


Chapter 6


Mechanisms, Impact, and Therapeutic Strategies for Oxidative Stress in Metabolic Diseases: Understanding and Mitigating Oxidative Stress

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ABSTRACT

This chapter explores the intricate relationship between oxidative stress and metabolic diseases, specifically diabetes and obesity. It begins with an overview of these conditions, emphasizing their global impact and associated metabolic dysfunctions. The discussion shifts to the biochemical mechanisms of oxidative stress, focusing on mitochondrial dysfunction and ROS production. It examines how oxidative stress affects pancreatic beta-cell function and insulin resistance, linking hyperglycemia to increased oxidative damage. Additionally, the chapter addresses adipose tissue dysfunction and the interplay between inflammation and oxidative stress in obesity-related complications. It concludes by discussing strategies to mitigate oxidative stress through pharmacological and lifestyle interventions, such as antioxidant

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therapies, dietary changes, regular exercise, and caloric restriction. This comprehensive approach aims to provide insights into effectively managing oxidative stress, thereby improving metabolic health and addressing the challenges posed by diabetes and obesity.

1. INTRODUCTION TO METABOLIC DISEASES AND OXIDATIVE STRESS

In international health, chronic non-communicable diseases, particularly metabolic disorders such as diabetes and obesity, have become major causes of morbidity and mortality. Owing to the increasing prevalence of metabolic syndrome, which has been increasing in the recent past, is mostly caused by poor diet and a lack of exercise in addition to stressful environments (Ruze, et al., 2023). First, obesity not only is a risk factor for type 2 diabetes but also contributes to the worsening of metabolic distortions affecting various organs and systems (World Health Organization, 2023). The complex biochemical processes involved in the development of these diseases are most often associated with an event called oxidative stress, which is defined as the condition in which the body produces higher levels of ROS than dose the capacity of the antioxidant system (Lopez-Otin & Kroemer, 2021). Moreover, when metabolic diseases are treated via the One Health approach, the well- being of people depends on the well- being of the animal and the environment. This perspective recognizes the components causing metabolic disorders, including environmental endocrine-disrupting chemicals and animal-derived food items, that influence health, hence compounding illnesses such as diabetes and obesity. One health approach supports comprehensive approaches that recognize how shifts in agriculture, climate, and environmental policies impact health. For example, antibiotic residues in animals can lead to antibiotic-resistant bacteria, affecting people's conditions and making the management of metabolic diseases challenging (World Health Organization, 2022). It can therefore be beneficial to adopt a One Health approach for the prevention of metabolic diseases to develop more effective interventions that address this problem through improvement in different aspects of health.

1.1. Outline of Diabetes and Obesity: Comprehensive Influence and Metabolic Dysfunction

Importantly, obesity is very closely related to diabetes. Obesity also leads to insulin resistance and type 2 diabetes and is a causal factor for a phenomenon known as metabolic syndrome, which is characterized by dyslipidemia, hypertension and hyperglycemia (Ibrahim et al., 2024). These diseases have become predominant

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