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Numerical study of age-structured two-sex population dynamics model for transmission of Thalassemia disease

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Thalassemia is an inherited blood disorder that is characterized by the absence or reduced synthesis of globin chains of hemoglobin. It is an autosomal recessive disorder, which means both the parents must be affected with or carriers for the disease to transfer it to the next generation. The high prevalence of thalassemia makes it one of the major health problems and a priority genetic disease. Very recently, authors formulated an age-structured two-sex continuous-type population dynamics model that describes the genotype composition of the population resulting from the thalassemia trait. Further, the existence of a non-negative continuous solution to the proposed model was established. The purpose of this study is to numerically solve the mathematical model by applying the Crank-Nicolson form of the finite difference method of characteristics, combined with the trapezoidal rule. To verify the model and test the numerical scheme, a numerical simulation was run to predict the growth of the population of Sri Lanka structured by the thalassemia trait over the decade between 2011 and 2021. We underestimated both the total male and female population not having the thalassemia trait by merely 3.8% and 1.1%, respectively. In addition, the error estimations of individuals with thalassemia minor and major have never been greater than 10%. The estimated errors of those two thalassemia classes are quite significant due to the law accuracy of data. In conclusion, these findings show the overall validity of the age-structured two-sex population model for thalassemia transmission as well as the usefulness of our approximation algorithm.

Keywords: Age-structured, Crank-Nicolson method, Numerical study, Thalassemia, Two-sex

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