Mathematical Modeling and Analysis of Cannabis Epidemic in a South Africa Province

L. Coetzee[1], S. Gatyeni[1], H. Lutermann[2], A. Matusse[2],
F. Nyabadza[1] and Y. Terefe[2]

[1] Department of Mathematics, University of Stellenbosch
lezaniec@gmail.com, siphokazi@aims.ac.za , f.nyaba@gmail.com
[2] Department of Mathematics and Applied Mathematics,
University of Pretoria
hlutermann@zoology.up.ac.za, Americo.matusse@uem.mz,
yibeltal.terefe@up.ac.za

The use of illegal drugs is associated with considerable morbidity and mortality but also costs to a society linked to health care and drug-related crimes. Cannabis is frequently considered a 'soft' drug for first-time illegal drug users that is considered a gateway to so-called 'harder' drugs. Hence, understanding the initiation of cannabis use and addiction may provide insights that can inform policies aiming to reduce the consumption of cannabis. We develop a mathematical model to analysis the dynamics of cannabis use in a South Africa metropolis (i.e. Durban) for which empirical data of cannabis use has been collected since 1996. The threshold parameter $\mathcal{R}_0$, the basic reproduction number, is determined and used in the analysis of the model. It is shown that the model has multiple cannabis persistent equilibria. For a certain range of $\mathcal{R}_0$, the locally asymptotically stable cannabis-free equilibrium co-exists with the locally asymptotically stable cannabis persistent equilibrium which indicates the model may exhibit backward bifurcation phenomenon. In this case, the cannabis consumption will remain endemic in the population even though the basic reproduction number is less than unity. Numerical experiments are given to support the theoretical analysis of the model.