The prevalence of overweight individuals and obesity has increased dramatically in the Unites States. Obesity has become a disease of epidemic proportions. One billion adults worldwide are overweight and of these 300,000 are obese. In particular, 64% of U.S adults and 15% of children and adolescents are overweight. Two major factors have contributed to the epidemic of obesity: changes in individuals behavior and environment. Data indicates that by 1970, Americans were spending $6 billion on fast food, and by 2000 they were spending about $110 billion. By 2002, fast food consumption accounted for more than 40% of a family's food budget. This and fast-food accessibility is partly to blame for observed patterns of obesity and overweight.

The aim of this project is to study the potential role of peer-pressure in fast-food consumption as well as its effect on an individual’s weight. We explore these effects on the dynamics of obesity at the population level using an epidemiological model. In this framework, we can explore the impact of intervention strategies. Statistical data analysis provides insights on the relation between demographic factors and weight.

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We developed an epidemiological model in which we consider the total population of the United States. This model allowed us to analyze the progression rate from normal weight individuals (N) to overweight (O1) and obese (O2) individuals. The classification of N, O1, O2 individuals is based on their BMI (Body Mass Index), which is a number calculated by the individual’s weight and height. The progression from normal to overweight individuals is measured by incorporating a peer pressure, \( \beta \), by which individuals start eating at fast food restaurants. People start eating at fast food restaurants not only because other people invite them to come along but also because of socio-economic status. Hence, we should gear our attention in fast-food accessibility and fast-food consumption as well as its effect on an individual’s weight. We explore these effects on the dynamics of obesity at the population level using an epidemiological model. In this framework, we can explore the impact of intervention strategies. Statistical data analysis provides insights on the relation between demographic factors and weight.

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The non-linear differential equations system is:

\[
\begin{align*}
\frac{dN}{dt} &= \beta N (O_1 + O_2) - \mu N, \\
\frac{dO_1}{dt} &= \beta [N (O_1 + O_2) + \phi O_1] - (\gamma + \mu + \Phi) O_1, \\
\frac{dO_2}{dt} &= \gamma O_1 + \phi O_2 - \mu O_2 - \Psi O_2, \\
\frac{dQ_1}{dt} &= \Phi O_1 - (\phi + \mu) Q_1, \\
\frac{dQ_2}{dt} &= \Psi O_2 - Q_2 + \mu Q_2, \\
P &= N + O_1 + O_2 + Q_1 + Q_2
\end{align*}
\]

where \( \Phi = \alpha_1 + \frac{\mu_1}{\mu_2} - 1 \) and \( \Psi = \alpha_2 + \frac{\mu_2}{\mu_2} - 1 \).

In order to analyze our model, we considered several cases: a nonlinear quitting model, a nonlinear quitting model without relapse, and a linear model with relapse. To explore the dynamics of our models, we calculated the \( R_0 \), which is defined as the average number of secondary cases produced by a typical infected individual. After analyzing each individual case, a common result was obtained: \( \beta \) (peer pressure to become a fast food eater) was the most sensitive parameter and hence has the strongest effect in reducing \( R_0 \).

Peer Pressure to Stop Eating Fast Food

Figure (7) shows the effect of peer-pressure for the overweight individuals to stop eating fast food, \( \alpha_1 \). In Figure (a), \( \alpha_1 \) is given a low value, \( \alpha_1 = 0.2 \), which results in \( R_0 = 2.679 > 1 \). From the dynamics of the model, we are able to predict that in 15 months (1.3 years), 22% of the normal weight individuals will become obese. Now, in Figure (b), the value of \( \alpha_1 \) changes to \( \alpha_1 = 0.95 \), decreasing \( R_0 \) to 0.804, the obesity epidemic is under control. With this choice of \( \alpha_1 \), the normal weight individuals will progress to the overweight compartment, however since \( \alpha_1 \) is high, these individuals will also leave the compartment at a fast rate, hence not advance to obesity.

The models with the support of the numerical analysis, showed that peer-pressure, \( \beta \) had a strong influence on individuals to become a fast-food eater. Furthermore, the rate at which individuals stop eating fast food, \( \alpha_1 \) also seemed to be effective in controlling the obesity epidemic. It would appear that in order to reduce the current obesity rates, we should focus on lowering the peer pressure from fast food eaters. However, controlling \( \beta \) is difficult to achieve since \( \beta \) is deduced from the peer-pressure due to frequent fast food eaters, social and economic status. Hence, we should gear our attention in increasing the peer pressure to stop eating fast food, \( \alpha_1 \). This is a more realistic approach since it is easier to increment health awareness programs that are accessible to the general public. Furthermore, the statistical analysis showed a correlation between an individual’s weight, education and race.

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