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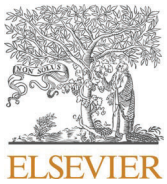

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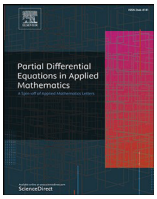

Development and simulation of a mathematical model representing the dynamics of type 1 diabetes mellitus with treatment

Rania O. Al–Sadi *, Abdul-Sattar J. Al-Saif

Department of Mathematics, College of Education for Pure Science, Basrah University, Basrah, Iraq

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ABSTRACT

The research aims to understand and study type 1 diabetes and its response to treatment using a mathematical model. We employ a novel method that combines the Shehu transformation with the Akbari–Ganji approach and the Padé approximation to derive approximate solutions for this model. The research findings convincingly show the effectiveness of the method used. The results show a positive impact of the investigated treatment on individuals with type 1 diabetes. Strong agreement is observed between the results obtained from this model's solutions and those of previous studies, confirming the accuracy and reliability of the simulation method employed. This method is considered a successful simulation technique for future studies, enhancing our understanding of the effects of treatments on individuals with type 1 diabetes. From a practical standpoint, the study's results can offer valuable insights to healthcare professionals, enabling them to make more informed decisions regarding treatment strategies. These insights have the potential to optimize treatment plans, potentially leading to improved health outcomes for patients. Furthermore, this research paves the way for further advanced studies in the field of medical modeling and simulation.

1. Introduction

Diabetes is one of the most common diseases worldwide, affecting millions of people of all ages. Sugar is one of the main sources of energy in the body, and the blood sugar level is regulated by insulin, which plays a critical role in metabolizing sugar and converting it into usable energy. However, this process is disrupted in the case of diabetes. Diabetes can be divided into two main types. Type 1 diabetes occurs when a person's body stops producing insulin completely or almost. Type 1 diabetes is less common, often appears at an early age, and requires regular insulin treatment.[1] Type 2 diabetes occurs when a person's body is unable to use insulin effectively or does not produce enough insulin. Type 2 diabetes is more common in people who are older and obese.[2] Understanding the causes and mechanisms of diabetes mellitus and its effects on health and the body is a very important topic, as it requires early and effective diagnosis and management to reduce potential complications and improve the quality of life for affected individuals.

Research and studies in this field are essential for the development of prevention and treatment methods and the improvement of health care provided to patients. Many researchers have attempted to investigate the interactions between glucose and insulin using mathematical models.[3,4] Shabestari et al.[5] presented a new mathematical model to describe the interactions between Beta cells, insulin, and glucose. The results showed that the new system can explain these interactions in various disorders such as diabetes or hypoglycemia. Ali and Tahir[6] proposed a mathematical model for the glucose and insulin regulation system in type 1 diabetes. The results of this study showed that the system has many dynamics in different conditions. Vorobyeva proposed a mathematical model to diagnose the course of retinopathy in diabetic patients, and its findings showed that it is consistent with the results of the clinical diagnosis of diabetes.[7] Nemati et al.[8] developed a new treatment for people with type 1 diabetes, and the treatment has proven successful after clinical trials, as the new treatment is based on the use of stem cells that produce insulin to treat people with type 1 diabetes. Karampelias et al.[9] identified a molecule that helps stimulate the growth of new insulin-producing cells. The molecule, CID661578 has been identified. Researchers have examined the molecular interactions in Beta cells and discovered that they bind to a protein called MNK2. It was also shown that when two other proteins are allowed to interact at higher levels, it ultimately leads to an increase in Beta cell regeneration and thus an increase in the level of insulin in the blood, which leads to a decrease in the amount of glucose in diabetic patients. The results of the study point to a new potential target for the treatment of diabetes. Nasif

* Corresponding author.
E-mail address: pgs.rania.ouda@uobasrah.edu.iq (R.O. Al–Sadi).

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