May 18th, 5:00 PM - 7:00 PM

# Modeling and Analysis of Social Contagion in Overweight and Obesity Epidemic

Chathuri Edirisinghe Arachchige
*Texas Tech University*, chathuri.t.sandamali@ttu.edu

# Modeling and Analysis of Social Contagion in Overweight and Obesity Epidemic

Chathuri Sandamali, Wenjing Zhang
Department of Mathematics and Statistics, Texas Tech University, USA

**Abstract**

Overweight and obesity have become a global epidemic due to the increasing unhealthy eating habits and sedentary lifestyles. Even though many intervention programs have been introduced, a mathematical approach to analyze the growing obesity epidemic is still crucial to plan and estimate the effectiveness of obesity intervention (prevention and treatment) programs. By treating excess weight gain as a disease transmitted by social influence, we propose a compartment model to predict the incidence of excess weight gain. Mathematical analysis shows that the system has at most two endemic equilibria ($E^*$) and one disease-free equilibrium point $E_0$. Applying the compound matrix method for the local stability, we prove that $E_0$ is locally asymptotically stable if the basic reproduction number $R_0 < 1$.i.e., the obesity can be eliminated when $R_0 < 1$. Furthermore, a closed-form formula for the occurrence of backward bifurcation is provided. In this scenario, a complete disease eradication cannot be expected for the condition $R_0 < 1$. By applying fluctuation lemma, we prove the global stability of $E_0$ and provide a parameter condition to extirpate the overweight obesity epidemic. For the proposed model, we considered that the parameter $\sigma$, rate of relative hazard of weight gain from recovered individuals to overweight is greater than unity. Due to biological reasons, the parameter $\sigma$ can also be less than or unity. The global stability of $E_0$ can be observed for $0 < \sigma \leq 1$ when $R_0 < 1$ and $R_0 = 1$ is a sharp threshold for the disease elimination. The unique non-trivial equilibrium ($E^*$) shows asymptotic stability when $R_0 > 1$, where the disease persists. In the presence of bi-stability, obtaining global dynamics are complicated due to the non-existence of compact absorbing sets. By applying the geometric approach, we discuss the global dynamics of the disease when it remains in society. The dynamics are examined of the overweight population through a numerical bifurcation analysis. Analytical and numerical analysis show that the proposed model is sufficient to show the complex epidemic patterns of the obesity epidemic, such as backward bifurcation and bi-stability. These complex behaviors of the obesity epidemic establish the challenges in implementing prevention and treatment actions.

Keywords: obesity, overweight, compound matrix, backward bifurcation, global stability