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November 2009 Issue

Cortisol — Its Role in Stress, Inflammation, and Indications for Diet Therapy

By Dina Aronson, MS, RD

Today's Dietitian

Vol. 11 No. 11 P. 38



Cortisol, a glucocorticoid (steroid hormone), is produced from cholesterol in the two adrenal glands located on top of each kidney. It is normally released in response to events and circumstances such as waking up in the morning, exercising, and acute stress. Cortisol's far-reaching, systemic effects play many roles in the body's effort to carry out its processes and maintain homeostasis.

Of interest to the dietetics community, cortisol also plays an important role in human nutrition. It regulates energy by selecting the right type and amount of substrate (carbohydrate, fat, or protein) the body needs to meet the physiological demands placed on it. When chronically elevated, cortisol can have deleterious effects on weight, immune function, and chronic disease risk.

Cortisol (along with its partner epinephrine) is best known for its involvement in the “fight-or-flight” response and temporary increase in energy production, at the expense of processes that are not required for immediate survival. The resulting biochemical and hormonal imbalances (ideally) resolve due to a hormonally driven negative feedback loop. The following is a typical example of how the stress response operates as its intended survival mechanism:

1. An individual is faced with a stressor.
2. A complex hormonal cascade ensues, and the adrenals secrete cortisol.
3. Cortisol prepares the body for a fight-or-flight response by flooding it with glucose, supplying an immediate energy source to large muscles.
4. Cortisol inhibits insulin production in an attempt to prevent glucose from being stored, favoring its immediate use.
5. Cortisol narrows the arteries while the epinephrine increases heart rate, both of which force blood to pump harder and faster.
6. The individual addresses and resolves the situation.
7. Hormone levels return to normal.

So what's the problem? In short, the theory is that with our ever-stressed, fast-paced lifestyle, our bodies are pumping out cortisol almost constantly, which can wreak havoc on our health. This whole-body process, mediated by hormones and the immune system, identifies cortisol as one of the many players. But isolating its role helps put into context the many complex mechanisms that lead to specific physiological damage.

Whole-Body Effects of Elevated Cortisol

Blood Sugar Imbalance and Diabetes

Under stressful conditions, cortisol provides the body with glucose by tapping into protein stores via gluconeogenesis in the liver. This energy can help an individual fight or flee a stressor. However, elevated cortisol over the long term consistently produces glucose, leading to increased blood sugar levels.

Theoretically, this mechanism can increase the risk for type 2 diabetes, although a causative factor is unknown.¹ Since a principal function of cortisol is to thwart the effect of insulin—essentially rendering the cells insulin resistant—the body remains in a general insulin-resistant state when cortisol levels are chronically elevated. Over time, the pancreas struggles to keep up with the high demand for insulin, glucose levels in the blood remain high, the cells cannot get the sugar they need, and the cycle continues.

Weight Gain and Obesity

Repeated elevation of cortisol can lead to weight gain.² One way is via visceral fat storage. Cortisol can mobilize triglycerides from storage and relocate them to visceral fat cells (those under the muscle, deep in the abdomen). Cortisol also aids adipocytes' development into mature fat cells. The biochemical process at the cellular level has to do with enzyme control (11-hydroxysteroid dehydrogenase), which converts cortisone to cortisol in adipose tissue. More of these enzymes in the visceral fat cells may mean greater amounts of cortisol produced at the tissue level, adding insult to injury (since the adrenals are already pumping out cortisol). Also, visceral fat cells have more cortisol receptors than subcutaneous fat.

A second way in which cortisol may be involved in weight gain goes back to the blood sugar-insulin problem. Consistently high blood glucose levels along with insulin suppression lead to cells that are starved of glucose. But those cells are crying out for energy, and one way to regulate is to send hunger signals to the brain. This can lead to overeating. And, of course, unused glucose is eventually stored as body fat.

Another connection is cortisol's effect on appetite and cravings for high-calorie foods. Studies have demonstrated a direct association between cortisol levels and calorie intake in populations of women.³ Cortisol may directly influence appetite and cravings by binding to hypothalamus receptors in the brain. Cortisol also indirectly influences appetite by modulating other hormones and stress responsive factors known to stimulate appetite.

Immune System Suppression

Cortisol functions to reduce inflammation in the body, which is good, but over time, these efforts to reduce inflammation also suppress the immune system. Chronic inflammation, caused by lifestyle factors such as poor diet and stress, helps to keep cortisol levels soaring, wreaking havoc on the immune system. An unchecked immune system responding to unabated inflammation can lead to myriad problems: an increased susceptibility to colds and other illnesses, an increased risk of cancer, the tendency to develop food allergies, an increased risk of an assortment of gastrointestinal issues (because a healthy intestine is dependent on a healthy immune system), and possibly an increased risk of autoimmune disease.^{4,5}

Gastrointestinal Problems

Cortisol activates the sympathetic nervous system, causing all of the physiologic responses previously described. As a rule, the parasympathetic nervous system must then be suppressed, since the two systems cannot operate simultaneously. The parasympathetic nervous system is stimulated during

quiet activities such as eating, which is important because for the body to best use food energy, enzymes and hormones controlling digestion and absorption must be working at their peak performance.

Imagine what goes on in a cortisol-flooded, stressed-out body when food is consumed: Digestion and absorption are compromised, indigestion develops, and the mucosal lining becomes irritated and inflamed. This may sound familiar. Ulcers are more common during stressful times, and many people with irritable bowel syndrome and colitis report improvement in their symptoms when they master stress management.⁵ And, of course, the resulting mucosal inflammation leads to the increased production of cortisol, and the cycle continues as the body becomes increasingly taxed.⁴

Cardiovascular Disease

As we've seen, cortisol constricts blood vessels and increases blood pressure to enhance the delivery of oxygenated blood. This is advantageous for fight-or-flight situations but not perpetually. Over time, such arterial constriction and high blood pressure can lead to vessel damage and plaque buildup—the perfect scenario for a heart attack. This may explain why stressed-out type A (and the newly recognized type D) personalities are at significantly greater risk for heart disease than the more relaxed type B personalities.⁶

Fertility Problems

Elevated cortisol relating to prolonged stress can lend itself to erectile dysfunction or the disruption of normal ovulation and menstrual cycles. Furthermore, the androgenic sex hormones are produced in the same glands as cortisol and epinephrine, so excess cortisol production may hamper optimal production of these sex hormones.⁵

Other Issues

Long-term stress and elevated cortisol may also be linked to insomnia, chronic fatigue syndrome, thyroid disorders, dementia, depression, and other conditions.^{4,5}

Assessing Cortisol Levels

The adrenal stress index (ASI), a salivary test, is the preferred test for adrenal function and a well-accepted, noninvasive, reliable indication of cortisol levels.⁷⁻¹⁰ However, a trained professional should interpret the results because factors such as age, gender, timing with the menstrual cycle, pregnancy, lactation, smoking, medications, medical conditions, caffeine and alcohol consumption, caloric intake, and other test results (particularly related hormone tests such as sex hormone levels) will contextualize the significance and meaning of the measurement.^{9,10}

The ASI is available as a home kit. Four saliva samples are taken at specific times and then shipped to a laboratory for analysis. Conveniently, in addition to measuring the adrenal hormones cortisol and dehydroepiandrosterone, the same test also measures antibodies to gliadin, often used as a marker for intestinal inflammation, Candida infections, and sensitivity to gluten-containing grains. (Note that this test cannot diagnose gluten sensitivity definitively.)⁷

A blood cortisol test is available, but it is considered inferior to the salivary test for three reasons: It tests cortisol levels only at one given point in time, which provides less information than levels at four times (which reveals important imbalances); the blood test itself (or simply going to the doctor) can stress a person enough to cause a cortisol surge; and it is considered less sensitive because it measures the total hormone level as opposed to specific components.⁵

The Good News

So far, it may seem as though stressed-out folks are destined for failed health despite their best intentions. Fortunately, there is much we can do for our clients (and ourselves) to reverse the path of

destruction. The best approach to keeping cortisol levels at bay is mastering stress management and optimizing diet.

Stress Management

First, regardless of our scope of practice, we can always recommend strategies for effective stress management. Books such as Woodson Merrell's ***The Source*** have some powerful yet commonsense, evidence-based advice for de-stressing and regaining optimal health. Some strategies include getting more and better quality sleep, breath work, acupuncture, cardio/resistance/relaxation exercises, and addressing psychological/emotional issues. Minimizing stress may require a team approach; we can acknowledge its importance and leave the details to the experts.

The Anti-Inflammatory Diet

Systemic inflammation, as noted previously, causes elevated cortisol levels. If we can naturally decrease inflammation in the body and minimize stress, decreased cortisol levels should follow, resulting in decreased chronic disease risk and improved wellness. The biochemical processes leading to and abating inflammation are complex and multi-faceted, but as experts in diet and lifestyle, we can make a significant difference.

Like any diet designed to manage a condition, there is no one perfect anti-inflammatory diet. However, based on known properties of foods and clinical research, we can devise a generally low-inflammatory diet and tweak it over time. Obviously, maximizing the anti-inflammatory foods and minimizing the proinflammatory ones is a big step toward controlling inflammation. Incidentally, dietary strategies for controlling inflammation may also help with adrenal support in general, since diet can directly affect adrenal burden (eg, cortisol is released in response to metabolic demands).

Since lifestyle factors are generally the most significant modulators of inflammation, nutrition professionals can make a huge difference in our clients' and patients' overall health.⁴ The following is a general list of diet and lifestyle factors believed to be the most significant contributors to inflammation:

- high glycemic load;
- saturated and trans fatty acids;
- caffeine;
- alcohol in excess;
- insufficient intake of micronutrients and antioxidants;
- a low-fiber diet;
- a sedentary lifestyle; and
- overweight.⁴

To minimize inflammation, the following are recommended:

- a low glycemic load diet;
- elimination of trans fats and minimal intake of saturated fats;
- elimination or reduction of caffeine;

- alcohol in moderation or not at all;
- boosting consumption of whole plant foods to maximize intake of fiber, antioxidants, and phytonutrients: with vegetables, fruits, whole intact grains, nuts, seeds, and beans;
- meeting recommended intake of omega-3 fatty acids (may be best measured as a ratio to omega-6 fatty acids);
- regular exercise; and
- probiotics, if warranted.

Clearly, these are merely guidelines. Therapeutic nutritional recommendations need to be customized for each individual's condition, preferences, and goals.

Note that while medications such as nonsteroidal anti-inflammatory drugs temporarily alleviate inflammation, hundreds of studies have demonstrated that long-term use can cause damage over time and even exacerbate systemic inflammation.

Summary

Cortisol is a fascinating hormone that is important to nutrition science on many levels. Understanding the science behind it, including its behaviors and relationships to other biochemical components, the immune system, and health outcomes, is crucial to our success in treating people who seek dietary intervention for stress, illness, fatigue, and other common complaints.

Implementation of targeted dietary and lifestyle approaches is an extremely powerful way to reduce stress, minimize inflammation, and reduce the risk for illness and chronic disease. True, the many biochemical processes involving cortisol and other hormones, stress, and inflammation and their impact on health and disease risk are complex and elaborate. The therapeutic diet and lifestyle strategies, however, are not. The more we learn about the way the body responds to the demands placed on it, as well as its extraordinary healing power, the more we are valued as professionals who can effectively change people's lives by improving health, inspiring change, and increasing longevity.

— *Dina Aronson, MS, RD, owns Welltech Solutions, a nutrition and technology consulting company.*

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