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MATHEMATICAL DYNAMICS MODEL OF LASSA FEVER WITH NUMERICAL AND SENSITIVITY ANALYSIS

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Abstract

We presented a deterministic model of Lassa Fever dynamics. The compartmental model is of five compartments which are the susceptible, the latent infected individuals, the infected individuals, the isolated infected individuals and the recovered individuals. We first proved that the solutions of the model are positive for all time, $t > 0$. We investigated the existence of steady states (the disease-free and endemic steady state or equilibrium). We proved that the disease free equilibrium is asymptotically stable whenever $\Re_0 < 1$ and the endemic equilibrium is shown to be also asymptotically stable. We were able to look at numerical solution of the model (simulation). This resulted in drawing seven graphs which were interpreted. The plots reveal that while strategies of reduction of the spread of the disease seems trivial but an increase in the rate of isolated of individuals diagnosed of Lassa Fever has a major role it plays in the spread and population being infected by the disease.

Keywords and phrases: Lassa Fever, endemic steady state, mathematical model of Lassa Fever, dynamical systems.

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References

[1] S. O. Adewale, I. A. Oklapade, S. O. Ajaro, G. A. Adeniran and T. O. Oyademi, Mathematical analysis of Lassa Fever model with isolation, Asian J. Nat. Appl. Sci. 5(3) (2010), 47-57.

[2] J. A. R. Akhmetzanov, Y. Asiai and H. Nishiura, Quantifying the seasonal drivers of transmission for Lassa Fever Nigeria, Phil. Trans. R. Soc. B 374 (2019), 1775.

[3] F. O. Akinpelu and R. Akinwande, Mathematical model of Lassa Fever and sensitivity analysis, J. Sci. Engng. Res. 5(6) (2018), 1-9.

[4] N. Bawa, S. Aabdulrham and O. R. Jimoh, Stability analysis of disease-free equilibrium state of Lassa Fever disease, Internat. J. Sci. Math. Edu. 9(2) (2013), 115-123.

[5] C. Castillo-Chavez and B. Song, Dynamical models of tuberculosis and their application, Math. Biosci. Enging. 1(2) (2014), 361-404.

[6] A. Dahmane, J. Van Griensven, M. Van Herp, R. Van den Bergh, Y. Nzomukunde, J. Prior, P. Alders, A. Jambai and R. Zachariah, Constraints in the diagnosis and treatment of Lassa Fever and the effects on mortality in hospitalized children and women with obstatic conditions in rural district hospital in Sierra Leone, Trans. Royal Trop. Med. Hygiene 108(3) (2014), 126-132.

[7] C. Droten, B. M. Kalmmerr, H. Schmitz and S. Gianther, Molecular diagnostic of viral hemorrhagic fever, Antiviral Res. 57 (2003), 67-87.

[8] T. S. Famiira, A mathematical modeling of Lassa Fever dynamics with non-drug compliance rate, Internat. J. Math. Trends Tech. 47(5) (2017), 305-318.

[9] E. Fichet-Calvet and D. J. Rogers, Risk maps of Lassa Fever in West Africa, Plos Neglect. Tropical Diseas. 3(3) (2009), 388-390.

[10] D. Greenky, B. Knust and E. J. Dziuban, What Pediatricians should know about Lassa Fever, JAMA Pediatr. 172(5) (2018), 407-408.

[11] H. J. Hallam, S. Hallam, S. E. Rodriguez, A. D. T. Barrett, D. E. C. Beasley, A. Chua, T. C. Ksiazek, G. M. Milligan, V. Sathelyammoorthy and L. M. Reece, Baseline mapping of Lassa Fever virology epidemiology and vaccine research and development, NPJ Vaccine (2018) (Hppts://do.org/10-1038/s41541-018-0049-5).

[12] S. C. Inyama, A mathematical model for Lassa Fever with reserved population; Advancesin Mathematics; Proceedings of a Menmorial Conference in Honour of Late Professor C. O. E. Sowunm; Department of Mathematics, University of Ibadan, Ibadan, Nigeria, 2009.

[13] Nigeria Center for Disease Control, Weekly Epidemiological Strategies Report. An Update of Lassa Fever outbreak in Nigeria, 2019.

URL: https://ncdc.govt.ng/report/207/2019-august-weel-34.

[14] O. S. Obabiyi and A. A. Onifade, Mathematical model of Lassa Fever transmission dynamics with variable human and research population, Internat. J. Differ. Equat. Appl. 16(1) (2017), 67-91.

[15] C. O. Ogabi, T. V. Olisa and M. A. Madufor, Controlling Lassa Fever in northern part of Edo state, Nigeria using SIR Model, New Sci. J. 5(12) (2012), 457-464.

[16] D. Okuonghaeand R. Okuonghae, A mathematical model for Lassa Fever, J. Nigerian Assoc. Math. Phys. 10 (2016), 457-464.

[17] M. O. Onuora, M. O. Akinwande and M. S. Ojo, Sensitivity analysis of Lassa Fever model, Internat. J. Math. Statist. Stud. 4(1) (2016), 30-49.

[18] J. K. Richmond and D. J. Bagiole, Laasa Fever epidemiology clinic features and social consequences, British Math. J. 327 (2003), 127-135.

[19] S. Usman and I. I. Adamu, Modeling the transmission dynamics of the Lassa Fever infection, Math. Theo. Model. 8(5) (2018), 42-63.

[20] P. Van de Driesshe and J. Watmough, Reproduction numbers and sub-threshold endemic equilibrium for compartmental models of disease transmission, Math. Biosci. 180 (2002), 29-48.

[21] WHO, WHO Lassa Fever, 2018.

Available from https://www.whoint/en/newroom/fact-sheet/detail/lassafever

[22] S. Zhoa, S. S. Musa, H. Fe, D. He and J. Qin, Large scale Lassa Fever outbreaks in Nigeria, quantifying the association between disease reproductive number and local rainfall, Epidemiological Infect. 148 (2020).