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REVIEW PAPER OPEN ACCESS

The potential role of stress in insulin resistance: A review

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Abstract

Insulin resistance is a common syndrome in both developed and developing countries. It is a risk factor for type 2 diabetes mellitus, which is the most common end stage of metabolic syndrome in the Philippines. Previously, research into type 2 diabetes focused on pancreatic beta cell failure and insulin resistance, as well as approaches to rectify these dysfunctions. However, there has been a surge of interest in recent years in the role that stress in peripheral tissues plays in the development of insulin resistance. The goal of this review is to concentrate on the mechanism of oxidative species formation and its direct relationship to insulin resistance, to address the role of stress in insulin stimulation through the disruption of different molecular pathways in target tissues. To discuss the role of stress in insulin Brain and Body Arousal, the cited condition that can be addressed through pharmacologically and therapeutically, and to investigate the potential consequences of this phenomenon.

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Introduction

Stress is part of human reality. It has an impact on everyone. Human bodies are built with the ability to detect stress and respond to it. Our bodies adjust to new circumstances with the aid of stress responses. Stress can help us stay focused, motivated, and prepared to avert danger. On the other hand, an individual could experience physical exhaustion, weariness, and an inability to cope because of stress. The biological reaction known as stress can be triggered by any intrinsic or external stimuli. By extending their length, contributing significantly to human illnesses, and serving as a triggering or exacerbating factor, chronic stress can make these consequences harmful (Chakole *et al.*, 2022).

The Society of Endocrinology describes the pancreas as an organ behind the stomach that produces the hormone insulin. Although insulin has several impacts, its major function is to regulate how the body consumes the carbohydrates found in particular foods. The human body converts carbohydrates into glucose, a form of sugar. Without insulin, cells are unable to use glucose as fuel and they will start malfunctioning. Extra glucose that is not used by the cells will be converted and stored as fat so it can be used to provide energy when glucose levels are too low. Insulin has several other metabolic effects (such as stopping the breakdown of protein and fat. In addition, Li, *et al.* (2022) further describes insulin as a peptide hormone that is made and released by islets of the pancreas. It is responsible for carefully controlling how much blood glucose is taken up by the liver, fat, and skeletal muscle cells. Along with supporting glucose homeostasis, insulin also helps to regulate a number of other cellular functions, such as the synthesis of glycogen, lipids, DNA, and proteins as well as the transport of amino acids and the creation and destruction of proteins.

According to Freeman and Pennings (2022), insulin resistance is identified as an impaired biologic response to insulin stimulation of target tissues, primarily the liver, muscle, and adipose tissue. It is primarily an acquired condition related to excess body fat, though genetic causes are identified as well. Lifestyle modification should be the primary focus for the treatment of insulin resistance. Medications also can improve insulin response and reduce insulin demand. Several studies have been conducted discussing how stress may contribute to diabetes. A study of Butler *et al.* (2022) stated that Diabetes Mellitus is a common stress-driven disease and stressful life events are positively correlated with a higher incidence of diabetes. Normally, a person will not be diagnosed with Type 2 diabetes right away, instead a person's body will be resistant to insulin first.

Stress is a normal human experience. However, too much of this may cause negative impact to the body system including insulin resistance. Considering the above-mentioned premise, this article would like to explore how the abnormal release of stress hormones during difficult situations may lead to insulin resistance. This study will further explore how insulin resistance will ultimately lead to Type 2 diabetes.

Insulin

Insulin is a polypeptide hormone that is primarily released by cells in the pancreatic islets of Langerhans. The hormone may work in tandem with glucagon to control blood sugar levels; glucagon has catabolic properties while insulin has anabolic ones. Insulin controls blood glucose levels and causes the liver, muscles, and adipose tissue to store glucose, which causes total weight gain (Adegoke *et al.*, 2021)

Insulin's polypeptide nature was discovered in 1928, and its amino acid composition was determined in 1952. It is actually a dipeptide with a molecular weight of 5802, 51 amino acids, and A and B chains that are connected by disulfide bridges. The A chain has 21 amino acids, while the B chain contains 30 amino acids. Its isoelectric point is pH 5.5.5. The N-terminal helix of the A chain is connected to the C-terminal helix in an anti-parallel fashion, while the B chain has a central helical segment. Two disulphide bonds connect the N- and C-terminal helices of the A chain to the central helix of the B chain, joining the two chains together. A linking peptide joins the N-terminus of the A chain in pro-insulin (Wilcox, 2005).

Stress: Brain and body arousal

The main job of cortisol is to make sure the body has enough energy for the fight-or-flight reaction. In the prefrontal cortex and hippocampus, it binds preferentially to gluco-corticoid receptors, enhancing Ca2+ availability and subsequently brain activity. weakens the immune system and lowers the activity of white blood cells, which are responsible for attacking foreign objects. Additionally, it raises blood sugar levels, which quickens metabolism.

The hippocampus and prefrontal cortex, which are particularly abundant in receptors triggered by stress hormones, are among the many areas of the brain that catecholamine's affect. An amplification loop might result when the amygdala is activated because the fear and other stress-related emotions that are produced cause further hormone release. The brain and muscles receive more oxygen and glucose thanks to adrenaline.

The stress system consists in a complex neuroendocrine structure, involving the central nervous system and the periphery. Glucocorticoids (GC) and catecholaminas, final mediators of hypotalamic-pituitary-adrenal-axis and sympathetic nervous system, are the main hormonal effectors of the stress system Chiarelli *et al.* (2023). During acute stress the whole body metabolism may not be affected, however, when it is chronically stimulated, the stress hormones can cause deleterious effects on glucose homeostasis.

Stress and insulin resistance

Insulin resistance, sometimes referred to as decreased insulin sensitivity, occurs when cells in your muscles, fat, and liver don't react to insulin as they should. Insulin is a hormone produced by your pancreas that is vital for life and controls blood glucose (sugar) levels. Insulin resistance can either be acute or chronic, and it occasionally can be treated.

Stress and Insulin Resistance can be related. People who are chronically stressed have poor glycemic control to varying degrees (Yang *et al.*, 2016). This indicates that stressful life events, traumatic experiences, general emotional stress, anger and hostility, distressed sleep and workplace stress may negatively modulate glucose homeostasis and induce insulin resistance (Lustman *et al.*, 2000; Lin *et al.*, 2004; Schneiderman *et al.*, 2005; Alexander *et al.*, 2007; Salleh, 2008)

Furthermore, stress can have a harmful impact on lifestyle, especially in those who are less able to handle the added stress (Lloyd *et al.*, 2005). For instance, excessive eating and hyperphagia are frequent in people who are under stress and can seriously disturb metabolic processes and gradually cause insulin resistance (Wardle *et al.*, 2000; Lloyd *et al.*, 2005; Razzoli *et al.* (2017). Mental stress, like worrying about work or family, typically increases blood sugar levels. If you experience physical stress, like if you're sick or injured, you may also see an increase in blood sugar levels.

Insulin resistance and type ii diabetes

According to Cleveland Clinic, anyone can develop insulin resistance-temporarily or chronically. Over time, chronic insulin resistance can lead to prediabetes and then Type 2 diabetes if it's not treated or able to be treated.

The pancreas releases more of the hormone in response to the body's insulin resistance to keep cells active and blood glucose levels under control. This explains why individuals with type 2 diabetes frequently have high amounts of circulating insulin. Since the pancreas may produce more insulin, insulin resistance alone won't initially cause any symptoms. However, over time, insulin resistance deteriorates and the pancreatic beta cells that produce insulin may deteriorate. The pancreas eventually runs out of insulin to get past the cells' resistance. Higher blood glucose levels are the end effect, which can lead to type 2 diabetes (American Diabetes Association)

The relationship between type 2 diabetes and insulin resistance has been understood for well over 50 years. Resistance to insulin is crucial. In addition to being the most accurate predictor of type 2 diabetes, once hyperglycemia is evident, it also serves as a

therapeutic target. Morino *et al.*, publish a series of experiments that shows a genetic mechanism connects the expression of lipoprotein lipase (LPL) to the expression of peroxisome proliferator-activated receptor (PPAR) and mitochondrial function. This is probably going to increase the muscular insulin resistance that makes type 2 diabetes more likely.

Conclusion

Stress is a major concern for individuals and organizations. Exhaustion is the outcome of prolonged stress. Individuals and organizations can take many approaches to lessening the negative health and work outcomes associated with being overstressed. Emotions play a role in organizational life. Understanding these emotions helps individuals to manage them. Emotional labor can be taxing on individuals, while emotional intelligence may help individuals cope with the emotional demands of their jobs.

During chronic stress, there is abnormal production of stress hormones which may lead to insulin resistance. Long stressful situations can have negative impacts on one's body such as slower metabolic rate and insulin resistance. When body continues to resist insulin, the blood sugar level increases as body cells are insensitive to the presence of insulin. As blood sugar level increases, the chance of acquiring Type 2 diabetes is more likely.

To prevent or minimized the occurrence of these, regular exercise is a great way to manage stress. avoid situations that make you feel stressed such as unnecessary arguments and conflict (although ignoring a problem is not always the best way to reduce stress). Assertiveness is fine but becoming distressed is not. A nutritious diet is important, and a good sleep routine is essential.

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