Biology and Medicine Through Mathematics
Conference

Optimal Control of Diet and Exercise

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Abstract: Optimal Control of Diet and Exercise

Health complications such as obesity, cardiovascular disease, stroke, and diabetes are in part attributable to the disproportionate allocation of body mass to adipose tissue (fat) versus lean body mass. Lean mass is not only more energetically expensive than fat mass, resulting in a higher metabolic rate, it provides additional benefits such as joint stabilization and injury prevention that are especially important for elderly populations and individuals with underlying conditions that cause muscle wasting, such as HIV/AIDS, cancer, heart disease, and autoimmune. Typical obesity interventions, however, focus on a rapid reduction of body weight by reducing energy intake, often at the expense of beneficial lean mass. By applying optimal control to the problem of body mass change during diet and exercise interventions, we seek to find dietary controls that produce a balancing effect between the competing goals of fat loss and lean mass retention. First, we describe the basic optimal control problem and the steps required to find an optimal control. Next, we prove the existence and uniqueness of an optimal control for the specific problem and then characterize it in terms of the necessary conditions. Finally, we compute the optimal control numerically and investigate dependence of the optimal control on parameters via simulations.