Chronic Stress: A Significant Factor in the Development of Type 2 Diabetes

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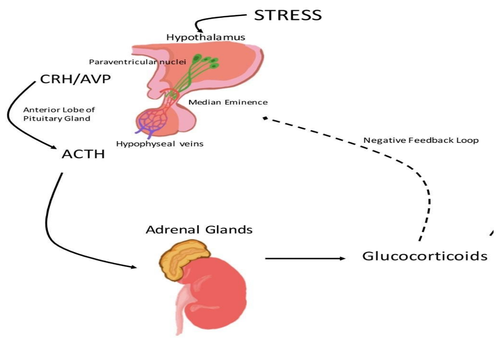
INTRODUCTION

Modern-day stress affects people of all backgrounds and ages, with links to various physical and mental health issues. Prolonged activation of the hypothalamic-pituitary-adrenal axis due to chronic stress leads to increased glucocorticoid secretion and disrupted glucose metabolism. This is associated with the development of diabetes, a prevalent chronic metabolic disorder impacting millions worldwide. With over 463 million adults currently affected, type 2 diabetes, characterized by insulin resistance, constitutes the majority of cases. While the exact mechanisms remain unclear, chronic stress is thought to contribute to insulin resistance through inflammatory pathways and lifestyle factors like poor diet, exercise, and sleep. Stress also disproportionately affects minority populations' diabetes risk due to social determinants like discrimination and limited healthcare access. Research suggests interventions like mind-body practices and addressing social and environmental factors may alleviate stress-induced diabetes risk. This review aims to illuminate the intricate relationship between chronic stress and diabetes, exploring its biological, psychological, and environmental dimensions, with the goal of informing prevention and treatment strategies.

BACKGROUND

The HPA axis is crucial for stress response. It involves the hypothalamus, pituitary gland, and adrenal glands. Chronic stress triggers excessive cortisol release, impacting glucose metabolism and insulin sensitivity, contributing to diabetes. The axis process involves hypothalamus releasing CRH, pituitary releasing ACTH, and adrenal glands producing cortisol. This helps mobilize energy during stress, affecting blood sugar levels and other functions. Understanding HPA's role aids in managing stress' impact on glucose regulation and diabetes risk.

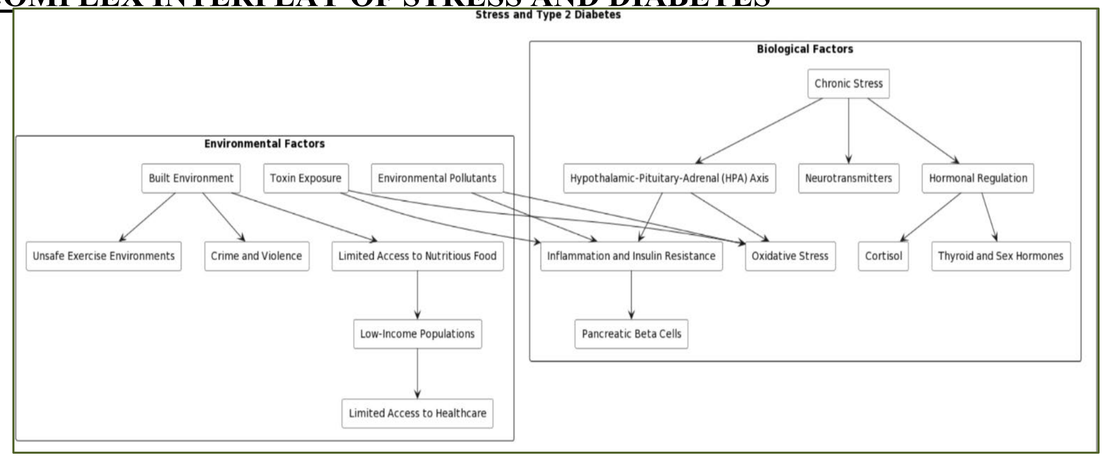


This Figure illustrates the HPA axis and hormone pathways. It's a feedback loop where introduced stressors initiate hormone flow indicated by arrows. Negative feedback signals return to the hypothalamus and anterior pituitary, suppressing glucocorticoid release and HPA axis activation (Burford et al., 2017).

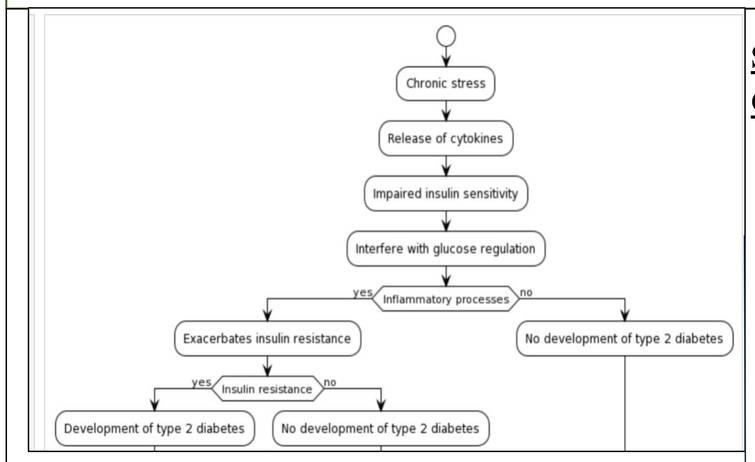
METHODS

To evaluate the relationship between chronic stress and type 2 diabetes, A literature review was conducted to evaluate 20 studies focusing on the effects of stress on glucose metabolism, inflammation, obesity, and insulin resistance. Some studies focus on the impact of chronic stress on the body's physiological systems, while others explore potential interventions to mitigate these effects.

COMPLEX INTERPLAY OF STRESS AND DIABETES



The flowchart illustrates the interconnectedness of chronic stress, biological factors, and environmental factors in the development of type 2 diabetes. Chronic stress can impact the HPA axis, leading to elevated cortisol levels, impaired glucose metabolism, insulin resistance, and an increased risk of type 2 diabetes. Biological factors such as inflammation, dysregulation of the HPA axis, reduced insulin sensitivity, and decreased insulin production also contribute to the development of type 2 diabetes. Environmental factors, including exposure to pollutants, limited access to nutritious foods, unsafe exercise environments, heightened crime and violence, and inadequate healthcare, further increase the risk of type 2 diabetes. Understanding and addressing these factors are crucial for effective prevention and management of type 2 diabetes (Braveman et al. 2014; Bourre, 2006; Clark et al., 2018, NCD Risk Factor Collaboration, 2016, Sinha et al. 2018; Tunstall, Pickett, & Johnsen, 2018, Walker et al., 2018).



The figure to the right demonstrates the process through which stress can cause type two diabetes. The flowchart provides a summary of the biological processes that eventually lead to type two diabetes (left side) or the same processes that do not lead to type 2 diabetes. The difference to determine the possible development of diabetes is whether there is an inflammatory process (Kyrou et al., 2019; Pasquali et al., 2017; Spranger et al., 2003).

SOCIOECONOMICAL AND CULTURAL FACTORS

- Socioeconomic disparities affect stress management and diabetes prevention in low-income populations.
- Cultural and socioeconomic barriers impact stress-coping abilities and exacerbate type 2 diabetes risk.
- Targeted interventions addressing these factors can reduce type 2 diabetes risk.

RESULTS

- Chronic stress triggers inflammation and disrupts HPA axis.
- Inflammatory response from chronic stress reduces insulin sensitivity and increases resistance.
- Experimental animals showed 6.4% decrease in insulin sensitivity due to chronic stress.
- Chronic stress impacts insulin-secreting pancreatic beta cells, reducing insulin production.
- Inflammation and oxidative stress worsen insulin resistance.
- Findings emphasize complex interplay of chronic stress, HPA axis, inflammation, and insulin processes.
- Insight gained can lead to targeted interventions for stress management and diabetes prevention.

CONCLUSION

Chronic stress significantly contributes to type 2 diabetes risk. Therapeutic approaches involving glucocorticoid receptor antagonists and anti-inflammatory drugs hold promise for managing stress-related diabetes by improving insulin sensitivity and reducing inflammation. While progress has been made, further research is needed to fully comprehend the intricate stress-diabetes link. Mindfulness meditation, yoga, and pharmacological interventions like propranolol show potential for stress reduction and diabetes prevention. Continued investigation is essential to validate their long-term effectiveness. Overall, understanding this relationship offers opportunities to develop tailored interventions that could alleviate the impact of chronic stress on type 2 diabetes and improve public health outcomes.

FUTURE DIRECTIONS

Genetic & Epigenetic Factors: Investigate how genetic variations and modifications impact susceptibility to stress-related type 2 diabetes.

Epigenetic Modifications: Study epigenetic changes caused by chronic stress, exploring their influence on glucose regulation and insulin resistance.

Cultural & Socioeconomic Factors: Recognize culture and socioeconomic factors, address barriers to stress management and diabetes prevention.

Addressing Disparities: Address racial/ethnic disparities in stress-related type 2 diabetes incidence, focus on mechanisms and fairness in prevention.

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REFERENCES