

## **A Quantitative Simulation Study of Obesity Development among a Young Population**

ZHAO G<sup>1</sup> and HALL KD<sup>2</sup>

<sup>1</sup>Clements High School; Sugarland, Texas; <sup>2</sup>NIDDK; National Institutes of Health; Bethesda, Maryland

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### ABSTRACT

**Purpose:** Studying the process of obesity development among a real human population is difficult due to its impracticalities and ethical limitations. Our study aims to discover quantitative relationships and patterns in body weight change and obesity development via a novel approach - mathematical modeling of human metabolism and body weight simulation. **Methods:** Using publicly available data from the CDC, 1000 male and 1000 female individuals 18 years of age were randomly generated as a virtual population following a normal distribution in body weight and height. Three sample groups, each consisting of 100 male and 100 female individuals, were randomly selected for study and were labeled as “normal weight”, “overweight”, and “obese” according to their individuals’ BMI values. Three case studies, in scenarios of consistent overeating, holiday overeating, and body weight loss, with a total of 850 simulations, were performed. **Results:** The simulations showed (i) The time to become obese and the amount of daily extra calories taken share an exponential relationship. (ii) The body weight gain from holiday season overeating can last up to 2 years if no extra physical activity is taken. (iii) Compared to normal weight individuals, obese individuals have a much higher energy-to-fat conversion rate (56% vs. 35%). (iv) Exercising is about 26% more effective in aiding fat reduction than dieting. (v) Changes in fat mass and fat-free mass share a competitive relationship in both long and short-term weight gain/loss. **Conclusions:** Suggestions to benefit individuals in body weight control and obesity prevention were concluded: (i) One should be watchful of his/her diet due to the exponential relationship between the amount of overeating and the time to become obese. (ii) The “snowball effect” accumulation of holiday season weight gain every year is heightened by a lack of physical activity and may prove to be a key factor in the rise of obesity in America. Thus, it is important for one to regularly exercise and increase physical activity after holiday overeating. (iii) It is imperative that obese individuals take extra caution during holiday seasons due

to their higher energy-to-fat conversion rates. (iv) Exercising is a better weight loss method compared to dieting, in terms of body composition change.

KEY WORDS: Mathematical Model, Body Weight Simulation, Holiday Overeating, Obesity Development Process