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MATHEMATICAL MODEL AND ANALYSIS OF THE EFFECT OF AWARENESS PROGRAM ON DIABETES DYNAMIC

(*Model Matematik dan Analisis Kesan Program Kesedaran Terhadap Diabetes*)

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ABSTRACT

The prevalence of diabetes worldwide is increasingly concerning, affecting individuals of all ages due to genetic predisposition and environmental factors. Diabetes can be prevented or delayed through lifestyle interventions such as a balanced diet, regular physical activity, and weight management. However, a lack of awareness often leads to late diagnosis and progression to diabetes, increasing the burden on the healthcare system. Public awareness plays a crucial role in promoting early interventions and encouraging individuals to adopt healthier behaviours. Considering the benefits of awareness, this study explores its impact on the development of diabetes through a nonlinear mathematical model. This model consists of six subpopulations representing different health statuses and the cumulative of media-driven awareness campaigns. We developed a flow diagram and made several assumptions to describe population dynamics, which led to a system of nonlinear ordinary differential equations. Local stability is analysed using the Jacobian matrix and the Lienard-Chipart criterion, while global stability is examined through the Lyapunov function. Numerical simulations of the model are carried out to verify and illustrate the analytical results. The results indicate that controlling the growth of media-driven awareness programs, increasing the transition of unaware healthy individuals gaining awareness or increasing the transition of unaware prediabetes individuals gaining awareness can reduce the burden of diabetes. Furthermore, exposure to media-driven awareness campaigns targeting unaware individuals may help in reducing the progression of prediabetes and diabetes when they begin adopting a healthy lifestyle.

Keywords: mathematical model; diabetes; stability analysis; numerical simulation

ABSTRAK

Prevalens diabetes di seluruh dunia semakin membimbangkan, menjejaskan individu dari semua peringkat umur disebabkan oleh predisposisi genetik dan faktor persekitaran yang menyumbang kepada penyakit ini. Diabetes boleh dicegah atau ditangguhkan melalui intervensi gaya hidup, seperti diet seimbang, aktiviti fizikal yang kerap, dan pengurusan berat badan. Namun, kekurangan kesedaran sering menyebabkan lewat didiagnosis dan perkembangan diabetes, meningkatkan beban ke atas sistem penjagaan kesihatan. Kesedaran awam memainkan peranan penting dalam mempromosikan intervensi awal dan menggalakkan individu untuk mengamalkan tingkah laku yang lebih sihat. Mengambil kira kelebihan kesedaran, kajian ini meneroka kesannya terhadap perkembangan diabetes melalui model matematik bukan linear. Model ini terdiri daripada enam subpopulasi yang mewakili status kesihatan yang berbeza dan jumlah terkumpul program kesedaran yang didorong oleh media. Kami membangunkan sebuah diagram aliran dan membuat beberapa andaian yang menerangkan dinamik populasi, yang membawa kepada sistem persamaan pembezaan biasa bukan linear. Kestabilan tempatan dianalisis menggunakan matriks Jacobian dan kriteria Lienard-Chipart, manakala kestabilan global diperiksa melalui fungsi Lyapunov. Simulasi berangka dijalankan untuk mengesahkan dan menggambarkan keputusan analitik. Keputusan menunjukkan bahawa adalah penting untuk mengawal pertumbuhan program kesedaran yang didorong oleh media, peralihan daripada individu sihat yang tidak sedar kepada sedar atau peralihan daripada pradiabetes yang tidak sedar kepada sedar boleh mengurangkan beban diabetes. Tambahan pula, pendedahan kepada program kesedaran yang didorong media yang menyasarkan individu yang tidak sedar mungkin

dapat membantu mengurangkan perkembangan pradiabetes dan diabetes apabila mereka mula mengamalkan gaya hidup sihat.

Kata kunci: model matematik; diabetes; analisis kestabilan; simulasi berangka

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