Original Research Article

STATISTICAL DISTRIBUTION OF LASSA FEVER IN EDO STATE, NIGERIA

Abstract

Lassa fever is an acute viral illness caused by Lassa virus and transmitted by contact with excretions or secretions of infected rats accessing food items and water inside human residences and other centers with human activities. It is an endemic in West African countries, especially Sierra Leone, the Republic of Guinea, Nigeria, and Liberia, where a high number of deaths is recorded yearly due to Lasser fever. In Nigeria, Edo state is one of the states with the highest index case. 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.

Keywords: Lassa fever, Description, Trend, Statistical Distribution, Edo State

1. Introduction

It has been observed that Lassa Fever is an acute viral hemorrhagic fever brought about by the Lassa infection which was first discovered in 1969 and named after the town of Lassa (where it first occurred), in Borno State, Nigeria (Amodu and Fapohunda; 2019 and (Tewogbola and Aung; 2019)). Lassa fever has become endemic in many parts of West Africa since it was discovered. Outbreaks of Lassa fever have been reported in various parts of Nigeria, including Edo State (Mofolorunsho, 2019). Studies have shown that it is transmitted through direct contact with excretions or secretions (including faeces and urine) of infected rats on food items and water inside human residences and other centres with human activities (Amodu and Fapohunda, 2019). The incubation period of Lassa fever ranges from 6-21 days (Mofolorunsho, 2016). Clinical studies have shown that out breaks of Lassa fever are usually associated with high

mortality 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 (Woyessa, 2019).

It has been observed that Lassa fever is a frequently underestimated but socially and economically devastating disease. 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. 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.

Ireye (2018) in her work on Assessment of Onset-to-Intervention Time and Outcome of Lassa Fever during an Outbreak in Edo State, investigated the duration of time of onset of illness to commencement of treatment and the implications on disease outcome among patients. The study observed that more than 14.6% of the cases died and 85.4% survived.

Ogbu (2004) in his work on high Lassa fever activity in northern part of Edo State stated that the purpose of reanalysis of confirmatory test was to establish simple statistics of the effects of Lassa fever in northern part of Edo State, Nigeria. According to the study, Lassa fever activity in the northern part of Edo state, Nigeria, was confirmed in 2004 by laboratory analysis of samples sent to Bernhard–Nocht Institute for Tropical Medicine Hamburg, Germany. The published report of that study was re-analysed to determine in statistical terms, what the values presented in percentages translate to in number of persons in the hospital and the area. In the year 2004, 12,000 persons presented with febrile illness at Irrua Specialist Teaching Hospital (ISTH), Irrua; 832 (6.5%) had 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. 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) are also considered.

3. Results

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

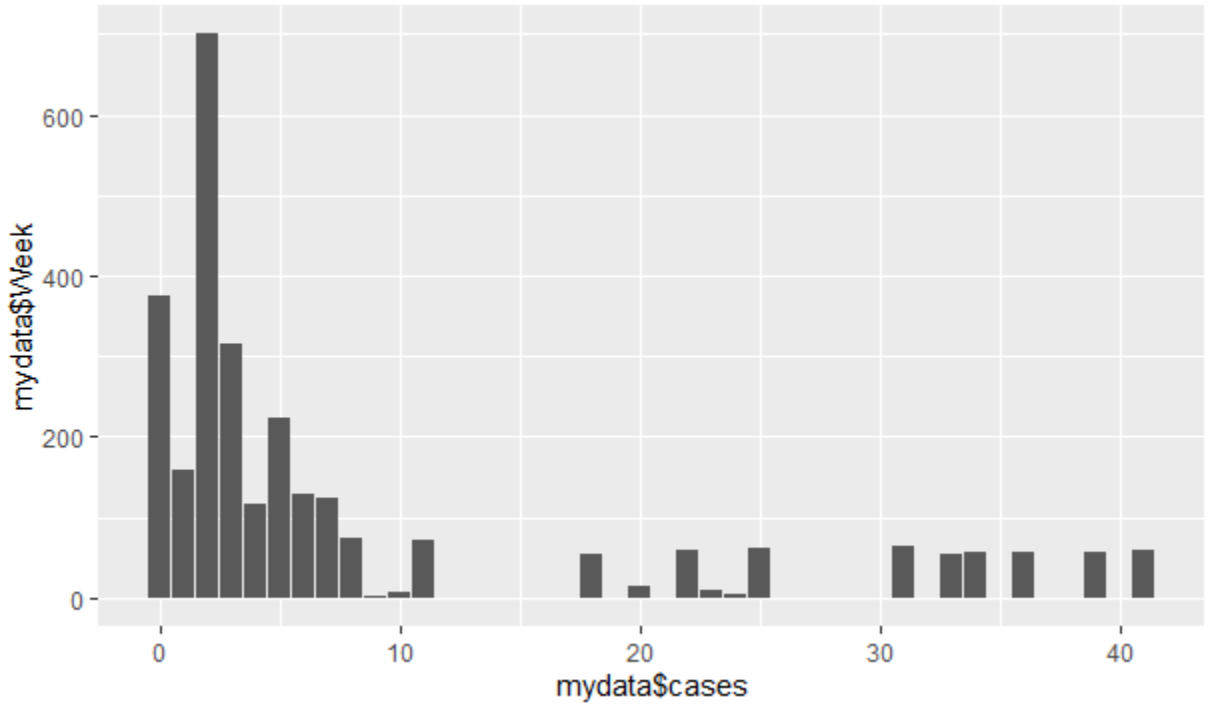

Fig 3.1: Frequency Curve on weekly Occurrence of Lassa Fever in Edo State (2019 – 2020)

Fig 3.1 shows the weekly occurrence of Lassa Fever in Edo State. The results show that an average of two cases 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.

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

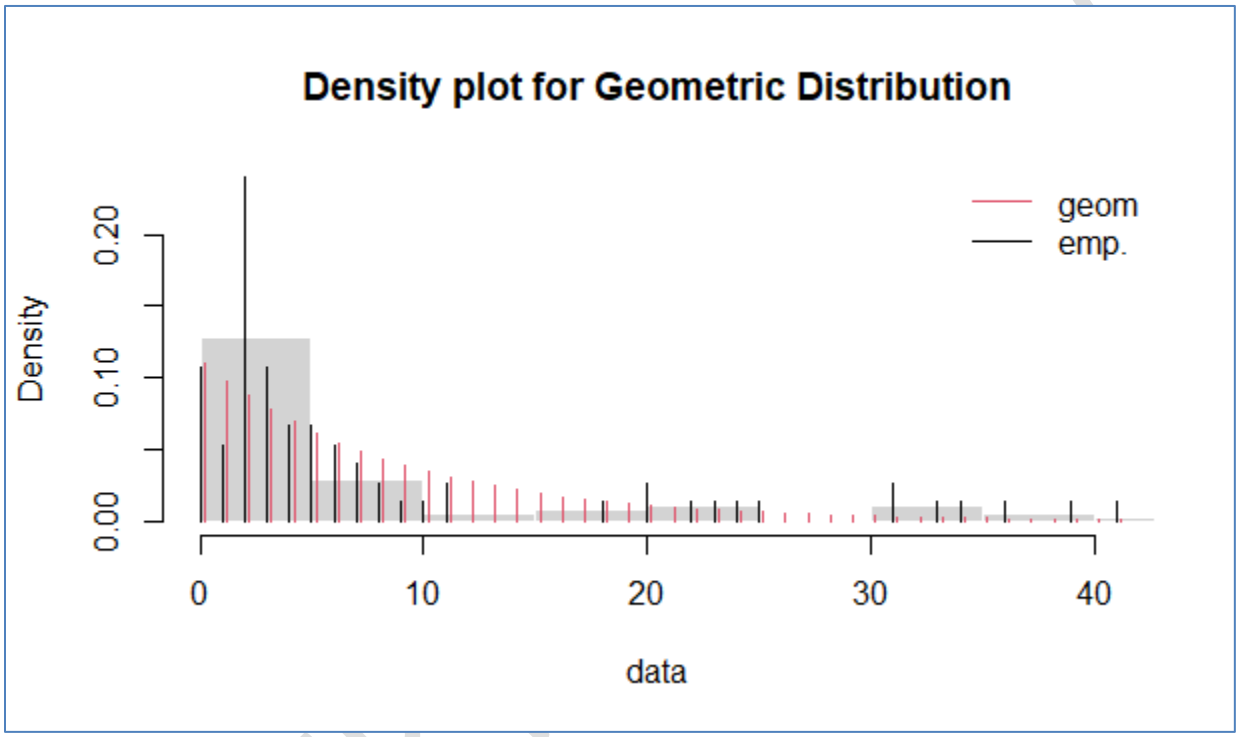

Fig 3.2: Geometric Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

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.

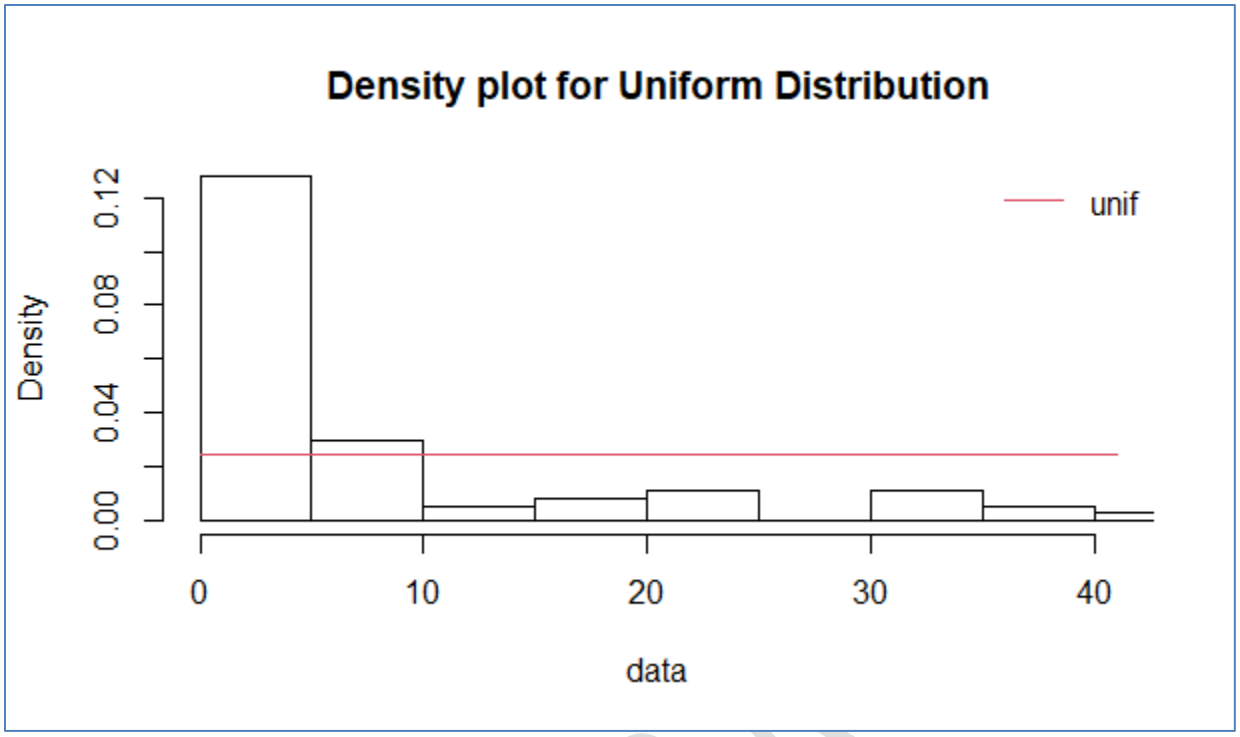

Fig 3.3: Uniform Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

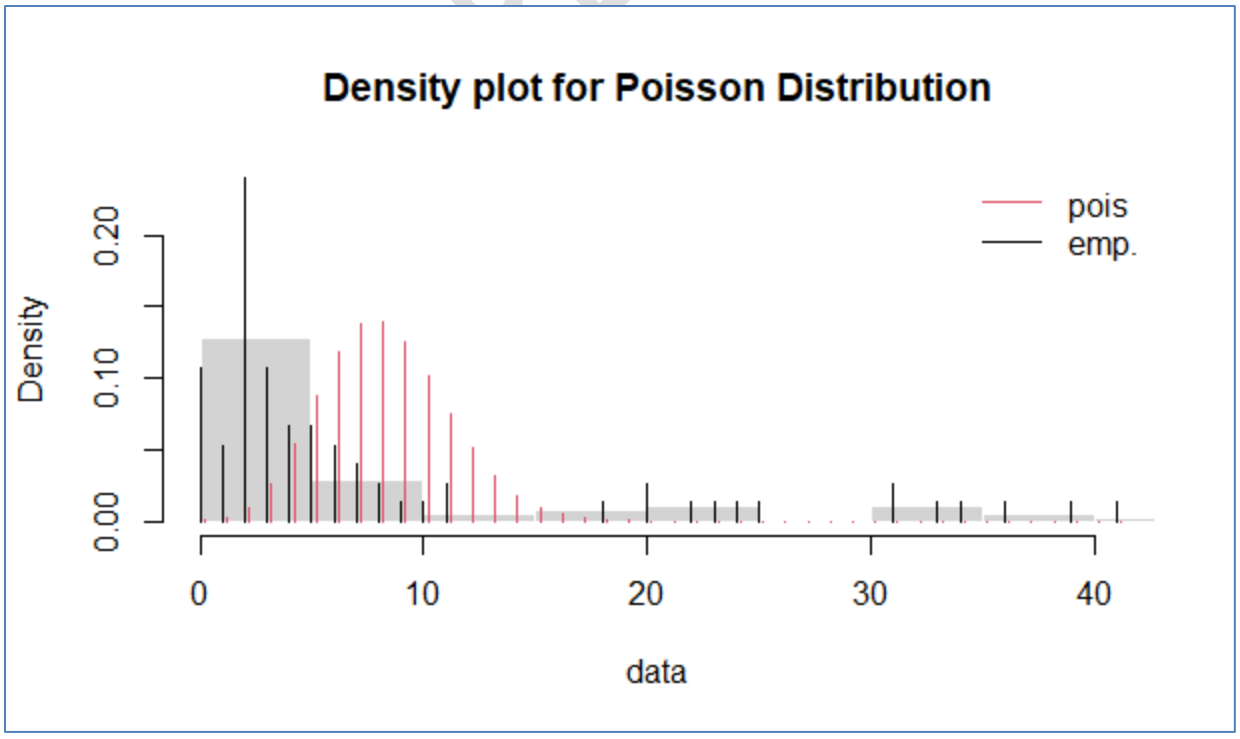

Fig 3.4: Poisson Distribution Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

The 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.

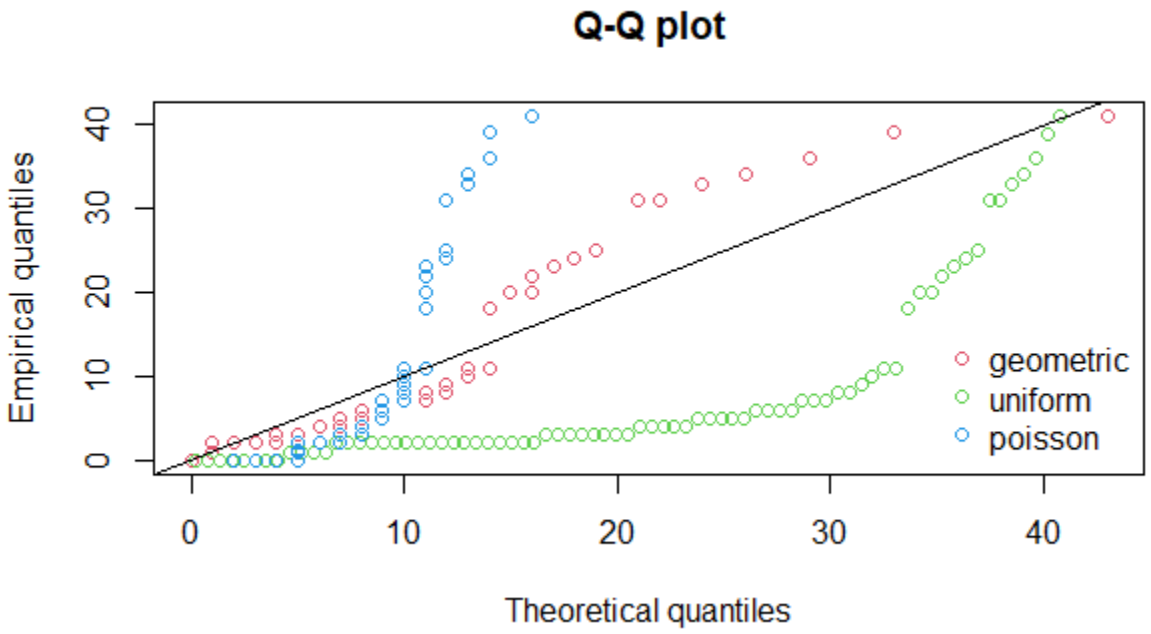

Fig 3.5: Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

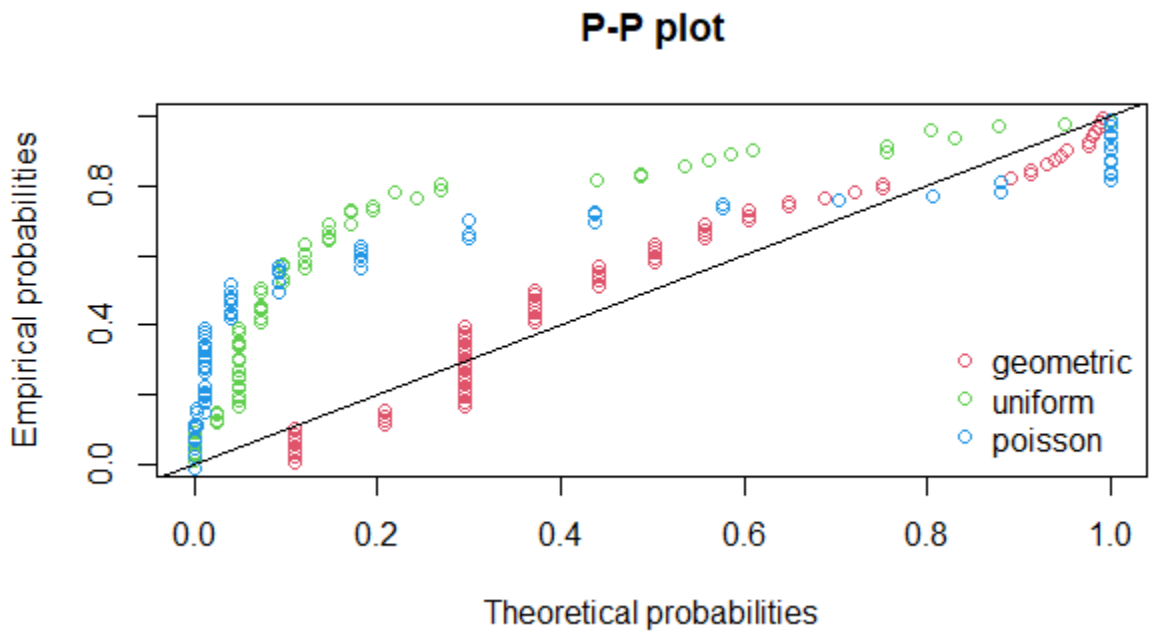

Fig 3.6: Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

The 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 came from the same distribution. It is expected that the points form a line that is roughly straight. 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.

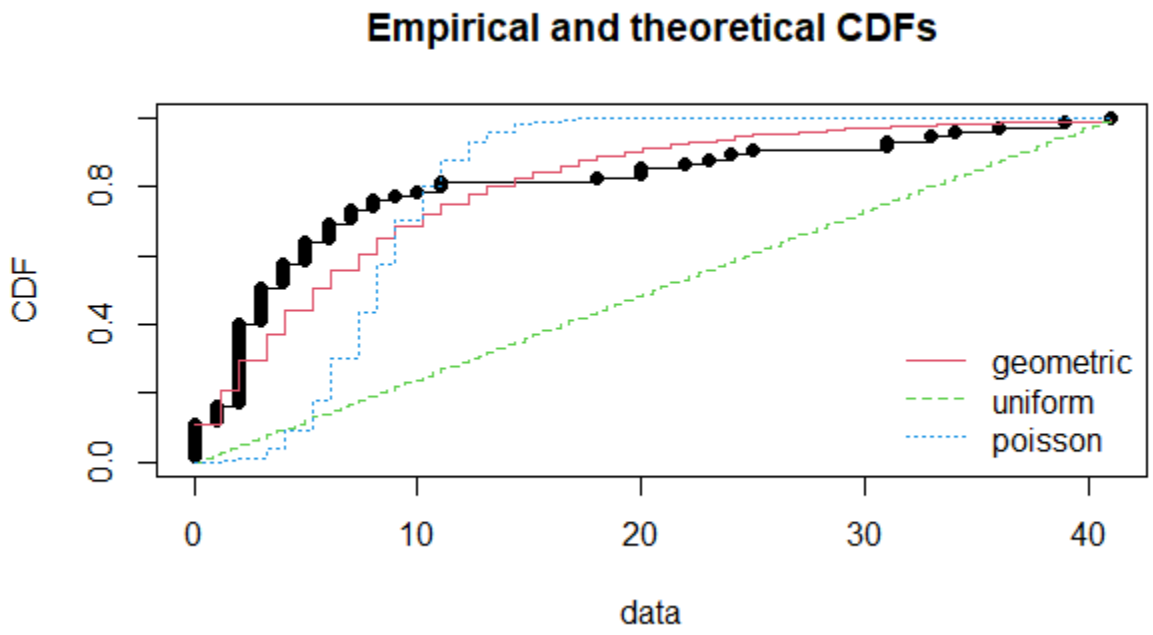

Fig 3.7: Probability Density Curve of Weekly Number of Confirmed Cases of Lassa fever in Edo State

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.

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.

References

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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.