Title: Simulating effects of food intake and physical activity on glucose dynamics: a case study

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ABSTRACT

Over 38 million adults and over 350,000 children live with diabetes in the United States (US). Managing diabetes to avoid hypo- and hyperglycemia is challenging because the physiology of glucose metabolism is complex, it is difficult to estimate effects of diet and physical activity on glucose levels, and other factors. Given these complexities, glucose management is well suited for learning through system dynamics simulation. We developed a proof-of-concept system dynamics model to simulate blood glucose over time by iteratively comparing model output to data collected from a single participant. Blood glucose levels were measured every minute by a continuous glucose monitor for 1200 minutes between 9:00am and 6:00pm over two days. We modeled the major dynamics driving daytime fasting blood glucose and blood glucose fluctuations in response to meals and physical activity. Including a second order delay in glucose intake following a meal was critical for improving model fit. Glucose lowering effects of physical activity were seen almost immediately. The model is calibrated to continuous glucose monitoring data from a single participant, limiting its generalizability, but setting the stage for future research that utilizes personalized, dynamic simulation models for clinical decision-making and diabetes self-care.

KEYWORDS

Glucose, insulin, diabetes, chronic disease management, diet, physical activity, simulation modeling, in silico, behavior change, continuous glucose monitor