S

Stress and Cortisol

Lauren Vorbach[1] and Kevin Bennett[2]
[1]Pennsylvania State University, Coraopolis, PA, USA
[2]Department of Psychology, Pennsylvania State University, Beaver, Monaca, PA, USA

Definition and Synonyms

Stress, initially described as a physical force, claimed its new meaning as a psychological, physiological, or chemical impact on an individual that changes the body's homeostasis (Chrousos 2009). Examples of stress include strife in the workplace, toxic chemical exposures (e.g., asbestos), and traumatic experiences, such as a house fire. When an individual undergoes stress, the body has its own mechanisms in store to adapt. Chrousos described the adaptation: "When any stressor exceeds a certain severity or temporal threshold, the adaptive homeostatic systems of the organism activate compensatory responses that functionally correspond to the stressor" (2009, p. 374). Researches have yet to explore all the effects of stress on the body; however, they have found a link between stress and cortisol. Cortisol is a hormone secreted by two, golf ball sized glands sitting above the kidneys, the adrenals. Cortisol not only resides within the adrenal glands but also travels throughout the body within the bloodstream (Staufenbiel et al. 2013). Individuals may not detect the effect that cortisol has on everyday bodily function. Researchers have found that stress can alter the way that cortisol is released, used, and stored.

Introduction

Stress if often discussed as a mental tension caused by environmental pressure on the brain and the body. One key factor in the body's response to stress is a hormone called cortisol. Not only does cortisol aid in adapting the body at that exact moment, but it has longer effects. Cortisol affects other bodily systems and parts, all of which reveal stress as a substantial factor in daily function.

Physiology of Cortisol in the Body

A set of adrenal glands produce the glucocorticoid hormone, cortisol (McEwen 2008). Before the adrenals produce and release cortisol, several things must occur. First, an outside stressor is sensed by an individual. After sensory neurons receive the stimuli and it exceeds the stressor threshold, the impulse is sent to the hypothalamus, a region of the brain dedicated to the autonomic nervous system and homeostatic bodily systems. The hypothalamus releases corticotrophin to the pituitary gland, a pea-sized gland in the brain. The pituitary then produces adrenocorticotrophic

T. K. Shackelford, V. A. Weekes-Shackelford (eds.), *Encyclopedia of Evolutionary Psychological Science*,
https://doi.org/10.1007/978-3-319-16999-6_1151-1

hormone (ACTH) and releases it into the bloodstream down to the adrenal glands. The glands release epinephrine and catecholamine, creating the "adrenaline" response individuals may get when presented with a stressor. The adrenals also release norepinephrine, which stimulates the liver (Lee et al. 2015). The hypothalamus, pituitary, adrenal process is often called the "HPA axis" or "HPA loop" (Gómez-Gallego and Gómez-García 2018).

Effects of Cortisol

Researchers found that there are many effects on cortisol of the body. Because the HPA axis involves neurological mechanisms that are responsible for homeostasis throughout the body, cortisol plays a major role in our body's maintenance. Generally, cortisol can increase sugar within the bloodstream and increase the accessibility of repairing materials throughout the body. Cortisol can also affect an individual's immunity, digestive system, and reproductive system, depending on levels and cortisol use (Chrousos 2009).

In stressful, flight or fight situations, through the HPA axis, cortisol and adrenaline levels will rise, and naturally and typically, fall back down to a baseline state through feedback from the hypothalamus and the hippocampus. Researchers have found that when stressors are prolonged, cortisol levels rise; however, it may not come back down to that baseline. Cortisol may stay in the bloodstream and circulate in the body, even after the stressors have been removed. Researchers saw that this acute state can contribute/cause anxiety, depression, heart disease, gastrointestinal diseases/problems, metabolism problems/weight gain, other endocrine/reproductive difficulties, and circadian rhythm (Fogelman and Canli 2018).

Chrousos (2009) listed the effects of both effects of hypo and hypercortisolism and change in the HPA axis. Increased activity conditions include: depression, anorexia, obsessive-compulsive disorder, panic disorder, excessive exercise, alcoholism, diabetes mellitus, obesity, and hyperthyroidism. Decreased activity include: adrenal insufficiency, depression, fatigue, fibromyalgia, premenstrual tension syndrome, hypothyroidism, rheumatoid arthritis, asthma, and eczema.

There are two more well-known diseases related to cortisol levels: Cushing's syndrome and Addison's disease. One of them, due to hypercortisolism is called Cushing's syndrome. Symptoms of Cushing's syndrome include: weight gain, round face, thin arms and legs, and easy bruising. Individuals may also experience difficulties with reproductive systems, such as irregular menstruation or amenorrhea (Krieger 1983). The other, Addison's disease, is due to hypocortisolism (i.e., sparse cortisol). Symptoms of Addison's disease include: fatigue, weight loss, hyperpigmentation, low blood pressure, abdominal pain, and salt craving (Levine et al. 2007).

Diagnostic Measures of Cortisol

Researchers and physicians may test cortisol various ways; however, each way measures cortisol in different areas. Cortisol may be found bound, unbound (free), or both unbound and bound (total). Bound cortisol is attached to "sex-hormone-binding" globin. Unbound cortisol is also found in the blood stream, not connected to anything. Total cortisol is the combination of bound and unbound cortisol (Levine et al. 2007). Based on what the researcher or physician is looking for, an individual may use hair or saliva samples, urine testing, or blood samples to check cortisol levels (Levine et al. 2007).

In order to begin a blood test, a health professional will take two separate blood samples, one in the morning and in the evening to record change in cortisol levels at different parts of the day. Blood would then be sent to a lab to analyze. Blood cortisol testing can test total cortisol levels (Levine et al. 2007).

The last three samples are less invasive. Salivary and urine samples can also test unbound cortisol (Hellhammer et al. 2009). Both samples can be taken throughout the day depending on the researcher and/or physician's instructions. The last form of testing is taking a hair sample.

Because hair is made from capillaries from the skin, blood from the hair can be examined over time. The samples can be taken and sent to a lab for testing (Lee et al. 2015).

Treatment of Stress and Cortisol

Physicians and professionals recommend a variety of treatment approaches to reduce stress and aid in lowering hypercortisolism. Typically, yoga, meditation, and enjoyable activities are recommended. Sullivan, Carberry, Evans, Hall, & Nepocatych described in a recent study, how individuals who participated in a type of restorative yoga had decreased cortisol directly after the class (Sullivan et al. 2017).

Treatment varies for everyone. Some may eventually partake in counseling or therapy. Others may need to lower their stress input to get the body back to homeostasis. Those individuals may need to identify whatever stressor is present and eliminate it or learn how to adapt or change it so that stress is lowered. Sometimes a stressor is physiologically inherent, meaning it is already present in the body. Stress within the body can increase cortisol levels. Seeing a physician about concerns of heightened cortisol levels may be suggested for this individual.

Conclusion

Stress not only changes the way the body functions, but also has long-lasting effects on the body's systems. Managing stress as well as attending the body's response to stressors could aid in cortisol regulation. Awareness of diagnostic methods also increases awareness as well.

Cross-References

▶ Cortisol Affords Immediate Action and Alertness

References

Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature Reviews Endocrinology, 5*(7), 374–381. https://doi.org/10.1038/nrendo.2009.106.

Fogelman, N., & Canli, T. (2018). Early life stress and cortisol: A meta-analysis. *Hormones and Behavior, 98*, 63–76. https://doi.org/10.1016/j.yhbeh.2017.12.014.

Gómez-Gallego, M., & Gómez-García, J. (2018). Stress and verbal memory in patients with Alzheimer's disease: Different role of cortisol and anxiety. *Aging & Mental Health, 23*(11), 1496–1502. https://doi.org/10.1080/13607863.2018.1506741.

Hellhammer, D. H., Wüst, S., & Kudielka, B. M. (2009). Salivary cortisol as a biomarker in stress research. *Psychoneuroendocrinology, 34*(2), 163–171. https://doi.org/10.1016/j.psyneuen.2008.10.026.

Krieger, D. T. (1983). Physiopathology of Cushing's disease. *Endocrine Reviews, 4*(1), 22–43. https://doi.org/10.1210/edrv-4-1-22.

Lee, D. Y., Kim, E., & Choi, M. H. (2015). Technical and clinical aspects of cortisol as a biochemical marker of chronic stress. *BMB Reports, 48*(4), 209–216. https://doi.org/10.5483/bmbrep.2015.48.4.275.

Levine, A., Zagoory-Sharon, O., Feldman, R., Lewis, J. G., & Weller, A. (2007). Measuring cortisol in human psychobiological studies. *Physiology & Behavior, 90*(1), 43–53. https://doi.org/10.1016/j.physbeh.2006.08.025.

McEwen, B. S. (2008). Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. *European Journal of Pharmacology, 583*(2–3), 174–185. https://doi.org/10.1016/j.ejphar.2007.11.071.

Staufenbiel, S. M., Penninx, B. W., Spijker, A. T., Elzinga, B. M., & van Rossum, E. F. V. (2013). Hair cortisol, stress exposure, and mental health in humans: A systematic review. *Psychoneuroendocrinology, 38*(8), 1220–1235. https://doi.org/10.1016/j.psyneuen.2012.11.015.

Sullivan, M., Carberry, A., Evans, E. S., Hall, E. E., & Nepocatych, S. (2017). The effects of power and stretch yoga on affect and salivary cortisol in women. *Journal of Health Psychology, 24*(12), 1658–1667. https://doi.org/10.1177/1359105317694487.