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PEMODELAN RAMALAN TREND PENYAKIT INFLUENZA H1N1 MENGGUNAKAN MODEL BERSEPADU SEIQRE

(Modelling Predicting of Novel Influenza H1N1 Trend Disease Using Integrated SEIQRE Model)

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ABSTRACT

The H1N1 influenza outbreak, which initially infected over 15,000 individuals in Malaysia, served as a stark warning to healthcare professionals and all stakeholders in Malaysia and global health sectors. This study proposes SEIQRE model to manage and prevent the spread of influenza through quarantine strategies and natural recovery mechanisms. By employing the Runge-Kutta method, the study provides deeper insights into the dynamics of H1N1 influenza and develops effective strategies to mitigate transmission and reduce risk in high-prevalence areas. Analysis of key epidemiological parameters reveals that reinfection plays a significant role in triggering a backward bifurcation, challenging the conventional reliance on a basic reproduction number less than one. A modified model excluding reinfection confirms a forward bifurcation. These findings underscore the importance of incorporating quarantine, bifurcation effects, and scaling factors into effective infection control strategies. This research contributes to global efforts to combat the H1N1 pandemic and safeguard public health in Malaysia.

Keywords: novel influenza H1N1; disease dynamics; preventive measures; transmission risk; epidemiological parameters; basic reproduction number

ABSTRAK

Wabak influenza H1N1, yang pada mulanya menjangkiti lebih daripada 15,000 individu di Malaysia, bertindak sebagai amaran tegas kepada para profesional kesihatan dan semua pemegang kepentingan dalam sektor kesihatan Malaysia dan global. Kajian ini mencadangkan model SEIQRE untuk mengurus dan mencegah penularan influenza melalui strategi kuarantin dan mekanisme pemulihan semula jadi. Dengan menggunakan kaedah *Runge-Kutta*, kajian ini mampu memperoleh pemahaman yang lebih mendalam tentang dinamik influenza H1N1 dan membangunkan strategi yang berkesan untuk mengurangkan penularan dan mengurangkan risiko di kawasan dengan prevalen tinggi. Analisis parameter epidemiologi utama menunjukkan bahawa jangkitan berulang memainkan peranan penting dalam mencetuskan bifurkasi terbalik, mencabar ketergantungan konvensional kepada nombor reproduksi asas yang kurang daripada satu. Model terubah suai yang tidak termasuk jangkitan berulang mengesahkan bifurkasi ke hadapan. Penemuan-penemuan ini menggariskan kepentingan memasukkan kuarantin, kesan bifurkasi, dan faktor skala ke dalam strategi kawalan jangkitan yang berkesan. Penyelidikan ini menyumbang kepada usaha global untuk memerangi pandemik H1N1 dan menjaga kesihatan awam di Malaysia.

Kata kunci: influenza H1N1 novel; dinamik penyakit; langkah pencegahan; risiko penularan; parameter epidemiologi; nombor reproduksi asas

Rujukan

Ashgi R. 2021. Comparison of numerical simulation of epidemiological model between Euler method with 4th order Runge Kutta method. *International Journal of Global Operations Research* **2**(1): 37–44.

Balraj P., Sidek H., Suppiah J., Khoo A.S.B. & Saat Z. 2011. Molecular analysis of 2009 pandemic influenza A(H1N1) in Malaysia associated with mild and severe infections. *The Malaysian Journal of Pathology* **33**(1): 7–12.

Braga J.U. 2024. Clinical predictors of severe forms of influenza A(H1N1)pdm09 in adults and children during the 2009 epidemic in Brazil. *PLoS One* **19**(2): e0291843.

Cartwright J.H.E. & Piro O. 1992. The dynamics of Runge–Kutta methods. *International Journal of Bifurcation and Chaos* **2**(3): 427–449.

Cooper I., Mondal A. & Antonopoulos C.G. 2020. A SIR model assumption for the spread of COVID-19 in different communities. *Chaos, Solitons & Fractals* **139**: 110057.

Dawood F.S., Iuliano A.D., Reed C., Meltzer M.I., Shay D.K., Cheng P.Y., Bandaranayake D., Breiman R.F., Brooks, W.A., Buchy P., Feikin D.R., Fowler K.B., Gordon A., Hien N.T., Horby P., Huang Q.S., Katz M. A., Krishnan A., Lal R. & Widdowson M.A. 2012. Estimated global mortality associated with the first 12 months of 2009 pandemic influenza A H1N1 virus circulation: A modelling study. *The Lancet Infectious Diseases* **12**(9): 687–695.

Emmanuel S., Sathasivam S., Hasmadi N.H.I., Mohamad Nasir N.H. & Velavan M. 2024. Estimating Upsurge of Hiv Cases in Malaysia by Using Heun's Predictor-Corrector Method. *Journal of Science and Mathematics Letters* **12**(1): 43-52.

Fowlkes A.L., Arguin P., Biggerstaff M.S., Gindler J., Blau D., Jain S., Dhara R., McLaughlin J., Turnipseed E., Meyer J.J., Louie J.K., Siniscalchi A., Hamilton J.J., Reeves A., Park S.Y., Richter D., Ritchey M.D., Cocoros N.M., Blythe D., … & Finelli L. 2011. Epidemiology of 2009 pandemic influenza A (H1N1) deaths in the United States, April-July 2009. *Clinical Infectious Diseases* **52**(suppl_1): S60–S68.

Guo Y., Ding P., Li Y., Zhang Y., Zheng Y., Yu M., Suzuki Y., Zhang H. & Ping J. 2022. Genetic and biological properties of H10N3 avian influenza viruses: A potential pandemic candidate? *Transboundary and Emerging Diseases* **69**(5): e3171-e3182.

Hashim J.H., Adman M.A., Hashim Z., Mohd Radi M.F. & Kwan S.C. 2021. COVID-19 epidemic in Malaysia: Epidemic progression, challenges, and response. *Frontiers in Public Health* **9**: 560592.

Hossain M.T., Miah M.M. & Hossain M.B. 2017. Numerical study of kermack-mckendrick SIR model to predict the outbreak of ebola virus diseases using euler and fourth order runge-kutta method. *American Scientific Research Journal for Engineering, Technology, and Sciences* **37**(1): 1–21.

Hossen M.K., Ahmed Z.E. & Hossain Z. 2019. A comparative investigation on numerical solution of initial value problem by using modified euler's method and runge-kutta method. *ISOR Journal of Mathematics (IOSR-JM)* **15**(4): 40–45.

Johnson E.J. & Hariharan S. 2017. Public health awareness: Knowledge, attitude and behaviour of the general public on health risks during the H1N1 influenza pandemic. *Journal of Public Health* **25**(3): 333–337.

Karim S.A.A. & Razali R. 2011. A proposed mathematical model of influenza A, H1N1 for Malaysia. *Journal of Applied Sciences* **11**(8): 1457–1460.

Liang S.Y., Theodoro D.L., Schuur J.D. & Marschall J. 2014. Infection prevention in the emergency department. *Annals of Emergency Medicine* **64**(3): 299–313.

Mohammad K.M., Akhi A.A. & Kamrujjaman M. 2025. Bifurcation analysis of an influenza A (H1N1) model with treatment and vaccination. *PLoS One* **20**(1): e0315280.

Nordin N.A., Ahmad R. & Ahmad R. 2015. Optimal control of vector-borne disease with direct transmission. *Jurnal Teknologi* **76**(13): 53–60.

Poalillo F.E., Geiling J. & Jimenez E.J. 2010. Healthcare personnel and nosocomial transmission of pandemic 2009 influenza. *Critical Care Medicine* **38**(4): e98–e102.

Pornphol P., Hammachukiattikul P., Sabastine E., Vadivel R. & Sathasivam S. 2024. Modelling the study of hand, foot and mouth disease using SVEIQAR derived model. *Journal of Advanced Research in Applied Sciences and Engineering Technology* **47**(2): 193–212.

Razali R. & Karim S.A. 2013. Estimation of the reproduction number of the novel influenza A, H1N1 in Malaysia. *International Journal of Science Inventions Today* **2**(5): 359–366.

Rustum N.S. & Al-Temimi S.A.S. 2022. Estimation of the epidemiological model with a system of differential equations (SIRD) using the Runge-Kutta method in Iraq. *International Journal of Nonlinear Analysis and Applications* **13**(2): 2807-2814.

Rutala W.A. & Weber D.J. 2019. Best practices for disinfection of noncritical environmental surfaces and equipment in health care facilities: A bundle approach. *American Journal of Infection Control* **47**: A96–A105.

Sathasivam S., Adebayo S.A., Velavan M., Yee T.H. & Yi T.P. 2024. Transmission of hepatitis B dynamics in Malaysia using modified SIS hybrid model with Euler and Runge-Kutta method. *AIP Conference Proceedings* **3016**(1):020010.

Tan D. & Zheng C. 2012. On a general formula of fourth order Runge-Kutta method. *Journal of Mathematical Science & Mathematics Education* **7**(2): 1–10.
Woolhouse M.E.J. 2019. Mathematical models of the epidemiology and control of foot-and-mouth disease. In Sobrino F. & Domingo E. (eds.). *Foot and Mouth Disease*: 355-381. Boca Raton, FL: CRC Press.

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