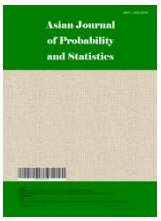

Asian Journal of Probability and Statistics

15(4): 88-96, 2021; Article no.AJPAS.77397
ISSN: 2582-0230

Statistical Distribution of Lassa Fever in Edo State, Nigeria

Nwaigwe, Chrysogonus Chinagorom [a], Bartholomew, Desmond Chekwube [a*] and Eze, Petra Adachukwu [a]

[a] Department of Statistics, Federal University of Technology Owerri, Owerri, Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJPAS/2021/v15i430366
Editor(s):
(1) Dr. Manuel Alberto M. Ferreira, ISTA-School of Technology and Architecture, Lisbon University, Portugal.
Reviewers:
(1) Isra Natheer Alkallak, University of Mosul, Iraq.
(2) Ehimen Ferguson A, Nigeria.
Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: https://www.sdiarticle5.com/review-history/77397

Original Research Article

Received 27 September 2021
Accepted 01 December 2021
Published 06 December 2021

Abstract

Lassa fever is a severe viral infection caused by the Lassa virus and spread by contact with excretions or secretions of infected rats gaining access to food and water inside human houses and other human activity areas. Sierra Leone, the Republic of Guinea, Nigeria, and Liberia are among the nations where it is endemic with a high number of deaths recorded yearly due to Lassa fever. In Nigeria, one of the states with the highest incidence is Edo. In order to reduce and predict the spread of Lassa fever in Edo state, the trend of the disease needs to be understood. Knowledge of the statistical distribution of a disease is one of the best ways to understand the trend of the disease. Currently, existing research on the statistical distribution of Lassa fever is very rare. The present work is an attempt to initiate research on the statistical distribution of Lassa fever with data obtained on weekly cases of Lassa Fever in Edo State, Nigeria. Based on the Kolmogorov Smirnoff and Anderson Darling's goodness of fit test for fitting distribution, the Geometric distribution outfitted the weekly confirmed incidences of Lassa fever in Edo State, Nigeria when compared with the Discrete Uniform and Poisson distributions. The study further revealed that on the average, two Lassa fever cases is recorded per week in Edo State within the study period. This number of cases per week is on the high side and should be immediately looked into.

Keywords: Lassa fever; description; trend; statistical distribution; Edo State.

**Corresponding author: Email: desmond.bartholomew@futo.edu.ng;*

1 Introduction

According to Amodu & Fapohunda [1] and Tewogbola & Aung [2], the Lassa infection causes an acute viral hemorrhagic fever known as Lassa Fever; which was first found in 1969 and named after a town called Lassa (where it first appeared) in Borno State, Nigeria. In West Africa especially in Edo State Nigeria, Lassa fever has become endemic as reported by Mofolorunsho (2019). Studies have shown that it is transmitted through direct contact with sick rats' excretions or secretions (including feces and urine) on food, water inside where people lives; and other places domiciled by humans [1]. Lassa fever can take anywhere from 6 to 21 days to develop [3]. Clinical studies have shown that outbreaks of Lassa fever usually brings high death rates as the cases are hardly discovered on time due to the fact that it presents similar symptoms with malaria and typhoid fever at the early stage. Some of the symptoms of Lassa fever are respiratory distress, weakness, difficulty in swallowing; vomiting with blood, muscle joint and back pains [4].

Furthermore, it has been observed that Lassa fever is a disease that is often overlooked but has severe social and economic consequences. The enlightenment for the prevention of Lassa fever and diagnostic facilities are either lacking or inadequate in many parts of Nigeria where Lassa fever is endemic (Mofolorunsho, 2019). It is therefore important to have knowledge of the distribution of the disease in each town so as to guide the government on awareness campaign and provision of facilities to prevent and control the disease. One of the ways to understand the distribution of a disease is through fitting of statistical distributions to observe the best distribution that fits the data collected on diagnosed cases of the disease. This helps us to develop a valid model to understudy the random process of occurrence of the disease. Statistical distributions provide a valid tool to deal with risk and uncertainty involved with random processes. A good model, if put into good use will help the planner to make informed decisions; guide against some losses and also save time. This is done by obtaining the probability distribution of the occurrence of the disease in the place and calculating the probability that a specific number will be infected at a given interval of time.

Alexandre et al. [5] conducted a prospective cohort study on patients admitted with confirmed Lassa fever at the Federal Medical Centre in Owo, Nigeria. All infected individuals were given conventional supportive care and intravenous ribavirin, as prescribed by the Nigeria Centre for Disease Control, and were monitored biologically for 30 days. Univariable and multivariable logistic regression models were used to explore a connection between baseline characteristics and mortality at day 30 after 30 days of surveillance. Age (45 years or older), a National Early Warning Score (NEWS2) of greater than or equal to seven, a kidney disease–Improving Global Outcome (KDIGO) stage of greater than or equal to two, plasma alanine aminotransferase 3 or more times the upper limit of normal, and a Lassa fever RT-PCR Ct value lower than 30 were all found to be independently associated with mortality.

Merson, Bourner, Jalloh, Erber, Sallam, Flahault & Olliaro [6] extracted, verified, and summarized some primary clinical investigations and reports of patients with Lassa fever, both suspected and confirmed in some selected published works using descriptive statistics. Most of the data were from Nigeria and their findings showed that the main symptoms of Lassa fever include: gastrointestinal sickness, as well as other neural system and musculoskeletal issues that aren't usually considered Lassa Fever symptoms. The study recommended that a strong Lassa Fever research community should generate a generalized research method that can build a new strong treatment for Lassa Fever and build trust in their ability to be integrated into clinical care.

Akpede et al. [7] used Observational study of Lassa Fever caseload and mortality from 2001 to 2018 in Nigeria to estimate the relative risk of confirmed case’s death on admission and case fatality. In their work, they used reverse transcription polymerase chain reaction (RT-PCR) test, medians and frequencies and showed that the contribution of confirmed Lassa Fever to deaths has a relative risk of 5.9 and the relative risk of Case Fatality among patients with confirmed Lassa Fever is 2.9.

Okoroiwu, López-Muñoz and Povedano-Montero [8] retrieved 1101 scientific research articles on Lassa Fever from SCOPUS database published between 1970 to 2017. Their work basically examined the growth of publications on Lassa Fever. The results of their research revealed that the increase of scientific literature on Lassa fever followed a linear pattern, with high transient writers suggesting low productivity and non-specialized authors from related fields writing intermittently.

In her paper, Assessment of Onset-to-Intervention Time and Outcome of Lassa Fever During an Outbreak in Edo State, Ireye [9] looked into the length of time between the onset of illness and the start of treatment, as well as the effects on disease outcome among patients. More than 14.6 percent of the cases died, while 85.4 percent survived, according to the report.

Ogbu [10] employed re-analysis of confirmatory tests to establish basic statistics of the effects of Lassa fever in his study on high Lassa disease activity in Edo State's northern region. According to the study, laboratory analysis of samples supplied to the Bernhard–Nocht Institute for Tropical Medicine in Hamburg, Germany, revealed Lassa fever activity in the northern part of Edo state, Nigeria, in 2004. The study's published report was re-analyzed in order to identify in statistical terms what the results reported in percentages equated to in terms of the number of people in the area. In 2004, 12,000 people visited Irrua Specialist Teaching Hospital (ISTH) in Irrua with a febrile illness; 832 (6.5 percent) with Lassa fever confirmed by reverse transcriptase.

From the foregoing review, it is not out of place to state that little or no work has been done on the statistical distribution of Lassa fever. This study is therefore an attempt to initiate the study of the statistical distribution of Lassa fever, using data obtained from Edo State, Nigeria from 2019 to 2020 on Lassa fever.

2 Methodology

This study employed two methods of fitting distributions to data, the Kolmogorov-Smirnov test of goodness of fit and the Anderson-Darling test. These two tests are popularly known in statistics for their ability to verify if a given dataset comes from a particular distribution. Three distributions were fitted to the data, namely, discrete uniform distribution, geometric distribution and Poisson distribution. Some graphical approaches to distribution fitting like the density plot, Q-Q (Quantile vs Quantile) plot, CDF plot and P-P (Probability plot) were also considered.

3 Results

In this section, results obtained from fitting of distributions to weekly cases of Lassa fever in Edo state are stated.

Fig. 3.1 shows the weekly occurrence of Lassa Fever in Edo State. The results show that an average of two cases per week of Lassa Fever occurred in Edo State between 2019 and 2020. The curve depicts the trend of the disease in Edo State within the period under study which gives us an idea of the distributions to be fitted to the data.

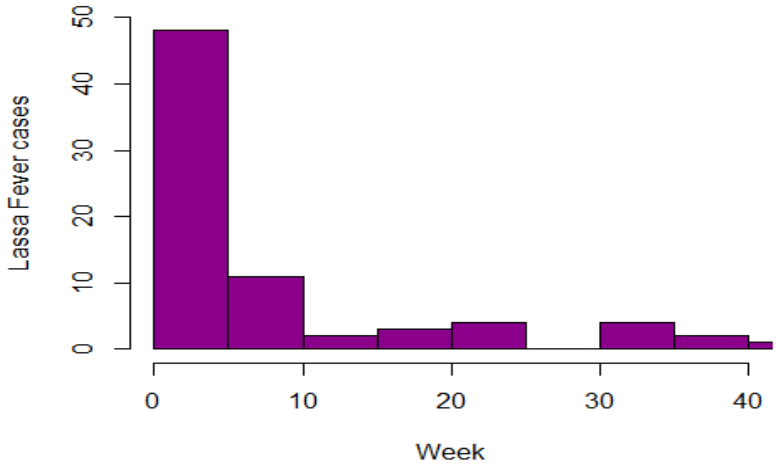

Fig. 3.1. Frequency Curve on weekly Occurrence of Lassa Fever in Edo State (2019 – 2020)

The results of Kolmogorov-Smirnov test and Anderson-Darling tests in Table 3.1 shows that among the distributions fitted to the data, geometric distribution best fits the data as it had the least statistic values and ranked as 1 on both tests.

Table 3.1. Outcome of Fitting of Distributions to Data on Weekly Confirmed Cases of Lassa Fever in Edo State

	Distribution	Kolmogorov Smirnov		Anderson Darling	
		Stat. value	R.	Stat. value	R.
1	Discrete Uniform	0.2973	2	32.291	2
2	Geometric	0.13762	1	2.9692	1
3	Poisson	0.47965	3	89.213	3

The results in Fig. 3.2 show the probabilities of occurrence of weekly cases of Lassa fever in Edo State. The results show that two (2) cases of Lassa fever are most likely to occur in Edo state each week.

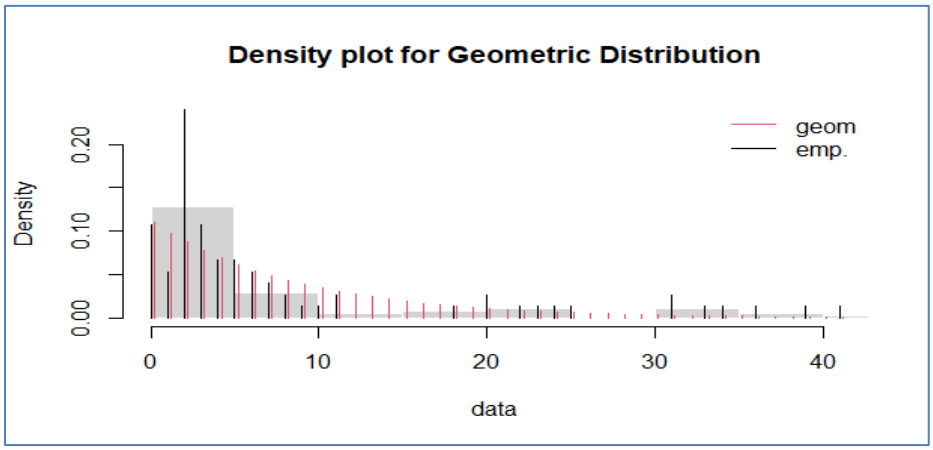

Fig. 3.2. Geometric Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

The Density plots shown in Fig. 3.2, Fig. 3.3 and Fig. 3.4 for Geometric, Uniform and Poisson distributions respectively are used to observe the distribution of the weekly number of Lassa fever in Edo State, Nigeria. It plots the graph on a continuous interval or time-period. Considering the density plots, it is further verified that the Geometric distribution best models the weekly Lassa fever in Edo State, Nigeria.

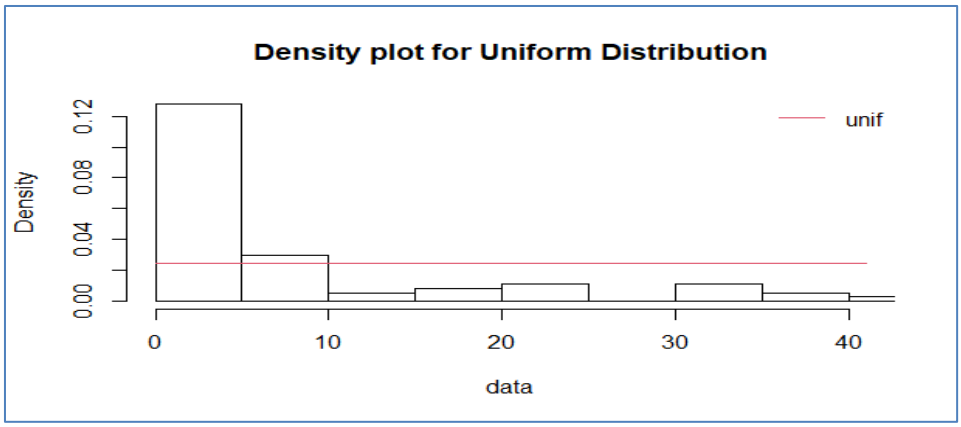

Fig. 3.3. Uniform Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

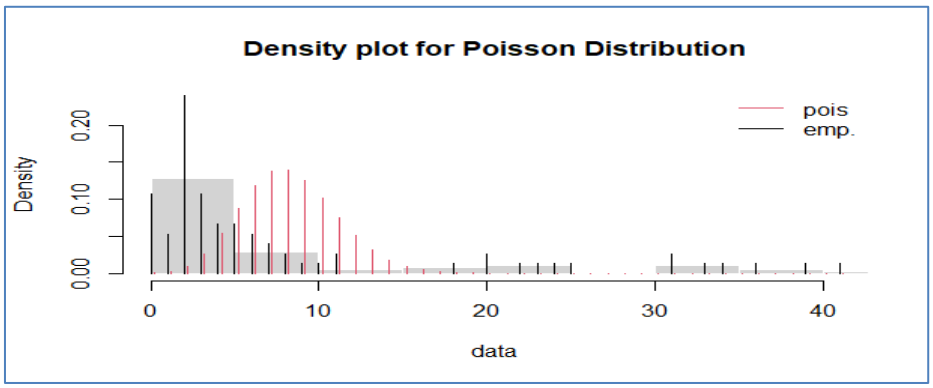

Fig. 3.4. Poisson Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

The P-P and Q-Q plot which is a scatterplot created by plotting empirical quantiles against the theoretical quantiles in Fig. 3.5 and Fig. 3.6 was used to check If both sets of quantiles were drawn from the same distribution, the result would be the same. It is expected that the points make a relatively straight line. It is clear that for both the P-P and Q-Q plots, only the Geometric distribution line appears to be straight when compared with the lines of the other distributions. This is also an indication that the Geometric distribution best fits the weekly number of Lassa fever confirmed cases in Edo State, Nigeria.

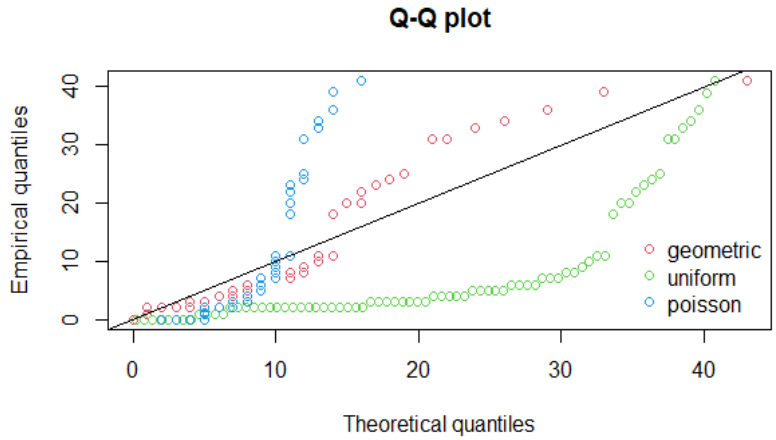

Fig. 3.5. Probability density curve of weekly number of confirmed cases of Lassa fever in Edo State

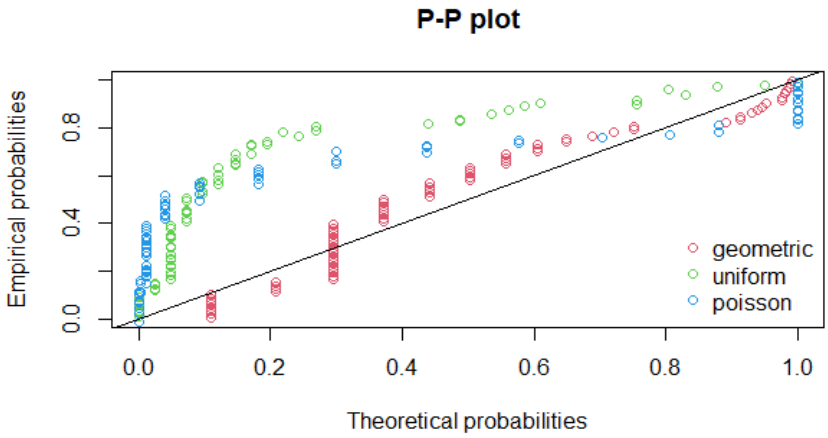

Fig. 3.6. Probability density curve of weekly number of confirmed cases of Lassa fever in Edo State

The cumulative distribution function (CDF) plot in Fig 3.7 shows the empirical cumulative distribution function of the of weekly number of confirmed cases of Lassa fever in Edo State, Nigeria. The red line which is the Geometric distribution line follows closely with the black lines that represents the observed. This is also another confirmation that the observed weekly number of confirmed cases of Lassa fever in Edo State, Nigeria follows the Geometric distribution.

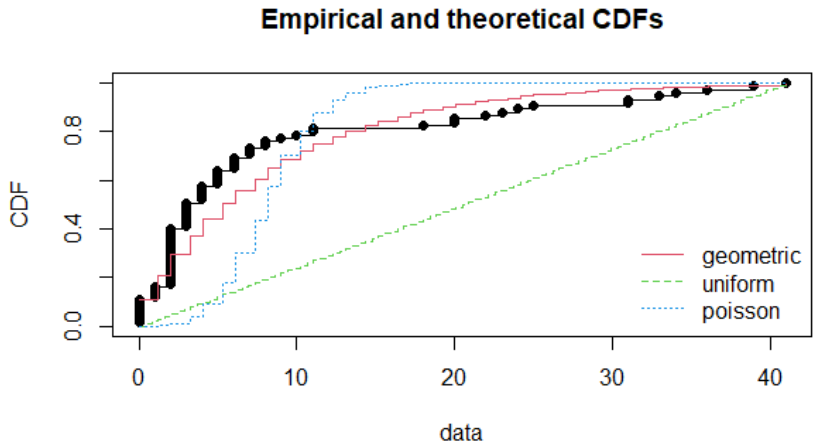

Fig. 3.7. Probability density curve of weekly number of confirmed cases of Lassa fever in Edo State

4 Conclusion

In this study, data were collected on weekly number of occurrences of Lassa fever in Edo State, Nigeria. Distributions were fitted to the data using Kolmogorov-Smirnov test and Anderson –Darling test. The results showed geometric distribution was the most appropriate fit for the data. The results further showed that two cases of Lassa fever are mostly likely to occur in Edo state weekly.

5 Recommendation

Based on the findings of this study, an average of two Lassa fever cases per week in Edo state is dangerous. Therefore, the appropriate disease control centers should urgently intervene to immediately stop the spread and existence of this endemic in Edo state, Nigeria.

Competing Interests

Authors have declared that no competing interests exist.

References

[1] Amodu SE, Fapohunda SO. Lassa fever and the Nigerian Experience: a review, Europian Journal of Biological Research. 2019;9(3):155-164.

[2] Tewogbola P, Aung N. Lassa fever: History, Causes, Effects and reduction Strategies, International Journal of One Health. 2019;6(2):95-98.

[3] Mofolorunsho KC. Outbreak of Lassa fever in Nigeria: Measures for Prevention and Control, Pan African Medical Journal. 2016;23:210.

[4] Woyessa AB, Maximore L, Keller D, Dogba J, Pajbo M, Johnson K, Saydee E, Monday J, Tuoployill R, Neha Mahmoud. Lesson learned from the Investigation and Response of Lassa Fever Outbreak, Margibi Country, Liberia 2018: Case Report, BMC infectious Disease. 2019;19:610.

[5] Alexandre D, Marie J, Ijeoma CE, Delphine G, Béatrice S, Chukwuyem A, et al. Lassa fever outcomes and prognostic factors in Nigeria (LASCOPE): a prospective cohort study, The Lancet Global Health. 2021;9(4):e469-e478.
ISSN 2214-109X.
Available:https://doi.org/10.1016/S2214-109X(20)30518-0.

[6] Merson L, Bourner J, Jalloh S, Erber A, Salam AP, Flahault A, et al. Clinical characterization of Lassa fever: A systematic review of clinical reports and research to inform clinical trial design. PLoS Neglected Tropical Diseases. 2021;15(9):e0009788.
Available:https://doi.org/10.1371/journal. pntd.0009788.

[7] Akpede GO, Asogun DA, Okogbenin SA, Dawodu SO, Momoh MO, Dongo AE, et al. Caseload and Case Fatality of Lassa Fever in Nigeria, 2001–2018: A Specialist Center's Experience and Its Implications. Frontiers in Public Health. 2019;7:170.
DOI: 10.3389/fpubh.2019.00170

[8] Okoroiwu HU, López-Muñoz F, Povedano-Montero FJ. Bibliometric analysis of global Lassa fever research (1970–2017): a 47 – year study. BMC Infectious Disease. 2018;18:639.
Available:https://doi.org/10.1186/s12879-018-3526-6

[9] Ireye F. Assessment of Onset-to-Intervention Time and Outcome of Lassa Fever during an Outbreak in Edo State, International Journal of Prevention and Treatment. 2018;7(2):1-5.

[10] Ogbu OB, Ajuluchukwu EN, Uneke CJ. Lassa fever in West African sub-region: an overview. Journal of Vector Borne. 2004;2:20-25.

Appendix A

Lassa Fever cases in Edo State 2019		
Week	**New Confirmed Cases**	**Cumulative**
1	9	9
2	3	12
3	31	43
4	24	67
5	20	87
6	10	97
7	6	103
8	11	114
9	20	134
10	23	157
11	8	165
12	4	169
13	6	175
14	2	177
15	1	178
16	2	180
17	0	180
18	3	183
19	2	185
20	2	187
21	2	189
22	2	191
23	4	195
24	2	197
25	4	201
26	1	202
27	5	207
28	4	211
29	4	215
30	2	217
31	7	224
32	2	226
33	2	228
34	0	228
35	0	228
36	3	231
37	3	234
38	3	237
39	7	244
40	5	249
41	2	251
42	6	257
43	2	259
44	5	264
45	2	266
46	5	271
47	3	274
48	2	276
49	0	276
50	1	277
51	0	277
52	0	277

Appendix B

Lassa Fever cases in Edo State from 30th Dec. 2019 - 7th June 2020		
Week	**New Confirmed Cases**	**Cumulative**
53	7	7
54	18	25
55	33	58
56	34	92
57	36	128
58	39	167
59	41	208
60	22	230
61	31	261
62	25	286
63	11	297
64	8	305
65	3	308
66	5	313
67	6	319
68	0	319
69	1	320
70	0	320
71	2	322
72	3	325
73	2	327
74	2	329
75	2	331

The appendixes show the data collected on weekly cases of Lassa fever in Edo state with their cumulative frequencies for that particular week.

Peer-review history:
The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)
https://www.sdiarticle5.com/review-history/77397