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The Effect of Stress on Insulin Production Across Different Generations

Om Patil[1], Rajagopal Appavu[#], and Jothsna Kethar[#]

[1]Cumberland Valley High School, Mechanicsburg, PA, USA
[#]Advisor

ABSTRACT

Stress has become a standard part of life for a majority of humanity, and its effects have a significant impact on the day-to-day lives of many. Stress has an even higher impact on the lives of those who have diseases, such as diabetes. Additionally, as people get older, stress affects them in various ways, especially regarding hormonal production. In this research paper, the question of how the output of a particular hormone, insulin, differs across different generations will be discussed. A clear connection was made through the compilation of many research papers concerning stress, insulin production, and age. As a person ages, their ability to handle emotional stress increases; however, their physical stress far exceeds that from a younger generation. Because of this physical stress, insulin production rates lessen, and the probability of diabetes developing increases. The original hypothesis outlines a similar thought process, except instead of focusing on physical stress, it disregarded it and instead concentrate on other factors. The point of this research paper was so that a clear connection between age, insulin production, and stress can be established so that other researchers can do further research on this topic.

Introduction

With all of its technology and knowledge, a silent epidemic has spread and infected people in the modern world. This silent epidemic is responsible for detrimental health effects and, in some severe cases, even death. Stress, a factor of life that is under-considered as a serious matter and the main culprit behind the silent epidemic, is also found to severely impact various diseases, including diabetes. In 2017 alone, statistics recorded that 87,647 died from diabetes and that diabetes recorded citations in the deaths of 270,702 (American Diabetes Association 2017). Additionally, age has a different relationship with stress which is equally essential in understanding the human body. If established, a connection between insulin production and stress can alter existing diabetes treatment plans to incorporate for this. Furthermore, Because stress is such a widespread issue with many effects, individuals with diabetes or those from older generations have the potential to have a more significant impact on their insulin production. Moreover, there is a negative relationship between stress and insulin production; the more stress, the less insulin produced and vice versa. Stress has an inhibitory effect on insulin production, making it less effective and harder to produce. Additionally, stress is more profound in younger generations rather than older generations; however, insulin production still slows down in older generations regardless of the stress. As humans, age, handling emotional stress becomes easier and more manageable, but insulin production slows down due to the other effects of aging.

Insulin production process

To understand the topic of this research paper, it is necessary to understand insulin and its production. Insulin is a hormone created inside beta cells (Those found in the islet cells) inside the pancreas. The pancreas is an organ located behind the stomach, and it holds the job of making fuel out of food. This job can be divided into two different categories: exocrine and endocrine. The exocrine role of the pancreas functions through exocrine glands that secrete enzymes that help digest various types of nutrients. The endocrine function consists of islet cells (Islets of Langerhans) which release insulin to lower blood sugar and glucagon to increase blood sugar. For the purposes of this paper, the topic of focus will be the endocrine function of the pancreas, as it is most relevant to insulin and its production.

Insulin assists in the storing and usage of glucose, the body's primary fuel source. The formation of insulin starts with a larger molecule referred to as "proinsulin." This large molecule breaks down into C-peptide and insulin. C-peptide helps determine the levels of insulin present in the body, which is essential for diagnosing diabetes. The more c-peptide present in the body, the more insulin, and vice versa. As shown in **figure 1**, the insulin production cycle shows when insulin and glucagon are released to maintain blood glucose levels. As demonstrated in the figure, the insulin production cycle starts after consuming a meal, resulting in blood glucose levels rising, which triggers the pancreas to release insulin. Insulin's connection to diabetes depends on what type. In type 1 diabetes, the pancreas cannot under natural circumstances create insulin; therefore, the body must import its insulin from medication, usually through injections. Additionally, **figure 2** compares the differences in the Islets of Langerhans in ordinary people and people with type 1 diabetes. The beta cells responsible for insulin secretion function without error in the normal islet, but these same beta ce, appear destroyed in the diabetic islet. These destroyed beta cells cause type 1 diabetics to need insulin supplements. In type 2 diabetes, insulin does not react well with the body, so insulin shots have to be injected so the body can digest glucose with minor issues.

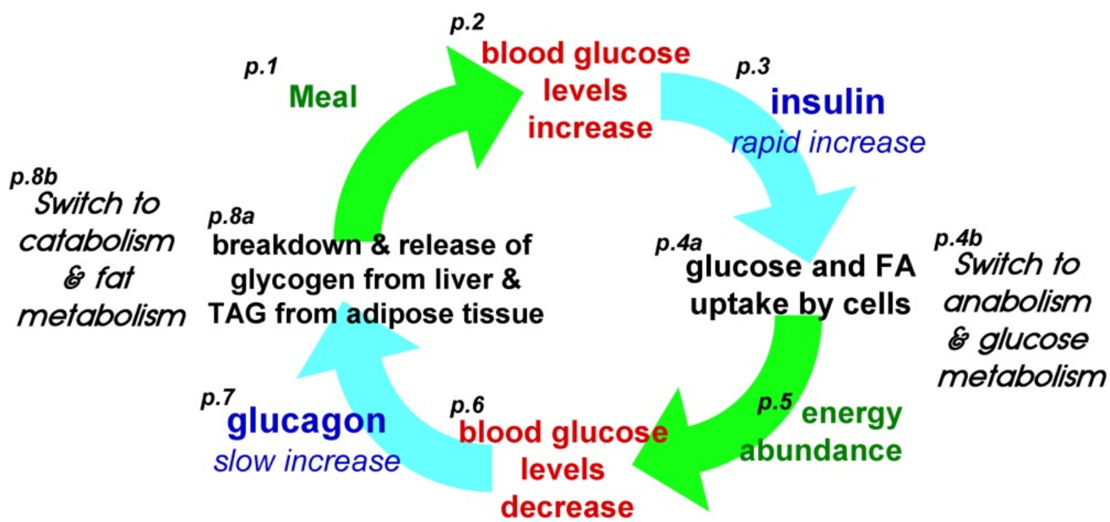

Figure 1. Insulin production cycle.

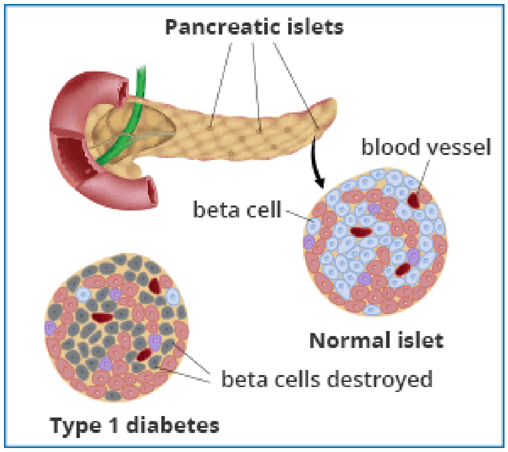

Figure 2. Diagram of beta cells in diabetic and normal pancreatic islets.

Stress and its relationship to insulin production

Another vital factor to correctly understanding the topic of stress and insulin production is fundamentally understanding stress. The concept of stress represents any event that causes abnormal disturbances in the relationship between a living organism and its surrounding habitat. There are also different types of stress, both beneficial and harmful. Positive stress, otherwise referred to as eustress, motivates and betters progress. Negative stress, on the other hand, is referred to as distress, and it causes complications regarding mental and physical health. The numerous stress-inducing events in the everyday life of an average individual most often contribute to the creation of distress, not eustress. Some examples of these stress-inducing events include "stress of work pressure, examinations, psychosocial stress, and physical stresses due to trauma, surgery, and various medical disorders" (Ranabir et al., 2011). In response to these stress-inducing events, the secretion rate and properties of multiple hormones change to acclimate the organism with its stressful situation, making it more capable at that moment by using the body's energy supply. Hormones that change in a response to stress include, but are not limited to, "corticoids, catecholamines, growth hormone, and prolactin" (Ranabir et al., 2011). However, concerning the topic of this research paper, the stress response also affects the release of insulin and its corresponding organ, the pancreas. Concerning the pancreas, increased periods of stress can cause Pancreatitis. Pancreatitis is a condition where the pancreas has inflammation due to a surplus of pancreatic enzymes causing damage. HSP is a group of proteins produced during acute stress (physical stresses) and have a variety of adverse effects on the pancreas, mainly negative. **Figure 3** displays specific HSP proteins and their impact on the pancreas, which lead to pancreatitis. Because pancreatitis has an inhibitory effect on insulin production, causing damage to the organ, a connection can be associated between insulin production and acute stress.

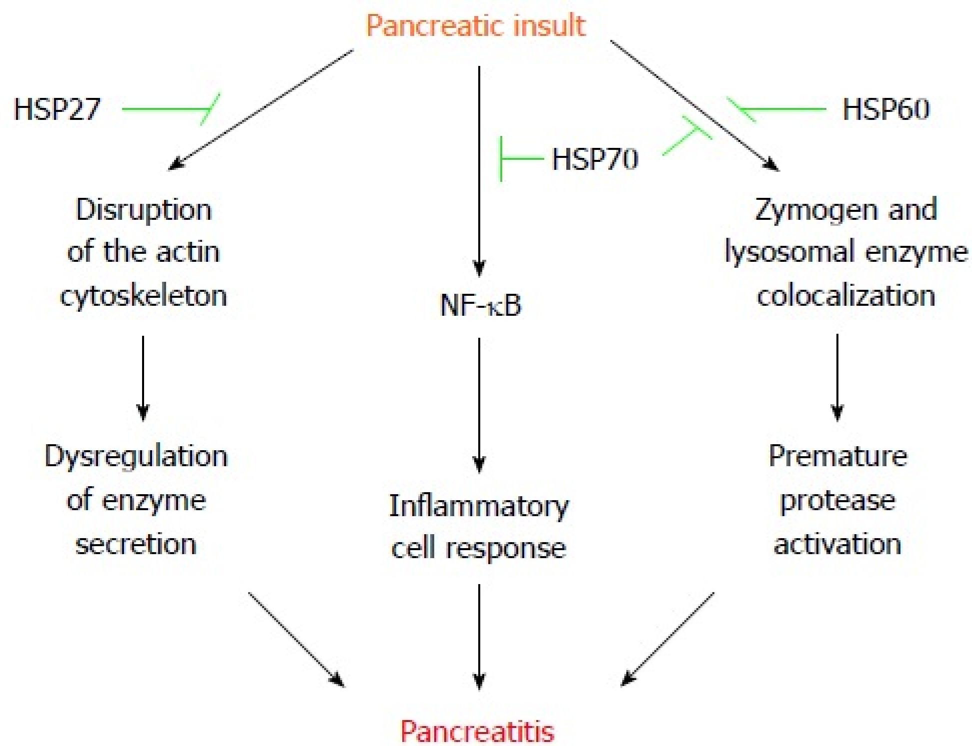

Figure 3. The effect of HSP27, HSP 70, and HSP60 on a pancreatic insult and how it leads to pancreatitis.

In addition to the previous connection with the pancreas, stress also directly relates to insulin production. Chronic stress is associated with insulin deficiencies as it can contribute to the development of insulin deficiencies. Additionally, chronic stress can cause insulin resistance, where the effect of insulin diminishdes due to the body having resistance to it. This insulin resistance is a significant component of type 2 diabetes.

Another hormone stress produces that shares its own connection to insulin production is cortisol. Cortisol is a hormone that creates insulin resistance in muscle and fat cells and is responsible for counteracting insulin. Cortisol is released by the adrenal gland, which is given the signal to release cortisol from the hypothalamus and the pituitary gland. However, when the body is under a stress response, the amygdala starts by signaling the hypothalamus to activate the sympathetic nervous system, which then activates the adrenal glands. In the stress response, cortisol also functions to maintain a state of high alert as well as producing energy through its catabolic properties. The harmful properties of cortisol occur when cortisol levels elevate above normal levels. When this happens, insulin resistance heightens, which means more insulin is needed to perform its usual tasks. The state of high alert caused by cortisol also limits insulin production. Something else that's very important to consider with stress is ER stress. The ER, otherwise known as the endoplasmic reticulum, is an organelle present in all eukaryotic cells where it is responsible for a variety of functions: "That is the site of folding of membrane and secreted proteins, synthesis of lipids and sterols, and storage of free calcium" (Lin et al., 2008). The ER is in a stressed state during an increase in physiological stress or pathological stress. That can create an imbalance with the ER's capacity for protein folding and the demand for that protein folding. Moreover, ER stress can boost protein misfolding, which can lead to cell death and cellular dysfunction. This cellular dysfunction can affect the production of insulin, therefore, causing diabetes.

Insulin production also affects stress. **Figure 4** shows this relationship by showing the impact of glycemic control (blood glucose levels) on stress. When people with type 1 diabetes report improved glycemic control, positive stress increases as well. However, the opposite situation where people with type 1 diabetes report a decrease or a deterioration of glycemic control and negative stress increased by a significant amount. Furthermore, Glycemic control relies mainly on insulin production and its usage. Therefore, as insulin production levels and glycemic control change, the type of stress experienced by the patient changes correspondingly.

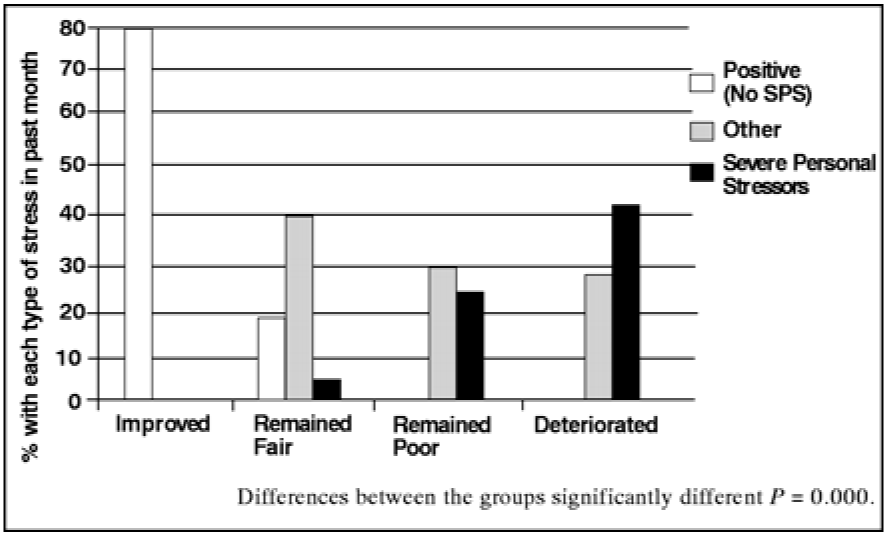

Figure 4. Glycemic control and its effect on positive and negative stress.

The connection between stress levels in different generations and insulin production

Stress and age share an intricate relationship, especially regarding both physical and emotional stress. The relationship between emotional stress and age is that the younger generations report having higher levels of emotional stress than the older generations. The older generations have less emotional stress due to their experience and knowledge of a healthy lifestyle or an individual(health official or psyciatrsit) guiding them with any issues concerning their stress levels.

Considering the previous point, studies of the effect of aging on insulin secretion imply that age causes a heightened resistance to insulin, a decrease in the ability to remove insulin from the bloodstream, and insulin secretory defects. The younger generation is more likely to have this higher insulin production, while the older generation has a lower production of insulin simply because of the effects of aging. **Figure 5** further highlights the increase in diabetes in a population as age increases. Because the diabetes rate increases, it is fair to associate insulin production lessening and aging.

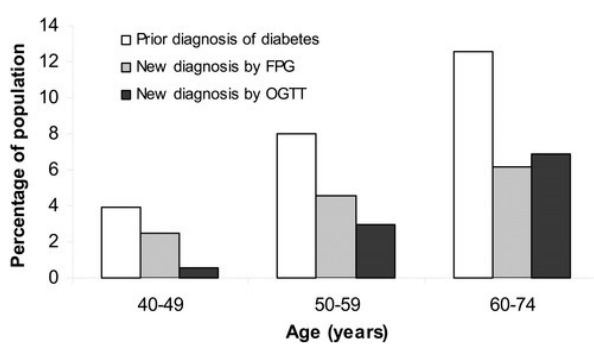

Figure 5. Percentage of a population diagnosed with diabetes through various methods at different ages.

Conclusion

Because stress is a common factor in many people's lives, its adverse effects on insulin production could negatively impact the quality of life for people with diabetes of all ages. The research analyzed in this research paper shows a clear connection between insulin production, stress, and age. In most cases, Stress decreases insulin production and insulin effectiveness because of its inhibiting properties regarding hormone production. Additionally, stress's effect on insulin production decreases with age (The exception is that insulin production will slow regardless just because of aging; stress will no longer be the foremost proponent in slowing down insulin production.). The implications of these findings are widespread, especially about diabetic treatment and prevention. For example, physicians can advise persons more susceptible to diabetes to live a more stress-free life. Another example involving diabetic treatment is doctors prescribing mitigating stress medication, improving an individual's life during a stressful time. In conclusion, with further research on this topic, stress prevention can become a more significant task for the whole medical community, especially for those involved in diabetes.

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