*International Journal of Biomedical Materials Research*
2025, Vol. 13, No. 1, pp. 1-9
https://doi.org/10.11648/j.ijbmr.20251301.11

Research Article

# Effects of Early Treatment of Lassa Fever and Symptoms in Nigeria

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## Abstract

Lassa fever is an acute viral disease characterized by a broad range of clinical symptoms. This study presents a comprehensive analysis of Lassa fever cases in Nigeria, focusing on demographic patterns, symptomatology, geographic distribution, and factors influencing outcomes of patients. Using secondary data collected from the Nigeria Centre for Disease Control (NCDC) from 2018 to 2021, Geographically, Edo and Ondo States accounted for the majority of cases, contributing 49.1% and 23.6% of recoveries, respectively, highlighting the regional concentration of Lassa fever burden. Factor analysis of symptoms revealed two distinct clusters: Late-stage symptoms, such as bleeding, respiratory distress, and chest pain, which were strongly associated with fatal outcomes, and Early-stage symptoms, including fever, fatigue, and gastrointestinal disturbances, which facilitated initial disease detection. Logistic regression identified early- stage symptoms, late-stage symptoms and advanced age as significant predictors of mortality, while early-stage symptoms shows a less pronounced likelihood of death compared to late-stage symptoms when there is timely intervention. The findings emphasize the importance of early detection of symptoms and treatment as critical strategies to mitigate the impact of Lassa fever. Additionally, targeted interventions should focus on capturing Lassa fever cases in rural areas of other regions and prioritize regions with high disease prevalence and vulnerable populations, particularly older adults. Enhanced diagnostic accuracy, timely treatment, and symptom monitoring are crucial to reducing mortality and improving outcomes for Lassa fever patients.

## Keywords

Disease Symptoms, Factor Analysis, Lassa Fever, Logistics Regression, Nigeria, Principal Component Analysis

## 1. Introduction

World Health Organization provides an authoritative overview of Lassa fever, a zoonotic viral illness endemic in West Africa [1]. The report highlights that the disease is caused by the Lassa virus, transmitted primarily through

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**Received:** 9 January 2025; **Accepted:** 1 February 2025; **Published:** 26 February 2025

contact with food or household items contaminated by the urine or feces of infected Mastomys rats. Human-to-human transmission can also occur through exposure to bodily fluids of infected individuals, particularly in healthcare settings where infection control measures are inadequate. A comprehensive overview of the symptoms and signs associated with Lassa fever, a viral hemorrhagic illness endemic to parts of West Africa was further provided by [2]. The resource emphasizes the disease's broad spectrum of manifestations, ranging from mild, nonspecific symptoms to severe and life-threatening conditions.

Lassa fever is an acute viral illness that manifests with a wide spectrum of symptoms. The disease typically begins with mild, flu-like symptoms, including fever, malaise, and weakness, which can resemble other common illnesses [3]. As the virus progresses, patients may experience additional symptoms such as sore throat, headache, muscle pain, and chest pain. In some cases, gastrointestinal symptoms such as nausea, vomiting, diarrhea, and abdominal pain also occur, indicating systemic involvement. The onset and severity of symptoms can vary widely, depending on the individual's immune response and the extent of viral replication.

The comprehensive examination of the clinical and epidemiological characteristics of Lassa fever, a hemorrhagic viral disease endemic to West Africa was presented by [4]. The authors explore the disease's multifaceted nature, highlighting its variability in clinical presentation, its transmission dynamics, and the significant public health challenges it poses in endemic regions. In more severe cases, Lassa fever can progress to involve multiple organ systems, leading to life-threatening complications. Patients may develop bleeding tendencies, including nosebleeds, bleeding gums, or blood in the stool or urine, as a result of coagulopathy. Neurological symptoms such as confusion, altered consciousness, and acute hearing loss are also reported, reflecting the potential for the virus to affect the central nervous system. Other critical manifestations include respiratory distress, difficulty breathing, and cardiovascular instability, which can result in shock. Jaundice, indicative of liver involvement, and swelling in the face or extremities are additional signs of severe disease.

Before 2016, Nigeria had limited capacity for laboratory diagnosis of Lassa fever, relying heavily on support from partners to carry out testing. Diagnostic efforts were primarily concentrated in specialized centers, including the Institute of Lassa Fever Research and Control (ILFR&C) at Irrua Specialist Teaching Hospital (ISTH) and the Lagos University Teaching Hospital (LUTH) laboratory. These facilities were among the few dedicated centers for Lassa fever diagnosis in the West African region. Case evaluations at these centers revealed that Lassa fever transmission occurred year-round, with peak incidence typically observed between January and March. [5]

Recognizing Lassa fever symptoms early is critical for timely diagnosis and effective treatment. The early symptoms, though nonspecific, should raise suspicion in endemic areas or in individuals with recent exposure to rodents or other risk factors. Left untreated, the disease can rapidly escalate, with mortality rates significantly higher among those who develop severe complications. Early intervention with antiviral therapy, such as ribavirin, supportive care, and infection control measures, can substantially improve outcomes. Awareness of the symptom progression is vital for both healthcare providers and communities in endemic regions to reduce the impact of this potentially fatal disease.

Detailed criteria for the classification and laboratory confirmation of Lassa fever cases was provided by [6]. According to their definitions, a suspected case of Lassa fever is identified when an individual exhibits at least one symptom, such as malaise, fever, headache, sore throat, cough, nausea, vomiting, diarrhea, muscle pain, central chest pain, retrosternal pain, or hearing loss, along with a history of exposure to rodent excreta or urine. Alternatively, a suspected case may involve similar symptoms accompanied by a history of contact with an individual diagnosed with probable or confirmed Lassa fever within 21 days of symptom onset. Unexplained bleeding or hemorrhaging is also considered sufficient to classify a case as suspected. A probable case is defined as a suspected case in which the patient has died without any specimen being collected for laboratory testing. In contrast, a confirmed case is any suspected case that is verified through laboratory tests. Laboratory confirmation can be achieved through the detection of IgM antibodies specific to Lassa virus, a positive result from reverse transcription PCR (RT-PCR), or the isolation of the virus from a clinical sample. These criteria play a critical role in guiding the diagnosis, management, and epidemiological monitoring of Lassa fever, particularly in affected regions.

This study aims to explore the impact of initiating early treatment for Lassa fever on patient outcomes, including recovery rates and severity of complications. Additionally, it seeks to identify and differentiate symptoms associated with the early and late stages of the disease, providing critical insights for timely diagnosis and intervention. By understanding these symptom patterns and the benefits of early medical intervention, the research aspires to contribute to improved clinical management protocols and reduce mortality rates associated with Lassa fever.

## 2. Literature Review

Several studies have been carried out on Lassa fever. Utilizing molecular tools to screen rodents across multiple geographic locations in West Africa for LASV presence. The authors discovered that, in addition to Mastomys natalensis, other rodent species, such as Mastomys erythroleucus and Hylomyscus pamfi, also harbor LASV. These findings underscore the complexity of LASV ecology and suggest that the virus may have a broader host range than previously understood. This revelation has significant implications for the epidemiology of Lassa fever, as it challenges the singular

reservoir-host model that has dominated discussions about LASV transmission [7].

Critical insights into the geographic distribution and risk factors associated with Lassa fever in West Africa was revealed. The authors developed risk maps that are essential tool for understanding the ecological and environmental conditions that facilitate the transmission of Lassa fever and can guide public health interventions in high-risk areas. The study emphasizes the importance of integrating ecological, epidemiological, and behavioral data to develop more effective strategies for preventing and controlling Lassa fever outbreaks [8].

Thorough overview of Lassa fever in the West African sub-region, shedding light on its epidemiology, clinical manifestations, transmission dynamics, and the public health challenges it presents was provided by [9]. They emphasize the importance of improving diagnostic capabilities, enhancing infection control measures, and promoting public health education to reduce the disease burden. While some progress has been made in understanding the disease and controlling outbreaks, the authors highlight the need for more robust research, including the development of a vaccine, to further mitigate the impact of Lassa fever in affected countries.

Detailed epidemiological breakdown of the outbreak, revealing that Lassa fever predominantly affected individuals in rural areas where close contact with rodents, the primary reservoir for the virus, is more common was presented by [10]. The demographic characteristics of those affected by the disease were analyzed, with a focus on age, sex, and health outcomes. Data indicated a higher proportion of cases among adults, especially those in productive age groups, with a significant number of fatalities reported. Gender disparities were also evident, as more males were affected compared to females, similar to findings in previous Lassa fever studies in Nigeria [11].

Comprehensive analysis of Lassa fever outbreaks over a four-year period, documenting both the seasonal and geographic variations in the incidence of the disease was provided by [5]. The study highlights that Lassa fever is endemic in Nigeria, with transmission occurring year-round, but with peak periods often observed between the dry season (November to April). The demographic analysis provides insight into how age, sex, and educational level impact Lassa fever outcomes. Consistent with findings from earlier research [12].

Lassa fever signs and symptoms can appear with a scope of side effects, from gentle to serious side effects. The underlying side effects are vague and can be confused with other normal sicknesses. The seriousness of the illness can fluctuate, and a few people might stay asymptomatic [13].

# 3. Methodology

## 3.1. Data Collection

This study utilized secondary data obtained from the Nigeria Center for Disease Control and Prevention (NCDC). The Lassa fever surveillance data was collected over four years (2018-2021) from all states and the Federal Capital Territory (FCT) in Nigeria. The dataset included demographic variables, reported symptoms, and the outcomes of Lassa fever cases, providing comprehensive insights into the epidemiology and clinical characteristics of the disease within the country. Dataset can be obtained through: Proposed title of the dataset: Epidemiological data on Lassa fever in Nigeria, 2018-2021.

## 3.2. Study Design

This study analyzed quantitative data derived from the routine surveillance records of the Nigeria Center for Disease Control (NCDC), focusing specifically on confirmed Lassa fever cases. The data encompassed reported symptoms, demographic variables, and case outcomes. Factor analysis was employed to explore and identify the key attributes driving the reported symptoms of Lassa fever. These identified attributes were then examined further to understand their influence on the outcomes of confirmed cases using logistic regression model. This approach provided insights into the relationships between symptom patterns and clinical outcomes, enabling a deeper understanding of the factors impacting disease progression and mortality.

## 3.3. Factor Analysis Model

In a factor analysis model, each observed variable $X_i$ (where i=1, 2,…, p, for p observed variables) is assumed to be influenced by m underlying, unobserved factors $F_1, F_2, \ldots, F_m$, along with an error term. The model is mathematically represented as:

$$X_i = \alpha_{i1}F_1 + \alpha_{i2}F_2 + \cdots + \alpha_{im}F_m + \varepsilon_i \quad (1)$$

Where:

$\alpha_{ij}$ are the factor loadings, representing the strength of the relationship between the observed variable $X_i$ and the latent factor $F_j$.

$F_j$ are the latent factors (unobserved variables) shared across multiple observed variables, capturing the common variance among them.

$\varepsilon_i$ is the unique variance or error term for $X_i$, accounting for the variance in $X_i$ that is not explained by the latent factors.

## 3.4. Factor Extraction

To identify underlying factors in a dataset, various methods can be employed, including Principal Component Analysis (PCA). While PCA is not technically a factor analysis method, it is often used as a preliminary step to estimate the number of factors. PCA is a statistical technique that reduces the di-

mensionality of data by transforming a large set of correlated variables into a smaller set of uncorrelated variables, known as principal components, while preserving as much variance in the original data as possible.

Before conducting PCA, it is common practice to standardize the data, especially when variables are measured on different scales. Standardization ensures that each variable contributes equally to the analysis. For a data matrix X of dimensions n ×p, where n represents observations (rows) and p represents variables (columns), the standardized matrix Z is calculated as follows:

$$Z_{ij} = \frac{X_{ij} - \mu_j}{\sigma_j} \quad (2)$$

Where, $\mu_j$ and $\sigma_j$ denote the mean and standard deviation of variable j, respectively. This transformation ensures that each variable has a mean of 0 and a standard deviation of 1.

## 4. Data Analysis and Discussion of Results

The demographic analysis of Lassa fever cases reveals important patterns in the outcomes of confirmed cases, shedding light on the influence of various factors such as sex, education, age, and geographic distribution as presented in Table 1.

In terms of sex, males represented a larger proportion of cases, accounting for 54.9% of recoveries and 58.4% of deaths. This further confirmed the risk factor of Men commonly affected than women [14]. This indicates a slightly higher vulnerability among men compared to women, who comprised 45.1% of recoveries and 41.6% of deaths. The reasons for this disparity may include behavioral differences, occupational exposure, or biological factors that could influence susceptibility and disease progression.

Educational background also played a significant role in outcomes. Individuals with no formal education experienced a higher mortality rate (13.1%) relative to their recovery rate (7.1%), suggesting that limited access to healthcare or delays in seeking treatment may contribute to worse outcomes. On the other hand, those with tertiary education exhibited the highest recovery rate (48.2%), reflecting the possible benefits of better health literacy and access to resources. People with secondary education represented a significant portion of cases, with 34.1% recovering and 38.5% succumbing to the disease. Meanwhile, those with nursery or primary education accounted for the smallest proportion of cases, with 10.6% recoveries and 7.0% deaths.

Age emerged as a critical determinant of outcomes, with older individuals facing a higher risk of mortality. Among those aged 50 years and above, 36.0% died, compared to a recovery rate of 24.1%. Conversely, younger individuals aged 0-19 and 20-29 years had higher recovery rates of 17.5% and 24.0%, respectively, alongside lower mortality rates of 12.7% and 15.6%. Middle-aged groups, such as those aged 30-39 and 40-49 years, showed more balanced outcomes, but the risk of death increased progressively with age. This trend suggests that older adults may have underlying health conditions or weaker immune responses, exacerbating disease severity.

Geographically, Edo State bore the brunt of the outbreak, contributing nearly half of all recoveries (49.1%) and deaths (49.5%). Ondo State followed, with 23.6% of recoveries and 23.1% of deaths (see Figures 1 and 2). Other states, including Ebonyi, Bauchi, Plateau, and Taraba, reported smaller proportions, each accounting for less than 6% of total cases. States grouped as "Others" collectively accounted for 12.4% of recoveries and 10.4% of deaths. These geographic disparities underscore the concentrated burden of Lassa fever in specific regions, particularly Edo and Ondo, which may be attributed to limitations in the coverage and reach of the Disease Surveillance and Notification Officer (DSNO) network. In many instances, cases are not reported at healthcare facilities, particularly in rural areas where access to healthcare services and diagnostic facilities is often inadequate. This underreporting can skew the data, resulting in an inaccurate representation of the true burden of Lassa fever in these regions, necessitating targeted public health measures.

Overall, the analysis highlights the significant impact of demographic factors on Lassa fever outcomes. Addressing these disparities through improved health education, timely treatment, and focused interventions in high-risk groups and regions is essential for mitigating the disease's impact and improving survival rates.

***Table 1.*** *Demographic characteristic by Outcome of confirmed cases.*

| Outcome of case | | Recovered | Deceased | Total |
|---|---|---|---|---|
| Sex | Female | 1034 (45.1) | 182 (41.6) | 1216 (44.6) |
| | Male | 1257 (54.9) | 256 (58.4) | 1513 (55.4) |
| Education | No formal education | 165 (7.1) | 58 (13.1) | 223 (8.1) |
| | Nursery/primary | 246 (10.6) | 31 (7.0) | 277 (10.1) |
| | Secondary | 788 (34.1) | 170 (38.5) | 958 (34.8) |

| Outcome of case | | Recovered | Deceased | Total |
|---|---|---|---|---|
| | Tertiary | 1114 (48.2) | 183 (41.4) | 1297 (47.1) |
| | 0 - 19 | 404 (17.5) | 56 (12.7) | 460 (16.7) |
| | 20 - 29 | 555 (24.0) | 69 (15.6) | 624 (22.6) |
| Age | 30 - 39 | 445 (19.2) | 87 (19.7) | 532 (19.3) |
| | 40 - 49 | 352 (15.2) | 71 (16.1) | 423 (15.4) |
| | 50 + | 557 (24.1) | 159 (36.0) | 716 (26.0) |
| | Edo | 1135 (49.1) | 219 (49.5) | 1354 (49.4) |
| | Ondo | 546 (23.6) | 102 (23.1) | 648 (23.5) |
| | Ebonyi | 130 (5.6) | 25 (5.7) | 155 (5.6) |
| State | Bauchi | 119 (5.1) | 23 (5.2) | 142 (5.2) |
| | Plateau | 40 (1.7) | 13 (2.9) | 53 (1.9) |
| | Taraba | 57 (2.5) | 14 (3.2) | 71 (2.6) |
| | Others | 286 (12.4) | 46 (10.4) | 332 (12.1) |

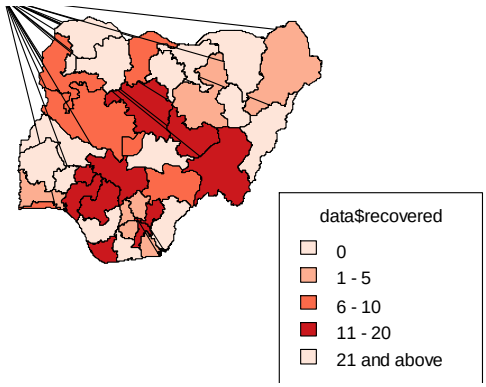


***Figure 1.*** *Distribution of confirmed cases by recovery.*

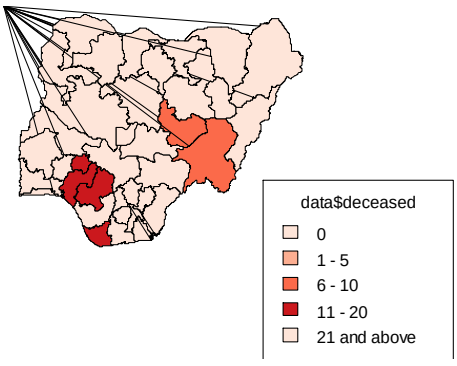


***Figure 2.*** *Distribution of confirmed cases by death.*

Figures 1 & 2, presents a detailed geographic distribution of confirmed Lassa fever cases by outcome of case (recovered or deceased) across various states in Nigeria. Each state is categorized into specific recovery/death ranges, represented by distinct color gradients to facilitate visual interpretation.

Figure 1 provides a critical visual summary of recovery patterns, allowing for the identification of regions with significant recovery efforts and those potentially underserved. States shaded in deeper red tones signify hotspots of both Lassa fever infections and successful recovery interventions. Conversely, states with lighter shades or no shading may represent areas with fewer reported cases. Also, Regions with higher death counts, particularly those in dark orange and deep red, require immediate attention as shown in Figure 2.

***Table 2.*** *Rotated Factor Matrix.*

| Symptoms | Factor | |
|---|---|---|
| | 1 | 2 |
| Muscle pain | .584 | .185 |
| Joint pain arthritis | .538 | .146 |
| Refusal feeding drink | .494 | .195 |
| Difficulty breathing | .474 | .183 |
| Malaise new | .385 | .257 |
| Bleeding bruising | .377 | .114 |
| Chest pain | .337 | .258 |
| Anorexia loss of appetite | .307 | .542 |
| Fatigue weakness | .233 | .498 |

| Symptoms | Factor | |
|---|---|---|
| | 1 | 2 |
| Nausea new | .296 | .433 |
| Abdominal pain | .080 | .381 |
| Cough new | .191 | .379 |
| Vomiting new | .120 | .326 |
| Diarrhea new | .200 | .308 |
| Sore throat | .280 | .297 |
| Headache new | .100 | .277 |
| Fever new | .031 | .139 |

To ensure the accuracy and reliability of the Principal Component Analysis (PCA) performed, the symptoms considered for the early and late stages were standardized to have the same scale (0 or 1) and unit of measurement. Standardizing the data ensured that each variable contributed equally to the identification of the underlying components, preventing any single variable from dominating the analysis due to differences in scale or magnitude.

***Table 3.*** *Extracted factors.*

| Factor 1: Late Symptoms | Factor 2: Early Symptoms |
|---|---|
| Muscle pain, Joint pain arthritis, Refusal feeding drink, Difficulty breathing, Malaise new, Bleeding bruising, Chest pain | Anorexia loss of appetite, Fatigue weakness, Nausea new, Abdominal pain, Cough new, Vomiting new, Diarrhea new, Sore throat, Headache new, Fever new |

Table 2 presents a rotated factor matrix that reveals two key factors associated with Lassa fever symptoms, providing insight into how these symptoms cluster and relate to one another. Factor 1 encompasses symptoms that are typically more severe and potentially life-threatening, such as muscle pain, joint pain (arthritis), difficulty breathing, and refusal to feed or drink. Other symptoms included in this factor are malaise, bleeding or bruising, chest pain, anorexia (loss of appetite), and fatigue or weakness. These symptoms are often indicative of systemic involvement and can reflect more acute manifestations of the disease, often associated with complications or more severe illness.

Factor 2, on the other hand, appears to capture a broader range of symptoms, many of which are commonly reported in the early stages of Lassa fever and may be less specific but still relevant to diagnosis and management. These include anorexia, fatigue, nausea, abdominal pain, cough, vomiting, diarrhea, sore throat, headache, and fever. The symptoms in this factor are often nonspecific and can overlap with other infectious diseases, making them more challenging to distinguish in the early stages of illness. The matrix suggests that these symptoms, though present, may be associated with less severe forms of the disease or earlier stages of infection.

The loadings for each symptom indicate the strength of their relationship with each factor, helping to prioritize which symptoms are most closely associated with the underlying disease characteristics. Overall, the matrix provides valuable insights into the symptomatology of Lassa fever, highlighting both the acute, severe manifestations and the more general symptoms that may appear at different stages of infection. This differentiation can aid in improving diagnostic accuracy and patient management, helping clinicians identify the stage and severity of the disease more effectively.

Table 3 further presents two key sets of symptoms associated with Lassa fever, which were identified through factor analysis: early symptoms and late symptoms.

The late symptoms are typically observed as the disease progresses and may signal a more severe stage of the infection. These include muscle pain and joint pain or arthritis, which are common as the infection spreads through the body. Refusal to feed or drink is often seen in severely ill patients, particularly in children, and indicates worsening health. Difficulty breathing is another critical symptom of late-stage Lassa fever, suggesting respiratory distress. Malaise, or a general feeling of discomfort and fatigue, tends to increase as the disease advances. Bleeding and bruising, which are signs of hemorrhagic complications, are also common in the later stages and can indicate a life-threatening progression. Additionally, chest pain can develop, often related to respiratory issues or inflammation within the body.

The early symptoms, on the other hand, appear in the initial phase of the illness and can overlap with other common febrile diseases, making early diagnosis more challenging. These symptoms include anorexia, or a loss of appetite, which is often one of the first signs of illness. Fatigue and weakness are also prominent early indicators, leaving the patient feeling exhausted and lacking energy. Nausea, abdominal pain, and new onset of vomiting and diarrhea often accompany these early symptoms and are part of the gastrointestinal symptoms commonly seen in the early stages. A new cough, sore throat, and headache are also frequent in the initial phase of Lassa fever. The presence of fever, another hallmark symptom, is usually one of the first signs of infection and sets the stage for further symptom development.

Understanding these early and late symptoms is essential for timely diagnosis and appropriate treatment. Early symptoms can help identify the disease in its initial stages, while the appearance of late symptoms indicates a more severe stage that requires urgent medical attention.

*Table 4. Logistics regression model of outcome of cases by demographic and symptom stages where deceased is coded as 1 and recovered as 0.*

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Male | -.127 | .109 | 1.361 | 1 | .243 | .881 |
| Late symptoms | .376 | .059 | 39.973 | 1 | .000 | 1.456 |
| Early symptoms | .302 | .068 | 19.774 | 1 | .000 | 1.352 |
| Age Groups | | | 36.037 | 4 | .000 | |
| 0 - 19 | -.673 | .172 | 15.298 | 1 | .000 | .510 |
| 20 - 29 | -.890 | .161 | 30.608 | 1 | .000 | .411 |
| 30 - 39 | -.425 | .152 | 7.804 | 1 | .005 | .654 |
| 40 - 49 | -.425 | .163 | 6.788 | 1 | .009 | .654 |
| Constant | -1.232 | .106 | 135.975 | 1 | .000 | .292 |

The logistic regression model, which analyzed the outcomes of Lassa fever cases with deceased individuals coded as 1 and recovered individuals coded as 0, provided valuable insights into the factors influencing the likelihood of fatality as presented in Table 4.

Gender was not found to significantly affect the outcome, with males showing only a marginally reduced odds of death with $p > 0.05$ and Exp(B) = 0.881. This suggests that, while male gender is often considered a risk factor for various diseases, it did not emerge as a key determinant in the outcome of Lassa fever cases in this study.

Symptom stages, however, were found to be significant predictors of the disease's outcome. The presence of late-stage symptoms (such as severe hemorrhaging, multi-organ failure, or shock) was strongly associated with an increased likelihood of death with $p < 0.05$ and Exp(B) = 1.456. This indicates that the later the symptoms manifest, the greater the risk of fatality, underscoring the critical importance of early detection and intervention. Furthermore, the presence of early-stage symptoms (such as fever, malaise, and headache) also significant to risk of mortality, although the effect of early stage symptoms was less pronounced than that of late symptoms with $p < 0.05$ and Exp(B) = 1.352. Though, both early and late stage symptoms were strongly associated with an increased likelihood of death by Lassa fever but this effect is less pronounced in early stage symptoms compared to late stage symptoms.

Age was another significant factor influencing the outcome. Younger age groups exhibited a markedly reduced risk of death, with the 0-19 years group showing the lowest odds of fatality with $p < 0.05$ and Exp(B) = 0.510. This is consistent with the general observation that children and young adults tend to have stronger immune responses, which may improve their chances of surviving viral infections. Similarly, the 20-29 years age group showed a significantly lower risk of death with $p < 0.05$ and Exp(B) = 0.411. Individuals in the 30-39 and 40-49 age groups also experienced a reduced risk, though the decrease in odds was less marked with $p = 0.005$ and $p = 0.009$, respectively. These findings suggest that the risk of fatality increases with age, which may be related to factors such as declining immune function and the presence of co-morbid conditions in older individuals.

Overall, the study highlights the critical role of early intervention in improving the survival chances of Lassa fever patients. The combination of demographic factors (such as age) and clinical presentation (particularly the stage of symptoms) provides important insights for medical practitioners, informing treatment strategies that could significantly reduce mortality rates. Early detection, prompt medical intervention, and targeted care for individuals with late-stage symptoms could have a profound impact on the outcomes of Lassa fever, particularly in high-risk groups such as older individuals.

## 5. Conclusion and Recommendation

In conclusion, this study provides a comprehensive analysis of Lassa fever outcomes, emphasizing the significant influence of demographic factors such as sex, education, age, and geographic distribution, as well as the clinical presentation of symptoms at different stages of the disease. The findings highlight that males are slightly more vulnerable to Lassa fever, comprising a larger proportion of both recoveries and deaths. Educational background plays a crucial role, with individuals having no formal education showing higher mortality rates, possibly due to delayed access to healthcare, while those with tertiary education had the highest recovery rates, suggesting better health literacy and resources.

Age emerged as a critical determinant, with younger individuals (0-19 and 20-29 years) exhibiting higher recovery rates and lower mortality, likely due to stronger immune responses. In contrast, older adults, particularly those aged 50 and above, faced a significantly higher risk of death, which

could be attributed to the presence of co-morbid conditions or weaker immune systems. The study also revealed notable geographic disparities, with Edo and Ondo states bearing the greatest burden of the disease, pointing to the need for targeted public health interventions in these regions.

The analysis of symptom stages highlighted that late-stage symptoms, including severe hemorrhaging and multi-organ failure, were strongly associated with higher mortality rates. Early symptoms, although less severe, still contributed to an increased risk of death, underscoring the importance of early diagnosis and treatment. The study also used factor analysis to identify clusters of symptoms, revealing a distinction between early symptoms, which are often nonspecific and harder to diagnose, and late symptoms, which are more severe and indicative of a worsening disease.

Finally, the logistic regression model confirmed that the stage of symptoms and age were the most significant predictors of outcomes, with older individuals and those presenting with late-stage symptoms at a significantly higher risk of death. Overall, this study emphasizes the importance of early intervention and the need for targeted public health strategies based on demographic and clinical factors. Improving health education, timely access to care, and focused efforts in high-risk areas are essential to reducing mortality rates and improving survival outcomes for Lassa fever patients.

## Abbreviations

| | |
|---|---|
| DSNO | Disease Surveillance and Notification Officer |
| ILFR&C | Institute of Lassa Fever Research and Control |
| LASV | Lassa Virus |
| LUTH | Lagos University Teaching Hospital |
| NCDC | Nigeria Centre for Disease Control |
| RT-PCR | Reverse Transcription Polymerase Chain Reaction |
| WHO | World Health Organization |

## Author Contributions

**Adetunji Kolawole Ilori:** Conceptualization, Methodology, Resources, Writing – original draft, Writing – review & editing

**Adeyeye Clement Awogbemi:** Conceptualization, Methodology, Resources

**Adebisi Michael:** Conceptualization, Investigation, Resources, Validation

**Toyosi Adebambo:** Conceptualization, Resources

**Kole Emmanuel:** Resources, Visualization

**Dayo Vincent Kayode:** Resources, Writing – original draft

## Data Availability Statement

The data that support the findings of this study can be found at: Proposed title of the dataset: Epidemiological data on Lassa fever in Nigeria, 2018 - 2021.

## Conflicts of Interest

The authors declare no conflicts of interest.

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