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Research Article

Economic Impact of Lassa Fever on Biological, Environmental and Hygienic Factors in Bauchi State

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Abstract— Lassa fever, a viral haemorrhagic illness, imposes a considerable economic burden on regions it affects due to its influence on biological, environmental, and hygienic aspects. The economic ramifications of Lassa fever are varied, impacting both individuals and communities. Biologically, the disease can result in severe illness and fatalities, causing reduced productivity and income loss among affected individuals. Additionally, it may lead to long-term health issues, further stressing healthcare systems and escalating healthcare expenditures. Moreover, Lassa fever can disrupt agricultural operations and food production, causing food scarcity and inflated prices. This can trigger a ripple effect on the economy, as food insecurity may lead to malnutrition and decreased productivity. The research investigates the complex economic repercussions of the disease on the afflicted community in Bauchi. The study population comprises the residents of Bauchi state, estimated at 8,308,300 individuals in 2022, with a sample of 400 selected using the Yamane method. The sampling process involved stratification based on senatorial districts, and two Local Governments from each zone were non-probabilistically sampled, with an equal allocation of respondents across the selected frame. Data collection employed a structured and closed-ended questionnaire, which was designed and validated (Cronbach's Alpha = 0.81). The findings emphasize the significant and multifaceted economic impact of Lassa fever on biological, environmental, and hygienic factors. Efforts to prevent and control the disease's spread are crucial to mitigate its economic consequences and safeguard the health and well-being of affected populations. It is recommended to strengthen public health resources and infrastructure, as controlling the disease outbreak necessitates enhanced surveillance, testing, and treatment. This may result in increased healthcare expenses and diminished productivity as resources are redirected to combat the outbreak.

Keywords— Lassa Fever, Economic Impact, Biological, Environmental, Hygienic, Factors

1. Introduction

Lassa fever is a viral hemorrhagic fever caused by the Lassa virus, which is primarily found in West Africa [1,2,3], primarily in Nigeria, Sierra Leone, Guinea, and Liberia. The dynamic nature of Lassa fever highlights the complex interplay between the virus, hosts, vectors, and human populations. Furthermore, understanding the spread, control strategies, economic impact, transmission patterns, and global behavior surrounding the disease is crucial for effective management and prevention. The study provides an overview of transmission dynamics, and risk factors associated with the disease as well as the economic burden. It explores the role of rodents as reservoirs, intermediate agents and vectors of Lassa virus, as well as human-to-human transmission. The global behavior of Lassa fever is also a cause for concern, as the disease has the potential to spread beyond its endemic regions through international travel and trade. Cases of Lassa fever have been reported in Europe and North America, highlighting the need for global surveillance and collaboration to prevent the spread of the virus. A study in [4] emphasized the importance of strengthening public health systems and implementing effective control measures to prevent the international spread of Lassa fever. The disease is transmitted to humans through contact with infected rodents, particularly the multimammate rat (Mastomys natalensis), which serves as the primary reservoir for the virus. Lassa fever is endemic in several countries in West Africa, including Nigeria, Sierra Leone, Liberia, and Guinea, where it poses a significant public health threat. It is sometimes exhibiting complex transmission patterns influenced by ecological, environmental, and socio-behavioral factors. Seasonal variations, climatic conditions, and agricultural practices can impact virus circulation and prevalence. The spread of Lassa

fever occurs through contact with rodent reservoirs, particularly the Mastomys natalensis species. Human-to-human transmission also plays a significant role, primarily through direct contact with bodily fluids. The dynamics of Lassa fever transmission are influenced by various factors, such as population density, healthcare infrastructure, and socio-economic status [5]. The spread is influenced by a variety of factors, including population density, urbanization, and climate change. As populations in West Africa continue to grow and urbanize, the risk of human exposure to infected rodents increases, leading to a higher incidence of Lassa fever cases, and furthermore, changes in climate patterns, such as increased rainfall and temperature fluctuations, can impact the distribution and abundance of the multimammate rat, further contributing to the spread of the disease [6]. The global equilibrium of Lassa fever is a complex phenomenon that is influenced by both local and international factors. While the disease is primarily confined to West Africa, cases of Lassa fever have been reported in other regions, including Europe and North America, due to trade and international travel [7]. This brings about the importance of global surveillance and collaboration in controlling the spread of the disease and preventing outbreaks in new regions. In order to achieve global equilibrium of Lassa fever, it is essential to implement comprehensive control measures, including surveillance, early detection, and treatment of cases, as well as public health education and community engagement. Additionally, efforts to control the rodent population and improve sanitation and hygiene practices can help reduce the risk of human exposure to the virus. For example, see reference in [3].The dynamics of Lassa fever involve complex interactions between the virus, the host (both humans and rodent reservoirs), and the environment. Understanding these dynamics is crucial for designing effective control strategies and predicting the behavior of the disease.

Controlling Lassa fever requires a multi-faceted approach involving surveillance, vector control, diagnostics, healthcare system strengthening, and public awareness campaigns [8]. Additionally, improved personal protective measures and adherence to healthcare protocols are crucial elements in minimizing transmission [9].

The trends in Lassa fever incidence and mortality over the past few decades using surveillance data from multiple countries in West Africa [10,11]. Result shows the temporal patterns and factors influencing the spread of the disease [12,13]. The findings reveal an alarming increase in Lassa fever cases, particularly in urban areas. The study also identifies demographic and environmental factors associated with higher transmission rates. Lassa fever is occurring sporadically and varying in intensity and geographic distribution. One of the key factors contributing to the dynamic nature of Lassa fever is the behavior of the virus itself. The Lassa virus is known to mutate rapidly, leading to changes in its genetic makeup and potentially altering its virulence and transmissibility. This genetic variability brought difficult in predicting the course of outbreaks and develop effective control measures.

2. Related Work

The economic impact of Lassa fever extends beyond the health sector, affecting agriculture, trade, and tourism. The cost of healthcare, loss of productivity, and trade disruptions due to the fear of outbreaks pose significant economic burdens on affected countries [14]. The economic consequences highlight the importance of investing in preventive measures and healthcare infrastructure. The concept of the random equilibrium refers to the state of the disease system where the number of new infections remains constant over time, resulting in a stable endemic equilibrium. In the case of Lassa fever, a random equilibrium implies that the disease persists at a steady level in a population, with periodic fluctuations but without growing or declining trends. The existence and stability of this random equilibrium depend on several factors, including the epidemiological parameters, interventions, and environmental factors.

In addition to the biological factors influencing the dynamics of Lassa fever, there are also economic implications associated with the disease. The cost of treating Lassa fever patients, implementing control measures, and conducting research on the virus can place a significant burden on healthcare systems and economies in the affected areas. A study in [15] estimated that the economic impact of a single Lassa fever outbreak in Nigeria could exceed $1 million USD.

Mathematical models are often used to study the dynamics of infectious diseases like Lassa fever. These models capture the spread of the disease by incorporating variables such as the number of susceptible individuals, infected individuals, and recovered individuals, as well as factors like the transmission rate, recovery rate, and contact patterns. The dynamic nature of Lassa fever can be explored by analyzing the behavior of these models and extend it using the regression modelling, incorporating biological, environmental and hygienic factors on the economic impacts of Lassa fever disease.

3. Methodology

Survey research design was used to determines the intersections the economic impact of Lassa Fever and biological factors, environmental, hygienic factors and other detrimental consequences of poverty on the economic impact of the disease in Bauchi state. The target population is Bauchi State which, according to the projected population of 2022 is 8,308,300 people upon which 400 were sampled using Yamane formula.

$$n = \frac{N}{1 + N(e^2)} = \frac{8{,}308{,}300}{1 + 8{,}308{,}300(0.05^2)} = 400 \text{ people}$$

The sample frame (Bauchi State) was stratified based on the senatorial districts and two Local Governments from each zone were non-probability sampled with equal allocation of respondents across each of the selected frame. Data was collected using a simple random sampling with a structured and closed ended questionnaire designed and validated (Cronbarch's Alpha = 0.81). The data collected was analyzed

at 5% level using correlation and regression analysis, t – test and analysis of variance.

3.1 Models Specification

Economic Impact of Lassa Fever (*EI*), specified model panel is formulated as:

$$EI = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$$

Where x_1=Biological Factors, x_2= Environmental Factors and x_3= Hygienic Factors while $\beta_i \ (i = 1,2,3)$ are the extent of impacts corresponding to the respective variables.

4. Results and Discussion

4.1Relationship between Economic Impact of Lassa Fever and Biological, Environmental and Hygienic Factors in Bauchi State

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.908	.827	.824	.1347496

The coefficient of multiple correlation, R, shows that there is a strong and positive relationship between the economic impact of Lassa fever and biological, environmental and hygienic factors (R = 0.908). R – square, the coefficient of multiple determination is 0.827. That is about 82.7% of the total variation is explained by the changes in the independent variables indicating that both the biological, environmental and hygienic factors explain the economic impact of Lassa fever by 82.7%. In other word, the amount of explanation explained by the set of independent variables by the proxies explain the economic impact of the disease by 82.7%.

The adjusted R – Squared value is 82.4%, this also shows that there is high relationship between the dependent and independent variables indicating the actual percentage of variation explained by the set of independent variables that actually affect the dependent variable.

Table 2:ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	32.584	4	8.146	448.67	.000
	Residual	6.827	376	.018		
	Total	39.411	380			

A multiple regression analysis was carried out to assess the impact of these variables on the economic impact of Lassa fever and study shows that if these variables were adequately managed and taken care of, the problem of Lassa fever will be significantly reduced. Result in ANOVA reliably justified the true influence of these variables as the P – value is less than the level of significance (P - value = 0.000 < 0.05).

Table 3: Coefficients

Model		Unstandardized Coefficients	Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.502	.079		6.385	.000
	Biological Factors	.421	.012	.425	27.052	.000
	Environmental Factors	.178	.016	.228	13.402	.000
	Hygienic Factors	.204	.013	.213	17.654	.000

All the predictors (biological, environmental and hygienic factors) yielded significant beta weights with $\beta_1 = 0.421$, $\beta_2 = 0.178$, and $\beta_3 = 0.204$ respectively with their varied t – values which are all statistically significant while their respective P-values are less than 0.05 (P < 0.05) in each case. The negative slope (constant) shows that there are factors, other than those investigated leading to the problem of economic impact of Lassa fever in the study area.

4.2 Respondent's Perceptions on the Economic Impact of Lassa Fever with Regards to Biological, Environmental and Hygienic Factors by Location.

Statement of Hypothesis

H_0: There is no significant difference on the respondent's perceptions of economic impact of Lassa fever on biological, environmental and hygienic factors by location.

Table 4: Descriptive

		N	Mean	Std. Deviation	Std. Error Mean
Place of Residence	Rural	219	2.84	.725	.049
	Urban	162	3.02	.687	.054

Perceived responses shows that the average response by location in urban areas is 3.02 while that of rural area is 2.84. The average respondents to have perceived that the economic impact of Lassa fever is associated with biological, environmental and hygienic factors and that rural areas is predominant than in urban areas. This is justified by the standard error which is found to be far from the mean, signifying its reliability.

Table 5: Place of Residence (Urban, rural)

		t-test for Equality of Means				
		T	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference
Place of Residence	Equal variances assumed	-2.448	379	.015	-1.80	.073
	Equal variances not assumed	-2.469	356.927	.014	-1.80	.073

Level of Significance and Critical Value

At 5% level, $\alpha = 0.05$ (two tailed test), 0.05. V, the degree of freedom is: $V = n_1 + n_2 - 2 = 219 + 162 - 2 = 379$ The critical value corresponding to the degree of freedom is: $t_{\alpha,v} = t_{0.05,379} = 1.645$

The calculated value of -2.448 (in absolute) is greater than the critical value (1.645), we therefore concluded that there is significant difference on the respondent's perceptions that biological, environmental and hygienic factors have a significant impact on Lassa disease by location.

5. Conclusion and Future scope

One of the key economic impacts of Lassa fever is the cost of healthcare. The disease can be severe and even fatal if not treated promptly, leading to high medical expenses for affected individuals and their families. In addition, the healthcare system in countries where Lassa fever is endemic may be strained by the need to treat a large number of cases during outbreaks, leading to increased costs for the government and healthcare providers.

The economic impact of Lassa fever also extends to the agricultural sector. The disease is often associated with poor sanitation and hygiene practices, which can lead to contamination of food and water sources. This can result in reduced agricultural productivity and food security, as well as increased costs for food safety measures and disease control efforts.

Furthermore, Lassa fever can have a negative impact on the environment. The disease is spread by rodents, which thrive in unsanitary conditions and can carry other diseases as well. Efforts to control the spread of Lassa fever, such as rodent control measures and improved sanitation practices, can have environmental implications, such as the use of pesticides and other chemicals that may harm the ecosystem.

In terms of hygiene, Lassa fever highlights the importance of good hygiene practices in preventing the spread of infectious diseases. Proper handwashing, sanitation, and waste management are crucial in reducing the risk of Lassa fever transmission. However, in many affected areas, access to clean water and sanitation facilities may be limited, leading to a higher risk of disease transmission and increased healthcare costs.

Overall, the economic impact of Lassa fever on biological, environmental, and hygiene factors is significant and multifaceted. Efforts to control the spread of the disease and improve hygienic practices in affected areas are essential in reducing the economic burden of Lassa fever and improving the overall health and well-being of communities at risk. In conclusion, Lassa fever is a dynamic disease with significant economic implications and the potential for global spread. Understanding the factors influencing the dynamics of the disease, such as viral behavior and economic impact, is crucial for developing effective control strategies and mitigating the impact of outbreaks. Collaboration between countries and international organizations is essential to prevent the spread of Lassa fever and protect global health security.
The study synthesizes evidence from the evaluation from the impact of interventions such as rodent control measures, community education and awareness programs, improved clinical management, and vaccination initiatives on reducing Lassa fever transmission and burden. The findings demonstrate the importance of a multi-faceted approach that combines surveillance, vector control, and community engagement. The study provides valuable insights for policymakers and public health practitioners in developing.

Availability of Data and Materials
Not applicable

Conflict of interest
The authors declare that, there are no conflicts of interest for the study.

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