<u>*Original Research Article*</u>

The role of weather in the spread of Lassa fever in parts of Northern Nigeria

Abstract

This study employed multiple regression analysis to evaluate the impact of weather variables (relative humidity, rainfall amount and maximum temperature) on the reported number of Lassa fever cases and to assess the strength of relationship between same for thirteen states in northern Nigeria (Adamawa, Bauchi, Jigawa, Borno, Kaduna, Katsina, Kano, Kebbi, Sokoto, Taraba, Yobe, Zamfara and Gombe states) over a five year period (2016-2020). Secondary data on Lassa fever disease and weather variables were described on a weekly basis from the data base of the Nigeria Centre for disease control (NCDC) as well as weather variables from the National Aeronautics Space Administration, U.S.A. (NASA). The study reveals that these weather variables accounted for 70% (r^2=0.70) of the cases of Lassa fever reported in Northern Nigeria. It occurred all year round but cases peaked during the dry months, from December to March where relative humidity is low and rainfall amount small. At confidence level of 0.05, there was a significant (p=0.000) strong positive correlation of r=0.83 between Lassa fever cases and weather variables. Of the three weather parameters, maximum temperature had a weak positive and insignificant (p=0.3) relationship with Lassa fever while relative humidity and rainfall had strong and moderate negative relationships of r = -0.7 and r = -0.5 respectively which were both significant at (r^2=0.000). In conclusion, there is need to cultivate sufficient preparedness strategies in order to cope with the burden to ensure general wellbeing of people resident in these affected areas using these weather parameters.

Keywords: Lassa fever, Infectious disease, Climate, Relationship, Disease, Northern, S.D.G

1 Introduction

Raabe & Koehler, in 2017 pointed that Lassa virus is one significant cause of illness in West Africa, it is also common among travellers as they return to their destinations with acute feverish complaint. However, it remains a neglected tropical disease despite being discovered in Nigeria more than fifty (50) years ago. The symptoms of Lassa fever can be nonspecific and mimic those of other endemic infections, especially early in illness which makes clinical diagnosis difficult; hence, laboratory testing becomes needful to confirm the diagnosis. Lassa fever when identified early is crucial for maximizing the benefit of available antiviral therapy, as treatment efficacy rapidly decreases following the clinical onset of the disease. Their work provided an overview of the currently available diagnostic tests for Lassa fever and their strengths and weaknesses.

Grant et al., in 2014 reiterated that Lassa virus is one of more than twenty five causative viruses of viral haemorrhagic fever. It was first recognized in Nigeria in 1969 and subsequently eminent across West Africa. Lassa fever different many viral haemorrhagic fevers is not a rare disease that arises only in outbreak form. It occurs yearly and infections may be in tens or even hundreds of thousands, with thousands of deaths recorded. Humans are diseased with Lassa fever through exposure to contaminated excreta of the rodent known as Mastomys natalensis. That is the primary source of transmission but sometimes with secondary transmission between humans via contact with infected bodily fluids. Sometimes, there are death tolls in hospitalized cases of about 25%. Prevention in the community is concerned toward limiting contact with rodents.

Tambo et al., in 2018 evaluated the impact of man-made conflict events and climate change impact in guiding evidence-based community "One Health" epidemiology and emergency response practice against re-/emerging epidemics. In August 2015, there was growing evidence of emerging and re-emerging zoonotic diseases including the recent Lassa fever outbreaks in almost 20 states in Nigeria that led to 101 deaths and 175 suspected and confirmed cases.

Tewogbola & Aung in 2020 said Lassa fever is a disease that is not popular worldwide, mostly due to the incapacity of the primary vector of the Lassa virus; rat to breed in temperate regions, hence it is confined to where it is conducive for it.

Emerging and re-emerging infectious diseases are becoming more frequent and developing countries are especially at increased risk. In Nigeria, one recurring infectious disease outbreak has been Lassa fever (LF). Between 1st January and 27th October in 2019, Nigeria, reported about 743 confirmed cases of LF and 157 deaths in confirmed cases. Lassa fever outbreaks continue to be persistent after fifty years of its identification. The true encumbrance of the disease in Nigeria is not adequately known also gaps in knowledge about the infection still persist (Olayinka et al., 2020).

In 2020, Abdulkarim et al. reported the epidemiology of Lassa fever in Bauchi State with notable increases in the rate of outbreak and case-fatality. A delay in seeking care by a patient for over seven days the major predictor of death.

Musa et al., in 2020 used mechanistic modelling to study the Lassa fever epidemics in Nigeria from 2016-2019. Their model describes the interaction between human and rodent populations with the consideration of quarantine, isolation and hospitalization processes. It supports the phenomenon of forward bifurcation where the stability between disease-free equilibrium and endemic equilibrium exchanges. Moreover, our model captures well the incidence curves from surveillance data which is able to reconstruct the periodic rodent and human forces of infection. It was suggest that the three major epidemics from 2016-19 can be modelled by properly characterizing the rodent or human force of infection while the estimated human force of infection also present similar outcome across outbreaks.

Abdullahi et al., in 2020 on the Lassa virus stressed that progressively, the Lassa virus has been acknowledged as a momentous public-health pathogen spread by rodents. The infection is life-threatening with a high possibility of severe morbidity and mortality. Ample studies have been carried out to scientifically understand the genomics and ecological epidemiology of Lassa but very few have focused on the short- and long-term impacts of environmental factors, human behaviours and rodent activities on transmission dynamics and control of the virus. Hence, this study seeks to understand the environmental factors involved in the transmission.

2.0 MATERIALS AND METHODS

2.1 The Study Area

Much of Northern Nigeria is high, flat plains covered by grasses and shrubs. There is very little water and almost everything is covered with sand. This is because the area is repeatedly being hit by dry and dusty north easterly winds which births harmattan, or strong winds. Drought is also a major issue in the region

Figure 1 Geographical Location of the Study Area (Northern Nigeria)

1.2 Data Types and sources

Lassa fever data were collected from the online data base of the Nigerian Centre for Disease Control (NCDC) for five years, which is from 2016 to 2020 for northern Nigeria to constitute of thirteen states namely Adamawa, Bauchi, Jigawa, Borno, Kaduna, Katsina, Kano, Kebbi, Sokoto, Taraba, Yobe, Zamfara and Gombe.

Weather variables like maximum temperature, relative humidity and rainfall amount for five years (2016-2020) were also sourced from the database of NOAA, International research institute for climate and society (IRI). Each data was aggregated weekly for analysis to suit the purpose of the research.

1.3 Method of Data Analysis.

Multiple regression formula was used in the analysis of relationship between dependent which is Lassa fever and multiple independent variables which are the climatic variables in view, these include Relative Humidity (RH), rainfall amount and maximum temperature.

The formula is represented by the equation Y as represented here

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_p X_p,$$

Where,

$\hat{Y}$ = Predicted or expected value of the dependent variable (Lassa fever)

b_0 = Value of Y when all of the independent variables (Climatic variables) are equal to zero (Constant)

b_1 through b_p = Estimated regression coefficients

X_1 through X_p = Distinct independent or predictor variables (Climate variable; Relative Humidity, Rainfall amount and maximum temperature)

3.0 RESULTS AND DISCUSSION

3.1 Behaviour patterns of Lassa fever and Weather Parameters

Figure 2 denotes the weekly behaviour of Lassa fever and Relative humidity for five years (2016-2020). The figure submits that over the study periods, as relative humidity dips between weeks 1 and 10, an increasing number of Lassa fever cases as seen with the peak at week 6 which corresponds to the week with least record of relative humidity. Lassa fever cases were experienced almost all week round but few cases are seen with increase in relative humidity from weeks 15 to 48. At week 52, cases are seen to rise with drop in RH. Period with peak cases of Lassa fever recorded relative humidity of less than 30%.

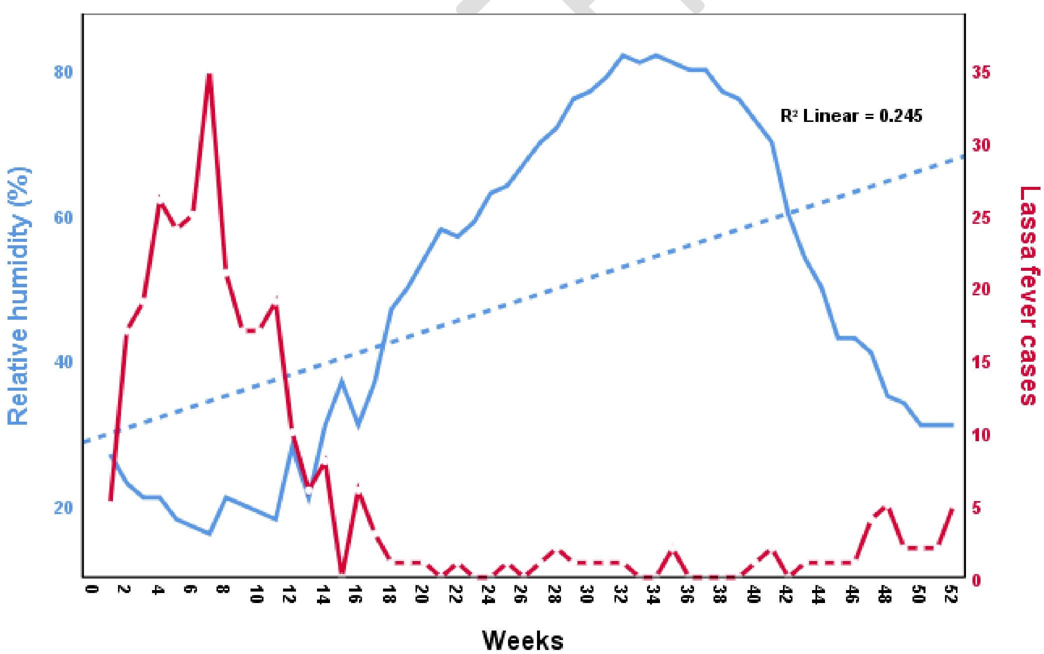

Figure 2 Weekly trend of Relative humidity and Lassa fever

Figure 3 denotes the weekly behaviour of Lassa fever and rainfall amount for five years (2016-2020). The figure depicts that over the study periods, there are cases of Lassa fever almost all week round. However, increasing number of Lassa fever cases are seen from week one to 10. In these weeks, there are records of little or no rainfall. When the rains began to emerge, cases of Lassa fever dropped drastically. Highest number of cases of the disease were recorded at week 6 which occurs in a period of no rainfall. Periods with highest cases of Lassa fever recorded rainfall amount of less than 20 mm

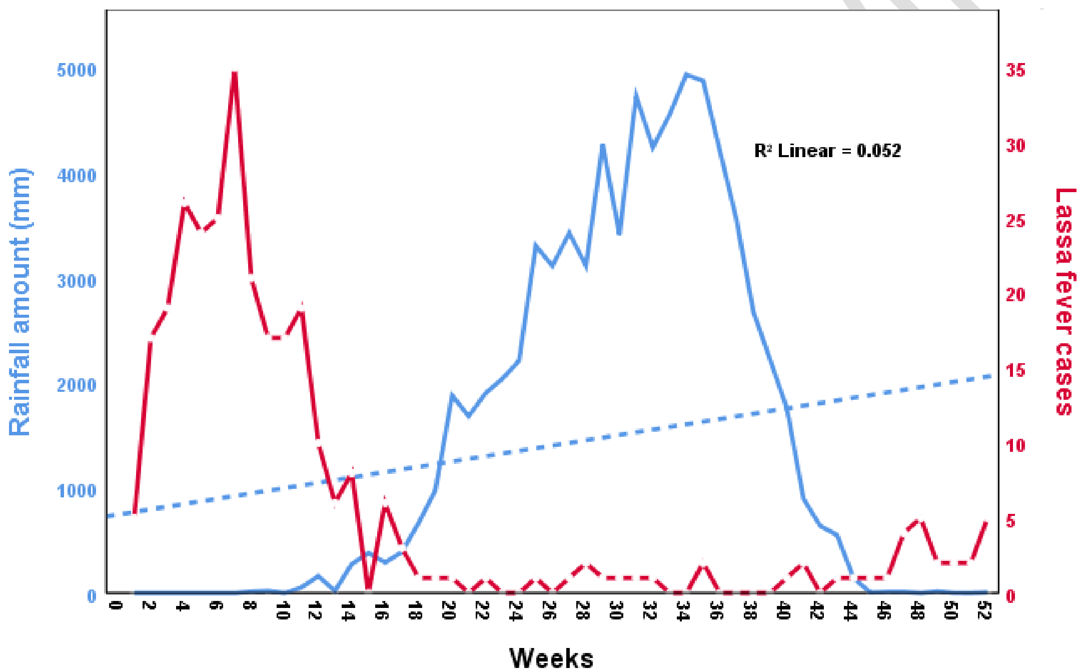

Figure 3 Weekly trend of Rainfall amount and Lassa fever

Figure 4 represents the weekly behaviour of Lassa fever and maximum temperature for five years (2016-2020). The figure depicts that over the study periods, there are cases of Lassa fever almost all week round. However, increasing number of Lassa fever cases are evident from week one to 10. Week 15 with the highest temperature value corresponds with one of the weeks with no cases of Lassa fever, afterwards, there was a drastic decline in temperature values. Period with peak cases of Lassa fever experienced maximum temperature between 28^{0}C and 35^{0}C.

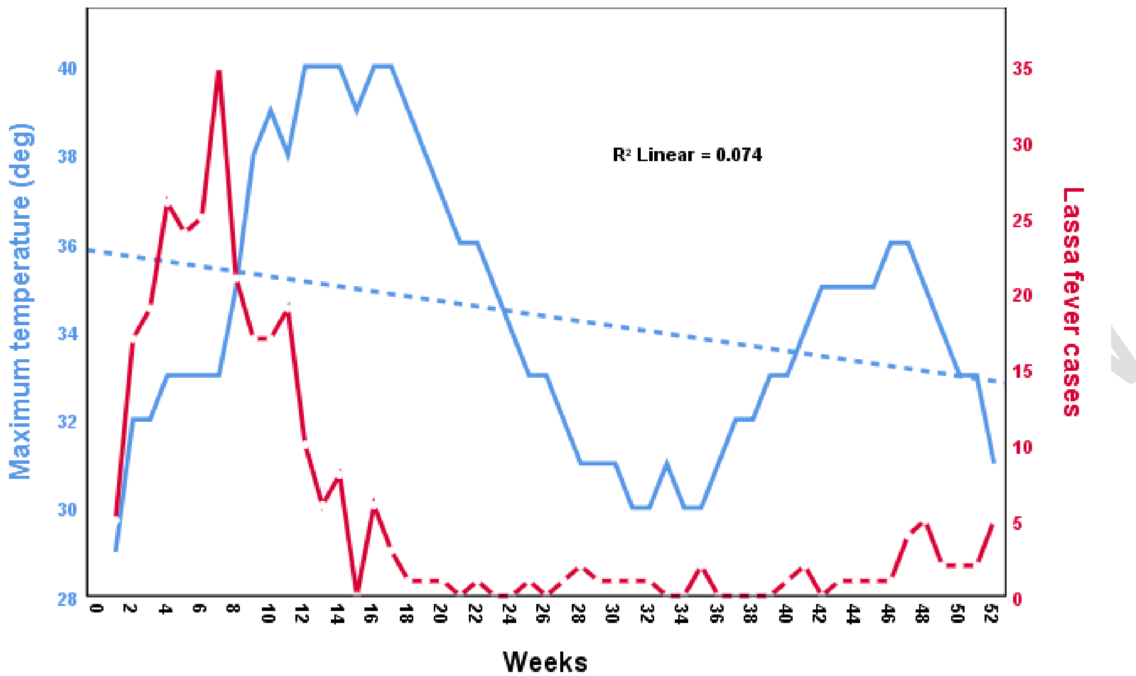

Figure 4 Weekly pattern of Maximum temperature and Lassa fever

3.2 Strength of relationship between Lassa fever and climate variables

These three variables accounted for 70% (r^2=0.70) of the cases of Lassa fever reported in Northern Nigeria which is significant at F=0.000. Cumulatively, these cases occurred in nearly every week. Cases climb sharply during the dry months, particularly from December to March where relative humidity is low and rainfall amount very insignificant. At confidence level of 0.05, there was a significant (p=0.000) strong positive correlation of r=0.83 between Lassa fever cases and weather variables. Of the three weather parameters, temperature had a weak positive and insignificant (p=0.2) relationship with Lassa fever while relative humidity and rainfall had a strong and moderate negative relationships of r=-0.7 and r=-0.5 respectively which were both significant at (r^2=0.000). This implies that as relative humidity and rainfall decrease, it, favours increase in cases of Lassa fever.

Weather variables		Relative Humidity	Rainfall amount	Maximum temperature
Pearson Correlation (r)	Lassa fever	-.726	-.494	.094
P value		0.000	0.000	0.3
Pearson Correlation (r)	Lassa fever	0.83		
P value		0.000		
Coefficient of determination (R^2)	Lassa fever	0.70		
F test		0.000		

Negative correlation between weekly Lassa fever cases in the period of study inlying that increase in relative humidity leads to a decrease in cases of Lassa fever but as relative humidity drops, cases of Lassa fever begins to rise. This relationship is strong at (r = -0.726) at a p value of 0.000 there by making the result statistically significant.

The relationship existing between rainfall and Lassa fever is inverse and moderate with r=-0.49 approximately -0.5, not as strong as relatively however, the result is statistically significant at a p value of 0.000. As for maximum temperature, there is a positive but very weak relationship between Lassa fever cases and maximum air temperature at r=0.09 and p value of 0.3. This signifies that as temperatures increase, Lassa fever cases based on the years of study increase as well although the relationship is weak. Howbeit, with the p value obtained, we fail to reject the null hypothesis that says there is no relationship between Lassa fever cases and maximum temperature.

Consideration the effect of these climatic variables on Lassa fever cases, there is a strong correlation positive relationship at r= 0.8 which is also statistically significant at a p value of 0.000.

Weather and climate accounts for seventy percent (70%) of the causes of Lassa fever cases in northern Nigeria within the years of studies at R^2 value of 0.70. The F statistics is significant at 0.000, hence the result proves statistically substantial.

From the above study, climatic variables are important factors in the occurrence and possible spread of Lassa fever in northern Nigeria especially Relative humidity and to a large extent rainfall.

It is revealed that during the dry months, because of little or no rainfall, bushes and plants that serve as shelter to rodents wither due to in adequate rainfall coupled with dry atmospheric conditions. Rodents which are also mammals are unable to withstand these harsh conditions therefore migrate from bushes in search of favourable and conducive weather and environmental conditions. They find their way into human settlements there by infecting man with the deadly virus.

When the rains begin and the atmosphere starts becoming moist, it is expected that the rodent should rove back to the bushes which should in turn reflect in no record of Lassa fever cases as opposed to the cases seen almost all week round during the years of study, they remain in communities with poor sanitary conditions or are overcrowded hence the cases.

Since so far, there is no known vaccine for the disease, having knowledge of weather parameters will assistance health practitioners in adequate planning for the season, which will go a long way in curbing the disease. Keeping the environment clean and maintaining personal hygiene will go a long way in curbing the spread of the disease.

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