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Psychological stress as a risk factor for the development of metabolic syndrome: a literature review.

Psychological stress as a risk factor for the development of metabolic syndrome: a literature review

Psychological stress as a risk factor for the development of metabolic syndrome: a review of the literature

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Summary

INTRODUCTION: Stress activates the hypothalamic-pituitary-adrenal (HPA) axis, releasing cortisol, which elevates glucose and may increase the risk of metabolic syndrome (MS), metabolic steatotic liver disease (MSHD), and type 2 diabetes mellitus (T2DM). This study sought to understand how chronic dysregulation of this axis contributes to MS and how early detection through laboratory tests can facilitate clinical management. METHODS: This is an integrative, descriptive, and analytical review, with searches in PubMed, CAPES, and Google Scholar using the descriptors "Stress, Psychological," "Cortisol," and "Metabolic Syndrome." Studies from 2021 to 2026, in humans or animals, that related psychological stress and HPA axis dysregulation were included, excluding hypercortisolism from other causes, such as Cushing's syndrome, adrenal tumors, and corticosteroids. RESULTS: Of the 373 studies identified, 11 were included after reading titles and abstracts. The studies were heterogeneous regarding the association between stress and metabolic syndrome (MS). Chronic stress was related to a higher degree of visceral fat, inflammation, elevated glucose, and a higher risk of type 2 diabetes mellitus (DM2). The authors emphasize that the impact of stress depends on the interaction of multiple systems and that early detection by laboratory markers is important for preventing metabolic and cardiovascular diseases. CONCLUSION: Dysregulation of the HPA axis by chronic psychological stress, as a contributing factor and not an isolated one, may favor MS. The biomedical professional, by analyzing cortisol and other biomarkers along with glycemic, insulin, and lipid profiles, plays an essential role in early diagnosis and research.

Keywords: Metabolic syndrome; cortisol; psychological stress.

Abstract

INTRODUCTION: Stress activates the hypothalamic-pituitary-adrenal (HPA) axis, releasing cortisol, which raises glucose and may increase the risk of metabolic syndrome (MetS), metabolic steatotic liver disease (MSLD), and type 2 diabetes mellitus (T2DM). This study sought to understand how chronic dysregulation of this axis contributes to MetS and how early detection through laboratory testing may facilitate clinical management. METHODS: A descriptive and analytical integrative review, searching PubMed, CAPES, and Google Scholar using “Stress, Psychological”, “Cortisol”, and “Metabolic Syndrome”. Human or animal studies from 2021 to 2026 relating psychological stress to HPA axis dysregulation were included; hypercortisolism from other causes, such as Cushing's syndrome, adrenal tumors,

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and corticosteroids, was excluded. RESULTS: Of 373 identified studies, 11 were included after title and abstract screening. Studies were heterogeneous regarding the association between stress and MetS. Chronic stress was related to greater visceral fat, inflammation, elevated glucose, and higher T2DM risk. The authors emphasize that stress effects depend on interactions between multiple systems and that early detection through laboratory markers is important for preventing metabolic and cardiovascular diseases. CONCLUSION: HPA axis dysregulation through chronic psychological stress, as a contributing rather than isolated factor, may favor MetS. Biomedical professionals have an essential role in early diagnosis and research by analyzing cortisol and other biomarkers alongside glycemic, insulin, and lipid profiles.

Keywords: Metabolic syndrome; cortisol; psychological stress.

Summary

INTRODUCTION: The stress activates the hypothalamic-pituitary-adrenal (HPA) system and releases cortisol, which elevates glucose and can increase the risk of metabolic syndrome (MetS), metabolic steatotic liver disease (MEH) and type 2 diabetes mellitus (T2DM). We seek to understand how chronic deregulation of this eje contributes to SM and how early detection through laboratory tests facilitates clinical management. METHODS: Integrative, descriptive and analytical review, with searches in PubMed, CAPES and Google Scholar using “Stress, Psychological”, “Cortisol” and “Metabolic Syndrome”. Studies from 2021 to 2026, human or animal, on psychological stress and HPA eje desregulation were included, excluding hypercortisolism from other causes, such as Cushing's syndrome, adrenal tumors and corticosteroids. RESULTS: Of 373 studies identified, 11 were included after reading titles and abstracts. The studies were heterogeneous in the association between estrés and SM. Chronic stress is related to greater visceral fat, inflammation, elevated glucose and risk of DM2. Its impact depends on the interaction of multiple systems, and early detection using laboratory markers is important to prevent metabolic and cardiovascular diseases. CONCLUSION: The desregulation of the HPA eje due to chronic psychological stress, as a contributing factor and not in isolation, can favor SM. The biomedicine professional, by analyzing cortisol and other biomarkers together with glucemic, insulin and lipid profiles, plays an essential role in early diagnosis and investigation.

Keywords: Metabolic syndrome; cortisol; psychological stress.

1. Introduction

Stress is the body's response to any real or perceived threat, which intensifies the Physiological and psychological activity to cope with stress. This agent can be of a certain nature. physical, which involves concrete physiological threats, such as acute pain or a A psychological condition in which an individual interprets a situation as aversive or Challenging, such as work demands, social disapproval, harassment, etc. A The stress response is mediated by cortisol, a hormone responsible for promoting adaptations. Metabolic processes that provide energy through the production of new glucose molecules for vital organs during "fight or flight" situations (Kaur et al. 2025).

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The hypothalamic-pituitary-adrenal (HPA) axis is primarily responsible for controlling synthesis and secretion of cortisol by the adrenal glands, playing a fundamental role. in the body's response to stress (Göver et al. 2024). When faced with a stressor, the The hypothalamus secretes corticotropin-releasing hormone (CRH), which stimulates the pituitary gland to... secrete adrenocorticotropic hormone (ACTH). This, in turn, acts on the adrenal cortex, promoting the production and release of cortisol. Among its main effects, cortisol increases the availability of glucose in the blood by stimulating hepatic gluconeogenesis and stimulating the production of proteins that block the insulin receptor activation cascade, reducing its use by tissues, ensuring energy for vital organs during situations of greater need. demand (Guyton & Hall, 2011).

Under physiological conditions, increased cortisol exerts negative feedback on the hypothalamus and pituitary gland, reducing the release of CRH and ACTH and terminating the response to stress (Smith and Vale, 2006). However, prolonged exposure to stressors can compromising this regulatory mechanism, altering sensitivity to glucocorticoids and favoring the dysregulation of the HPA axis and the maintenance of high cortisol levels in organism (Moreira et al., 2025).

Cortisol stimulates hepatic gluconeogenesis from amino acids, lactate, and glycerol. while reducing glucose uptake by peripheral tissues and intensifying the Lipolysis in adipose tissue. This process increases the amount of glucose and free fatty acids. in the bloodstream, increasing the risk of developing type 2 diabetes mellitus (Ribeiro et al.) (al., 2025). In parallel, the continuous increase in lipolysis releases large amounts of acids. Free fatty acids, which are directed to the liver, promote the accumulation of triglycerides in the... hepatocytes, leading to hepatic steatosis (Kuo et al., 2015)

According to the Ministry of Health (2017), metabolic syndrome is a set of Risk factors (central obesity, high blood pressure, impaired glucose tolerance, triglycerides, and HDL) altered) that manifest in an individual, increasing their chances of developing Heart disease and diabetes, based on insulin resistance. High cortisol levels. in the blood, combined with bad lifestyle habits such as: poor diet, sedentary lifestyle, Alcoholism is one of the factors that can contribute to the development of metabolic syndrome.

The aim of this study was to understand, through scientific literature, how the Chronic dysregulation of the hypothalamic-pituitary-adrenal axis resulting from psychological stress. It can interfere with metabolism, being a contributing factor to the development of metabolic syndrome and related pathologies, such as liver disease.

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Metabolic steatosis (DHEM) and type 2 diabetes mellitus (DM2), and how to detect them.
Early detection through laboratory tests can facilitate the management of diseases.

2 Methodology

This study was characterized as an integrative literature review, of a...
descriptive and analytical. Data collection took place between March and November 2026.
through a structured search in the PubMed, CAPES, and Google Scholar databases.
The search strategy was designed using a combination of controlled descriptors.
indexed in the Health Sciences Descriptors (DeCS).

The following terms in English were combined, with the application of
Boolean operators: “Stress, Psychological” AND “Cortisol” AND “Metabolic Syndrome”
in September 2026. As inclusion criteria, original articles were selected,
Reviews, dissertations, theses, and clinical studies published in the last five years (2021–2026).
without language restrictions, studies conducted on humans and experimental models with
animals, which directly address the relationship between psychological stress and dysregulation of
hypothalamic-pituitary-adrenal axis.

The following were the exclusion criteria: Studies involving diagnosed patients.
with Cushing's syndrome, adrenal cortex tumors, medication use
corticosteroids or any other clinical/physiological condition of hypercortisolism that does not
was primarily associated with psychological stress and issues focused on psychology.

3 Results

Based on a structured search conducted in the PUBMED, CAPES and databases
Google Scholar identified 373 studies, selected through reading their titles.
and abstracts. The inclusion criteria were applied according to the relevance of the studies to the...
research objectives, excluding duplicate articles, paid articles, and articles focused on Psychology and
Nutrition and that they were not related to psychological stress. At the end of the selection process, they were
Eleven studies were included for the development of this review, as illustrated in Figure 1.

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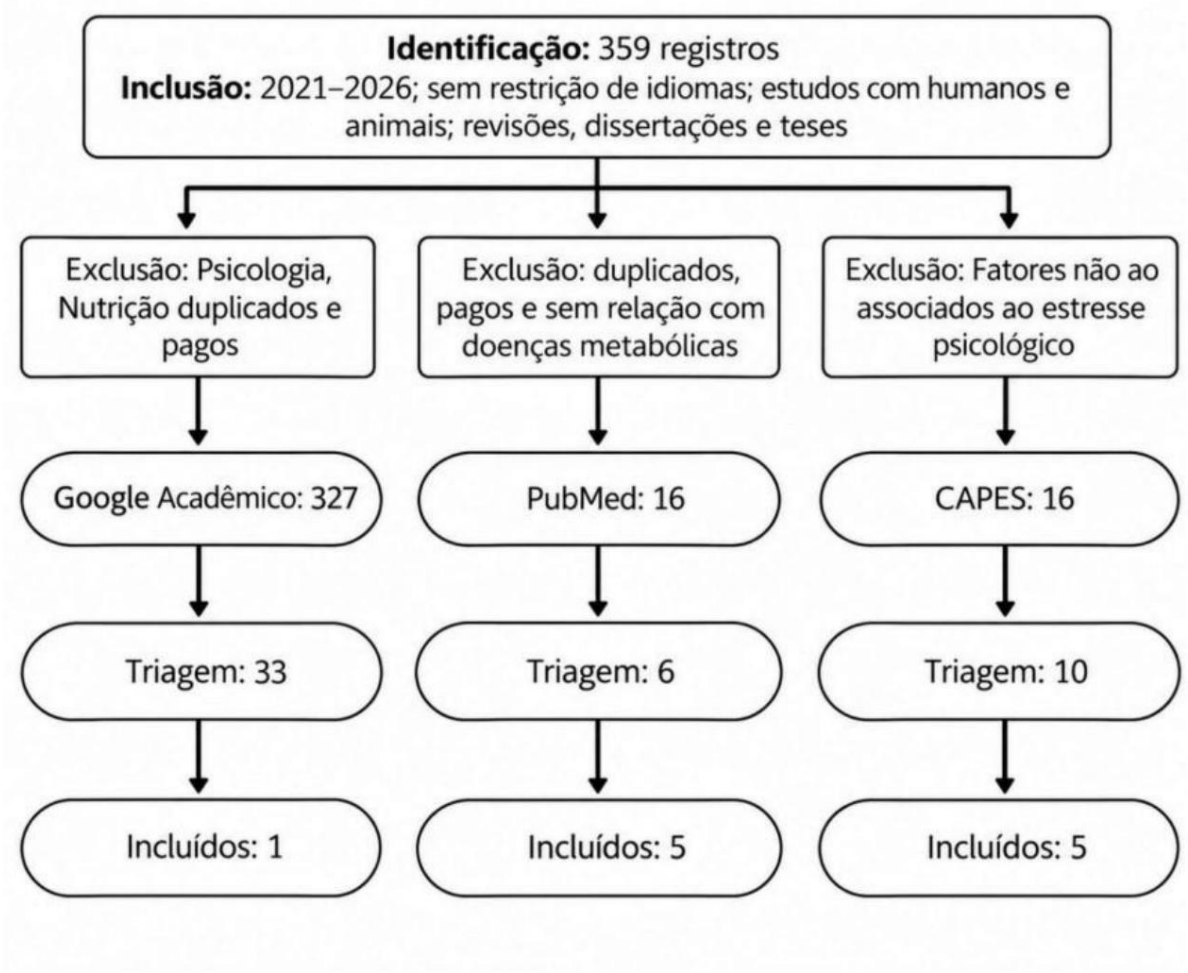
Figure 1 - Flowchart for article selection, 2026



Source: Author's own work

Among the 11 articles selected for review, the relationship between the psychological stress, physiological biomarkers, and metabolic changes, including the Metabolic syndrome, glycemic alterations, and steatotic disease were also analyzed. studies focused on evaluating laboratory markers potentially associated with stress Chronic. Detailed information about the articles is compiled in Table 1.

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Table 1 - Results found from the selected articles.

Year	Title	Authors	Results
2021	Chronic stress burden, visceral adipose tissue, and adiposity-related inflammation: the multi-ethnic study of atherosclerosis	Delker, Erin; Alyami, Bandar; Gallo, Linda; Ruiz, John et al	About half of the sample reported little or no stress, and one-fifth of the sample reported medium to high levels of stress. Higher levels of chronic stress were associated with greater amounts of visceral fat (VF) and subcutaneous fat (SF). Higher levels of GV were associated with increased levels of adiposity-related inflammation in a gradual pattern, not necessarily related to stress.
2021	Association between hair cortisol concentration and metabolic syndrome	Mazgelyte, Egle et al	The study indicated that 23.3% of participants had metabolic syndrome (MS), and among them, cortisol levels were significantly higher than in patients without MS. Elevated cortisol also correlated with abdominal circumference, blood pressure, and fasting blood glucose. Chronically elevated cortisol may contribute to metabolic syndrome, and point measurements only reflect the acute response of the HPA axis.
2021	Physiological biomarkers of stress: a systematic review	Noushad, Shamoon; Ahmed, Sadaf; Ansari, Basit.	Cortisol, ACTH, BDNF, glucose, HbA1c, triglycerides, cholesterol, prolactin, oxytocin, DHEA-S, CRP, IL-6, and IL-8 were identified as potential diagnostic biomarkers. The authors attribute prognostic and therapeutic value to these markers.
2022	Stress and eating responses in adolescent females predisposed to obesity: a pilot and feasibility study	Kidwell, Katherine; Reiter-Purtill, Jennifer et al	Adolescents with high stress levels reported more obesogenic eating behaviors and tended to have dysregulated cortisol, associated with increased food cravings. The study supports the theory that eating to cope with stress becomes a persistent habit even when cortisol decreases. Repeated consumption of palatable foods could attenuate the HPA axis.
2023	The association of psychological stress with syndrome and its sectional et al. sample mendelian randomization analyzes	Li, Cancan; Qi Tao, Tian; Tang, Yanyan; Lu, metabolic components: cross-bidirectional two-Huimin	No association was found between psychological stress and metabolic syndrome; no significant difference was found in salivary cortisol levels between populations with and without metabolic syndrome; patients with hypertension are more susceptible to developing metabolic syndrome.
2023	The role of the stress response in metabolic dysfunction- associated fatty liver disease: a psychoneuroendocrineimmunology-based perspective	Demori I, Grasselli E	Chronic stress, via elevated cortisol, could underpin the onset and worsening of metabolic syndrome through multiple mechanisms. Direct evidence exists in some cases, but well-designed animal and human studies, especially longitudinal ones, are still needed.

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Year	Title	Authors	Results
2023	Perceived Chronic Stress Is Associated With the German Diabetes Risk Score Among Adults Without Known Diabetes Germany	Nubel, Julia et al	The average predicted 5-year risk rates for type 2 diabetes (T2DM) were 2.7%, 2.9%, and 3.0% for chronic stress up to average, above average, and high, respectively. The adjusted average predicted 5-year risk was significantly higher among people with above-average (GMR = 1.10, 95% confidence interval = 1.02–1.19) and high (GMR = 1.21, 95% CI = 1.06–1.39) chronic stress compared to people with average chronic stress. No interactions were found with sex or other covariates.
2024	Allostatic load and metabolic syndrome in depressed patients: a cross-sectional analysis. depression anxiety	Osei, Francisco; Wippert, Pia-Maria; Block, Andrea.	It has been discovered that cortisol is inversely associated with metabolic syndrome, and that factors such as age, sex, assessment method, and study design play a significant role in cortisol levels and their association with MS. Despite this, cumulative stress can indeed alter the secretion and function of the HPA axis, increasing glucocorticoids, a dysfunction that can trigger metabolic diseases, immunosuppression, and mental health problems. However, because it is a low-grade inflammation, it can take several months to years for a metabolic syndrome to develop. The low cortisol levels in this situation may also be due to hypocortisolism driven by hyperactivity of the HPA axis, increasing sensitivity to negative feedback, leading to hypocortisolism.
2025	Stress-induced metabolic disorders: mechanisms, pathologies, and prospects	Zhang, Wei-Zheng	Chronic stress can contribute to the development and worsening of metabolic disorders through hormonal, inflammatory, cellular, and behavioral mechanisms. The authors emphasize that this relationship does not depend exclusively on cortisol, but involves the interaction of different physiological systems.
2025	Laboratory markers of chronic and acute stress: diagnostic value and clinical implications (part 2: neuroendocrine, immunological and metabolic biomarkers of chronic stress in the context of its influence on cardiovascular system)	Shkvarok-Lisovenko, Anastasia; Bushman, Yevheniia	Neuroendocrine, immune, and metabolic dysregulation is linked to hypertension, cardiovascular events, insulin resistance, and systemic inflammation. The authors argue that early detection of chronic stress is essential to prevent obesity, metabolic syndrome, and atherosclerosis.

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Year	Title	Authors	Results
2026	The impact of psychological stress on physical health	Ibraimi, Zebide	Measurement of isolated components of metabolic syndrome. Multidimensional impact of psychological stress, affecting both physiological measures (inflammation, blood pressure, BMI, glucose) and behavioral factors (sleep, activity). These results support the hypothesis that stress is a significant determinant of physical health and may contribute to the development of chronic diseases. These correlations emphasize the multifaceted impact of psychological stress on overall health, reinforcing the need for an integrated approach. Interventions are needed that address both mental and physical well-being.

The studies analyzed present heterogeneous results regarding the relationship between Psychological stress, cortisol concentrations, and metabolic syndrome were found. articles that did not identify a significant association between psychological stress and syndrome metabolic, however, others have described changes related to psychological stress in physiological and behavioral indicators, such as increased inflammation and higher levels blood glucose levels increased when compared to patients without elevated cortisol levels.

4. Discussion

Stress is defined as a state in which environmental demands exceed capacity. coping capacity perceived by the individual, resulting in psychological responses. behavioral and physiological factors. This situation can be crucial for physical health. which may contribute to the development and progression of several chronic diseases (Ibraimi, 2026).

Accumulated stress can develop into chronic stress and alter bodily function. hypothalamic-pituitary-adrenal (HPA) axis. In acute stress, neurons of the nucleus Paraventricular organs of the hypothalamus release the hormone CRH, which stimulates the anterior pituitary gland to... secrete ACTH and, thus, the adrenal cortex produces glucocorticoids, a process enhanced by epinephrine and norepinephrine. In chronic stress, however, the failure of negative feedback Glucocorticoid activity and sustained activation of the CRH-norepinephrine circuit lead to dysfunction. of the axis, favoring the development of metabolic diseases and immunosuppression (Osei et al, 2024)

Glucocorticoids raise blood glucose levels, and catecholamines increase cardiac output. Prolonged exposure to stress intensifies these reactions, favoring an increase in symptoms. sustained increase in catecholamines, which impairs metabolism and promotes inflammation (Zhang et al.

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al., 2025). In this context, Ibraimi (2026) describes that recurrent stressful episodes
can lead to allostatic load, a cumulative physiological wear and tear that compromises the
homeostasis and promotes illness, and has been associated with systemic inflammation, to
metabolic dysregulation, cardiovascular dysfunction, and immune system impairment.

In agreement, Shkvarok-Lisovenko and Bushman (2025) relate deregulation
neuroendocrine, immune and metabolic factors related to hypertension, cardiovascular events, and resistance to
Insulin and systemic inflammation, and advocate for the early detection of chronic stress as
a way to prevent obesity, metabolic syndrome (MS), and atherosclerosis. Zhang (2025) proposes
that persistent activation of the HPA axis elevates cortisol and increases insulin resistance and the
abdominal obesity, but emphasizes that the relationship between stress and metabolic disorders is not
It depends exclusively on cortisol, involving the interaction of hormonal mechanisms.
Inflammatory, cellular, and behavioral factors.

Regarding adiposity, Delker et al. (2021) in a multiethnic sample of adults with approximately
In studies conducted in the 65-year-old age group, higher levels of chronic stress were associated with greater
The amount of visceral and subcutaneous fat, but not the ratio between them. Higher levels of
Visceral fat has been linked to increased inflammation associated with adiposity, and these associations
They did not vary according to stress levels. This suggests that stress is associated with the accumulation of
fat, but the link between visceral fat and inflammation may not be dependent on
stressful episode.

From a behavioral point of view, Kidwell et al. (2022), in a pilot study with
A study of female adolescents predisposed to obesity showed that those with higher
Those who were stressed reported more unhealthy eating behaviors and tended to exhibit...
Dysregulated cortisol is associated with increased food cravings. The authors support this theory with...
Which foods to eat to cope with stress can become a persistent habit. Repeated consumption of
Palatable foods could attenuate the response to the HPA axis, which would help sustain the habit.
Eating to cope with stress, even when cortisol levels decrease.

Regarding glucose metabolism, Nübel et al. (2023) observed that, in adults
In Germans without a prior diagnosis of diabetes, perceived chronic stress was associated with
directly related to the increased risk score for the disease. Incidence projections of
Diabetes rates increased progressively over five years in line with stress intensity.
reported.

Additionally, Zhang et al. (2025) adds that chronic stress can
impairing GLUT4 translocation and promoting hepatic gluconeogenesis, inducing

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hyperglycemia and constituting a possible risk factor for type 2 diabetes. Demori and Grasselli (2023) propose that chronic stress, via elevated cortisol, can sustain the emergence and worsening of metabolic steatotic liver disease associated with metabolic dysfunction due to the mechanisms of gluconeogenesis, which involve lipolysis and glycerol uptake. for the formation of new glucose molecules, although they emphasize that longitudinal studies, in Animals and humans are still needed.

Regarding biomarkers of chronic stress, cortisol was the most prevalent biomarker. studied. Noushad et al. (2021) identified it, especially when measured in hair, as a one of the main biomarkers of chronic stress, alongside ACTH, neurotrophic factor derived from from the brain (BDNF), glucose, glycated hemoglobin (HbA1c), triglycerides (TG), cholesterol, oxytocin, dehydroepiandrosterone sulfate (DHEA-S), CRP, IL-6 and IL-8, attributing to them prognostic and therapeutic value.

Mazgelytÿ et al. (2021) investigated the concentration of hair cortisol (HCC). hair cortisol concentration) and metabolic syndrome (MS). 23.3% of participants Those who presented with the syndrome had significantly higher HCC than the others. The HCC It correlated with waist circumference, blood pressure, and fasting blood glucose, but not with HDL-C and triglycerides. The authors highlight that chronically elevated cortisol This can contribute to metabolic syndrome, while isolated measures only reflect the acute response of the disease. HPA axis.

This picture, however, is not uniform. Osei et al. (2024), in a cross-sectional analysis with In a study of depressed patients, an inverse association was found between cortisol and metabolic syndrome. The authors discuss this. How do age, sex, assessment method, and study design influence cortisol levels? its association with SM, and that, because it is a low-grade inflammation, SM can lead months or years to develop. Low cortisol levels can result from Prolonged hyperactivity of the axis, with increased sensitivity to negative feedback. Thus, Cortisol levels can behave differently depending on the phase of stress exposure, which It helps to explain seemingly contradictory results.

Finally, Li et al. (2023) observed that higher stress levels were related to higher risk of hypertension in men. These results contrast with the studies described. previously and suggest that the effect of stress may be more limited, depending on the The evaluated component and sex. It is also worth considering that Mendelian analysis used Genetic data from a European population is limited, which restricts the generalizability of the findings.

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In conclusion, the evidence gathered indicates that chronic stress is associated with metabolic and cardiovascular changes, especially adiposity, blood glucose and blood pressure, but the relationship with SM as a whole remains inconsistent. The findings reinforce the The need for integrated approaches that consider both mental and physical well-being. and longitudinal studies with standardized stress measures that clarify the direction and the mechanisms of this relationship.

5. Final Considerations

Dysregulation of the hypothalamic-pituitary-adrenal axis, associated with chronic stress, It can affect physical health through changes in cortisol secretion. These changes can interfere with glucose and lipid metabolism, in addition to contributing to resistance to Insulin, and consequently, the accumulation of abdominal fat and the development of... cardiometabolic changes.

However, chronic stress cannot be considered an isolated factor for Analyze the tendency towards metabolic syndrome, and yes, see it as a contributing factor. Exposure to Stressors, even before they become chronic, can lead to a predisposition for bad habits. Poor diet, sedentary lifestyle, and consumption of harmful substances can damage health. metabolic.

Serum and salivary concentrations reflect conditions related to the timing of hair collection, while hair analysis can provide information about hormonal exposure. accumulated over a longer period. Thus, depending on the time of collection, Individual characteristics, sample type, and clinical conditions should be considered in Interpretation of the results.

In addition to cortisol, other biomarkers may be relevant in the investigation of diseases that can develop as a result of prolonged exposure to the agents Stressors. Biomarkers of the immune, endocrine, and metabolic systems can help. in the early diagnosis of diseases, prognostic indicators and potential targets for Behavioral interventions in chronic stress.

The biomedical scientist works in the analysis and validation of laboratory markers resulting from... Chronic stress, such as cortisol and catecholamines, correlating them with glycemic profiles, Insulin and lipid levels to integrate neuroendocrine assessment with the metabolic condition of In addition to diagnostic practice, the biomedical professional plays an indispensable role in the patient. Clinical research focused on metabolic health. This approach makes it possible to measure with precision.

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How the allostatic load of psychological stress triggers metabolic dysfunctions,
enabling the validation of new biomarkers and the evaluation of the effectiveness of interventions.
therapeutics.

Therefore, it becomes essential to encourage studies that broaden and improve the...
scientific evidence in this area. This expansion is fundamental to clarifying how the
Laboratory assessment of the HPA axis and the systemic impacts of its dysregulation by stress.
Psychological assessment can enable early diagnosis of metabolic syndrome and its related conditions.
complications.

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