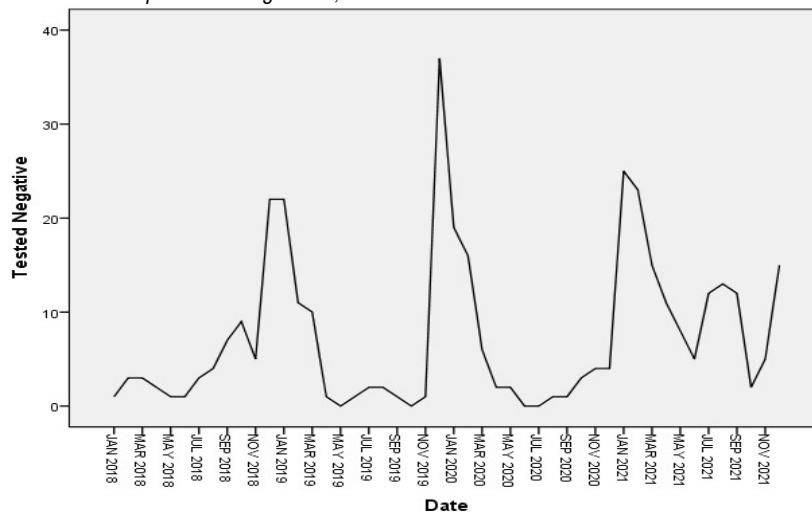
Source: ATBUTH, 2022

Time Series Plot of Lassa Patients Tested Negative

Model Description

Model Name	MOD_8
Series or Sequence	1 Tested Negative

Source: Author's Computation using SPSS, 2022



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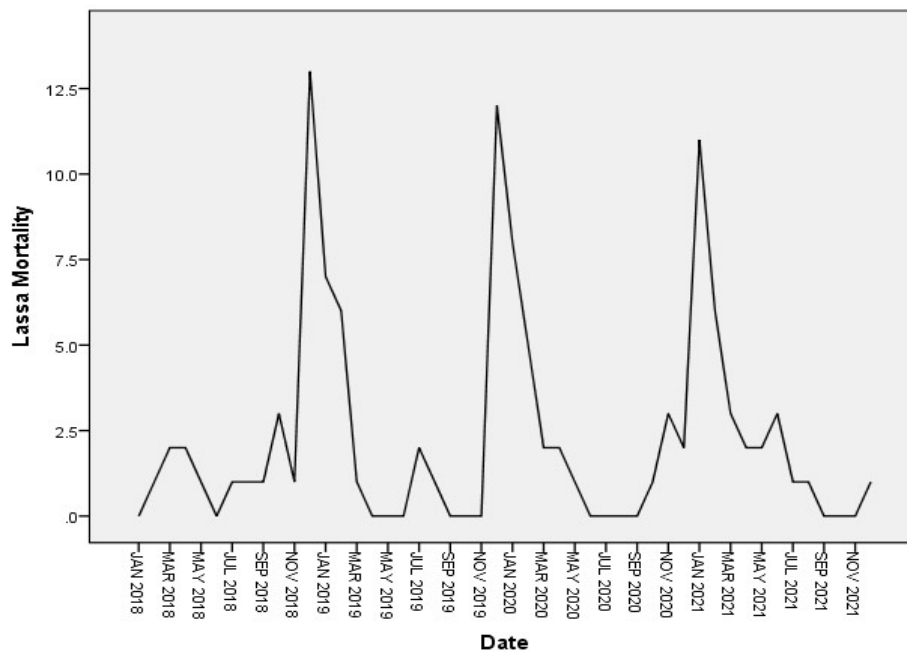
The fluctuations above shows the ups and downs that exactly depict seasonality movement indicating the periodic behavior of Lassa fever and composed of multiple underlying periodicities when a considerable amount of random noise is less effected within the data set. The plot provides the clearest means of identifying periodic components. The predictor represents factors that are within the control benchmark (treatment) with all of the candidate predictors to find the best model that have a statistically significant relationship with the dependent series, time. The peak of the oscillations is within November 2019 to February 2020.

Time Series Plot of Lassa fever Mortality

Model Description

Model Name	MOD_8
Series or Sequence	1 Lassa Mortality

Source: Author's Computation using SPSS, 2022



The oscillation in the Lassa mortality shows that Lassa fever mortality is purely periodic, but despite the periodicity, the trend is gradually and steadily declining. The death associated with the disease is time dependent and as such, time has a significant influence on the occurrence of the disease as well as mortality. This is because the presence of white noise within the data set follows a natural cause and no any colour noise is detected, assignable cause. The highest mortality is within November 2018 to January 2019, the second season is within November 2019 to January 2020 and so on.

This is in line with the study conducted by Adewuyi, et al. (2009) who shows the association of Lassa fever with the

season and the highest cases of Lassa fever were usually during the dry season, with the rainy season having the lowest. In the same vein, Redding et al. (2021) shows a link between the habitat of virus and rainfall as a contributing factor to the disease. Environmental factors, like temperature, humidity, and seasonality are predictors of Lassa fever transmission (Abdullahi et al., 2020) with dry season that is usually the peak of the cases in endemic areas in Nigeria which could be as a result of the varying interaction between humans and rodents during the rainy and dry season. It has an impact on Lassa fever transmission (Hansen et al. 2021), and can be used to predict outbreaks in the future. Others, like Ogbu et al. (2007), Akhmetzhanov



(2019), Zhao, et al. (2020) in their studies posited that in Nigeria, Lassa fever outbreaks have been known to occur during the dry season and between November and May, and has a positive association with rainfall; with

Nchom, et al. (2021) found that there was a hike in cases during the dry season when rainfall has significantly reduced and served as the proliferation of Lassa fever in Nigeria.

Predictive Ability of Lassa Model Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.746	.556	.551	3.7909

Source: Author's Computation using SPSS, 2022

The coefficient of correlation shows a positive and significant relationship ($r = 0.746$; $p = 0.003 < 0.05$) between Lassa infection and time. The coefficient of determination shows

that the dependence of Lassa on time is significant by 55.6%. That is to say about 55.6% of Lassa incidence depends on time (seasonality).

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6165.346	1	6165.346	32.378	.003
	Residual	8759.217	46	190.418		
	Total	9212.000	47			

Source: Author's Computation using SPSS, 2022

The measure of reliability of the significance of the established relationship and dependency shows that it is ensured that the

justification by the result in ANOVA as the p -value (0.003) is less than level of significance.

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21.726	2.684		18.095	.000
	Tested Negative	.377	.245	.222	11.542	.003

Source: Author's Computation using SPSS, 2022

The regression model established shows the effect of time on the occurrence of Lassa fever. It has a significant beta weight with its corresponding t -value that is statistically significant indicating a significant impact of time on Lassa incidence. The predictive equation is: $y = \beta_0 + \beta_1x$ which is equivalent to $y = 21.726 + 0.377x$.

CONCLUSION AND RECOMMENDATIONS

There is steady increase in magnitude of Lassa fever in Bauchi state with a transmission rate periodic and time dependent, driven by climatic factors such as rainfall, humidity. It poses a serious challenge and as such there is need set a benchmark for proactive plans to tackle the menace. The level

of awareness about the disease, there is much that is at the dark side of the disease about the environmental connections to the disease. The treatment centers of Lassa fever should be isolated from the major facilities for more inward treatment to enhance pro-activeness in dealing with the disease.

There is need for increased efforts by Government and other stakeholders to sensitize the public about the improved attitude towards the LASV preventive practices. The State government in conjunction with the State Primary Health Care Development Agency should organize training, workshops and seminars of health care workers using the Standard Operating Procedures (SOP) and



well defined guidelines on preventive practices procured by NCDC. Adoption of traditional and religious leaders as well as ward heads to be included in the door – to – door sensitization campaign which will enhance the public awareness about the disease. Good hygiene is critical for preventing the spread of infectious diseases.

REFERENCE

- Abdullahi I. N., Anka, A. U., Ghamba, P. E., Onukegbe, N. B., Amadu, D. O., (2020) Need for preventive and control measures for LASV through the one health strategic approach. *Proceedings of Singapore Healthcare* 29: 190-194.
- Adewuyi, G.M., Fowotade, A., Adewuyi, B.T. (2009) Lassa fever: Another Infectious Menace. *Afr J Clin Exp Microbiol* 10:144-155.
- Akanni, J., Adediipo A. (2018) Sensitivity analysis of the dynamical transmission and control of LASV virus. *Asian Res J Math*, 9(3):1–11
- Akhmetzhanov AR, Asai Y, Nishiura H (2019) Quantifying the seasonal drivers of transmission for LASV in Nigeria. *Phil Trans R Soc B* 374: 20180268.
- Carey, D. E., Kemp, G. E., White, H. A., et al., (1972) LASV epidemiological aspects of the 1970 epidemic, Jos, 380 Nigeria, *Trans. R. Soc. Trop. Med. Hyg.*, 66 (1972), 402-408.
- Chowell, G., Sattenspiel, L., Bansal, S. and Viboud, C., (2016) Mathematical models to characterize early epidemic growth: A review, *Phy. Life Rev.*, 18 (2016), 66-97
- Demby, A. H., Inapogui, A., Kargbo, K., Koninga, J., K. Kourouma, et al., (2004) LASV in Guinea: II. Distribution and Prevalence of LASVirus Infection in Small Mammals, *Vector Borne Zoonotic Dis.*, 4 (2004)
- Fichet-Calvet, E. and Rogers, D. J., (2009) Risk Maps of LASV in West Africa, *PLoS Negl. Trop. Dis.*, 3 (2009)
- Fisher-Hoch, S. P., Tomori, O., Nasidi, A. et al., (1995) Review of cases of nosocomial LASV in Nigeria: the high price of poor medical practice, *Brit. Med. J.*, 311 (1995), 857.
- Gibb R, Moses LM, Redding DW, Jones KE (2017) Understanding the cryptic nature of LASV in West Africa; *Pathog Glob Health* 111: 276-288.
- Hamblion, E. L., Raftery, P., Wendland, A., et al., (2018) The challenges of detecting and responding to a LASV outbreak in an Ebola-affected setting, *Int. J. Infect. Dis.*, 66 (2018), 65-73
- Hansen F, Jarvis MA, Feldmann H, Rosenke K (2021) LASVirus treatment options. *Microorganisms* 9: 772.
- Katherine, J., Siddle, Philomena Eromon, Kayla, G., Barnes, Samar Mehta. (2018) Genomic Analysis of LASVirus during an Increase in Cases in Nigeria in 2018: *The New England Journal of Medicine*: DOI: 10.1056/NEJMoa1804498
- Kolawole S, Dimitrios G, Connie S, Melanie S and Nadia T. (2019) A review of LASV vaccine candidates: Current Opinion in Virology 2019, 37:105–111.
- McCormick, J. B., Webb, P. A., Krebs, J. W., et al. (1987) A prospective study of the epidemiology and ecology of Lassa fever. *J Infect Dis* 155: 437-44.
- NCDC (2016): First Annual Report of the Nigeria Centre for Disease Control. http://www.ncdc.gov.ng/themes/common/docs/protocols/78_1515412191.pdf
- Nchom, J. I., Abubakar, A. S., Arimoro, F. O., Mohammed, B. Y. (2021) The role of weather in the spread of LASV in parts of Northern Nigeria. *International Journal of Tropical Disease and Health* 42: 33-40.
- Nwonwu, E. U., Alo, C., Una, A. F., Madubueze, U. C., Eze, I., Eze, N. C., Ogbonnaya, L. U. and Akamike, I. C. (2018) Knowledge of Lassa Fever and Its Determinants among Traders in Izzi Community in South-East Nigeria; *Archives of Current Research International*, 13(4): 1-9, 2018; Article no.ACRI.39904: ISSN: 2454-7077
- Ogbu, O., Ajuluchukwu, E., Uneke, C. J. (2007) Lassa fever in West African sub-region: An overview. *J Vector Borne Dis* 44: 1-11.



- Richmond, J. K., Baglole, D. J. (2003) LASV: epidemiology, clinical features, and social consequences. *BMJ* 2003;327: 1271–5.
- Redding, D. W., Gibb R., Dan-Nwafor, C. C., Ilori, E. A., Yashe, R. U., (2021) Geographical drivers and climate-linked dynamics of LASV in Nigeria. *Nature Communications* 12: 5759.
- Saez, A.M., Haidara, M. C., Camara, A., Kourouma, F., M. Sage, N. Magassouba, et al., (2018) Rodent control to fight LASV: evaluation and lessons learned from a 4-year study in Upper Guinea, *PLoS Negl. Trop. Dis.*, 12 (2018).
- Tomori O, Fabiyi A, Sorungbe A, Smith A, McCormick JB (1988) Viral hemorrhagic fever antibodies in Nigerian populations. *Am J Trop Med Hyg* 38:407–410
- World Health Organization (2018) Lassa fever-Nigeria Disease Outbreak.
- World Health Organization (14 February 2022). Disease Outbreak News; Lassa Fever-Nigeria. Available at: <https://www.who.int/emergencies/disease-outbreak-news/item/lassa-fever---nigeria>
- Zhao, S., Musa, S. S., Fu, H., He, D., Qin, J. (2020) Large scale Lassa fever outbreaks in Nigeria: Quantifying the association between disease reproduction number and local rainfall. *Epidemiol Infect* 148: e4.