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Yoga Therapy as an Intervention for Stress-Induced Hormonal Imbalance

Chronic stress is one of the greatest challenges in today's world of relative abundance and health. Chronic stress is a byproduct of our fast-paced modern world and many people experience negative health outcomes associated with long-term chronic stress. According to a report published by the American Psychological Association, 27% of American adults reported that most days they were so stressed they could not function ("Stress in America 2022: Concerned for the Future, Beset by Inflation."). This number increases significantly to 62% for women between the ages of 18 and 34 and to 48% for women between the ages of 35 to 44 ("Stress in America 2022: Concerned for the Future, Beset by Inflation."). Interestingly, one area of human disease and suffering that lies largely unexplored along with its connection with stress is women's hormonal imbalance. It is estimated that up to 80% of women will experience hormonal imbalance at one point in their lifetime and many women struggle to maintain healthy hormonal profiles throughout their lives. Women's hormonal health in relation to chronic stress is in significant need of research, support and viable solutions as the data reflects that women are more stressed than their male counterparts and have more complex hormonal landscapes that are impacted by chronic stress. In this paper, I will endeavor to contribute to the lack of support for women who are experiencing hormonal imbalance as a result of chronic stress. I will explain and synthesize some of the literature regarding bio-markers for chronic stress. Then, I will explain how chronic and acute stress has been shown to impact women's hormonal health. Additionally, I will demonstrate how stress impacts women with unique hormonal profiles. Finally, I will demonstrate that yoga (and by extension yoga therapy) has been proven to be a useful tool in managing chronic stress, and thus, can be useful in managing hormonal imbalances brought about by chronic stress.

What is Chronic Stress?

If you ask a researcher what chronic stress is, or which biomarkers within the body indicate chronic stress you may get a long-winded response that varies from person to person. My intention here is to define chronic stress for the purpose of our discussion regarding its impact on hormonal health and how yoga (and by extension yoga therapy) can be an effective tool in managing chronic stress.

The first key to understanding chronic stress is understanding how it is different from acute stress. According to a systematic review published in the International Journal of Health Sciences:

> *"Acute stress refers to a short-term and adaptive state. In contrast, chronic stress is a long-lasting condition known to be related to maladaptive response, implying harmful effects on bodily mechanisms. Persistent or prolonged stress results in the secretion of certain hormones or chemicals from the body, which indicates the body's constant stressful condition and affects the vital organs such as the brain, heart, or liver, in various aspects that might not favor the subject's health."* (Noushad).

Acute stress is often caused by clear events such as coming across a bear while on a hike or almost getting in a car accident. These stressful situations and their resolutions are what our nervous system evolved to cope with. Chronic stress occurs when a stressful situation begins and never finds a resolution. There are many triggers for chronic stress in our modern world such as financial stress, career stress and existential stress to name a few.

The stress response is governed by two primary mechanisms within the body. The Hypothalamic-pituitary-adrenal axis (HPA) and the sympathetic-adrenergic-medullary axis (SAM). According to a systematic review published in the International Journal of Health Sciences, the "HPA axis has a slow response toward a stressor whereas the SAM axis activates instantaneously and shows a very adaptive response to a stressor" (Noushad). Both responses work in concert to prepare the body for a survival-oriented response to a stressor and are generally aligned to increase the function of movement-based action and decrease extraneous functions of the body (more on this later). Both axes also utilize hormones, neurotransmitters and the nervous system to enact whatever survival response is deemed most appropriate.

Upon recognition of a stressor, the hypothalamus will begin to secrete corticotropin-releasing factor (CRF). In response the pituitary gland will then begin to secrete adrenocorticotropin (ACTH). The SAM axis will begin the production of epinephrine, norepinephrine and acetylcholine. In response to the ACTH produced within the HPA axis, the adrenal axis will begin to produce cortisol and other glucocorticoids. According to the aforementioned review, these catecholamines (epinephrine and norepinephrine) and glucocorticoids lead to "increased cardiac output, skeletal muscle blood flow, sodium retention, reduced intestinal motility, cutaneous vasoconstriction, increased glucose, bronchiolar dilatation and behavioral activation" in an immediate response to the stressor (Noushad). Plasma levels of CRF, ACTH, glucocorticoids and catecholamines can increase two to fivefold in humans in response to a stressor (Noushad). Increased blood plasma levels of these hormones along with increased glucose, triglycerides, prolactin, hemoglobin A1c, cholesterol, C-reactive protein, dehydroepiandrosterone (DHEA) sulfate, and interleukin -6 and 8 can all act as biomarkers for

chronic stress (Noushad). Once the stressor has been eliminated, complex feedback loops should help to downregulate the production of these hormones and neurotransmitters back to baseline and restore homeostasis. The individual's unique response to stress will determine how each of these biomarkers are expressed, but elevation above baseline during a non-stressful period is a good indicator of chronic stress and dysregulation within the body's systems.

The pursuit of homeostasis within the body can be documented across many systems. The nervous system along with the HPA and SAM axis are constantly working to restore balance following an incident that might tip the scales too far one way or the other. This attempt to restore balance is called allostasis. According to a paper published by the Laboratory of Psychoneuroendocrinology of the Centre for Studies on Human Stress at the University of Montreal, "Allostatic load represents the 'wear and tear' the body experiences when repeated allostatic responses are activated during stressful situations" (Juster). Allostatic load is taxing on the body in the long term as "normal homeostatic functioning is shifted towards abnormal ranges via the prolonged secretion of stress hormones and the subsequent maladaptations this strain exerts on interdependent systems" (Juster). The above-mentioned bio-markers can be indicators of allostatic load. This lack of homeostasis can lead to challenges like elevated levels of fasting glucose, wear and tear on the body's blood vessels, increased inflammation, chronic pain and general dysregulation of many of the body's systems. The body's hormonal regulation is also impacted significantly by allostatic load.

How does stress affect hormones?

The female body's hormonal systems and fluctuations are complex and unique to each woman. However, scientists and medical professionals agree that there are four hormones that play a key role in healthy reproductive cycles in women. Those four hormones are follicle-stimulating hormone (FSH), luteinizing hormone (LH), progesterone and estrogen. Any impact on the natural cycles of these hormones can lead to hormonal imbalance. Other hormones of note for our discussion here are gonadotropins and gonadal steroid hormones which are secreted by the hypothalamus and cause the production of hormones from the ovaries in women. Gonadotropin-releasing hormone (GnRH) is released in pulsating patterns that facilitate the production of LH and FSH in women.

There are many interesting effects of stress on hormone production in the body of a menstruating woman. In one study titled "Stress-induced Increases in Progesterone and Cortisol in Naturally Cycling Women" Dr. Alexandra Ycaza Herrera of the University of Southern California Davis School of Gerontology explained that "As the magnitude of a stressor increases, adrenal output of cortisol should also increase, and this increase in general adrenal output may also result in greater progesterone output" (Ycaza). Another study published in the Indian Journal of Endocrinology and Metabolism explains that during stress there is a suppression of GnRH which is most likely due to increased CRH being released during a stress response

(Ranabir). In a literature review titled “Female Infertility as a Result of Stress-related Hormonal Changes” published in the Journal of Gynecological and Reproductive Endocrinology and Metabolism, the author explains that “CRH may directly inhibit GnRH secretion and stimulate beta-endorphin production in the case of stress-related amenorrhea ... and diminishes the release of ovarian hormones” (Lewinski). The paper goes on to explain that changes in the autonomic nervous system brought on by stress and inhibited GnRH production can lead to a healthy ovary becoming a polycystic ovary and can also result in anovulation, ovarian vasoconstriction and a reduction of ovarian estrogen secretion (Lewinski).

The impact of stress on the lived experience of women, their menstrual cycles and their reproductive health is clear. A quote from the previously cited review “Female Infertility as a Result of Stress-related Hormonal Changes” explains succinctly:

> *“Elevated levels of glucocorticoids following the activation of the HPA favor energy mobilization, cardiac output and sharpened cognition overgrowth, cellular immunity, and reproduction. When circulating levels of glucocorticoids exceed levels essential to promote fertility, survival occurs at the expense of reproduction.”* (Lewinski).

The overall result of suppression of LH, GnRH, estradiol and progesterone is varying degrees of diseased hormone cycles in otherwise healthy women and can result in extreme cases in infertility. There is evidence to show that stress can lead to oligomenorrhea, amenorrhea, and premenstrual syndrome (Lewinski). Stress has also been shown to inhibit natural outcomes of female hormone patterns and reproductive cycles such as ovarian steroidogenesis, ovulation, endometrial development, follicular maturation and implantation of a fertilized egg. The World Health Organization attributes the leading cause of global infertility to ovulatory disorders (Vigil). Chronic stress is a possible causal factor for both functional hypothalamic amenorrhea and dysfunction of the HPO axis, which constitutes 85% of ovulatory disorders (Vigil).

A few studies that would warrant attention in our review of the literature studied the effect of stress on menstrual symptoms, premenstrual systems and disordered menstruation in otherwise healthy women. These studies clearly elucidate the connection between high reported levels of stress and adverse hormonal outcomes. The first study of note was conducted with 738 female college students from the age of 18-25 at Immam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (Rafique). The students were asked to anonymously complete menstrual problem identification and perceived stress scale questionnaires. After evaluating the results the study found that “Students with high perceived stress had 4 times, 2 times, and 2.8 times increased odds ratio for experiencing amenorrhea, dysmenorrhea, and premenstrual syndrome” (Rafique). A second study published in the Journal of Occupational and Environmental Medicine in 2004 gathered data from a population-based cohort of 338 healthy, newly married, nulliparous Chinese women (Wang). The study’s goal was to determine how perceived stress in one

menstrual cycle impacted the incidence of dysmenorrhoea in the following cycle (Wang). The study found that the risk of dysmenorrhoea was more than double for women with high stress as compared to those with low stress (Wang). Finally, in a study conducted by several prominent New England universities, 259 healthy women between 18 and 44 years old were studied for two menstrual cycles to observe how stress impacted ovulation (Schliep). The study found that women with higher levels of stress had lower levels of estrogen, LH, and lower luteal progesterone (Schliep). The women with higher levels of stress also had higher levels of FSH and high odds of anovulation (Schliep). According to the study, "For each unit increase in daily stress level, women had 70% higher odds of an anovulatory episode" (Schliep).

How does stress affect women with unique hormonal states?

Stress also affects hormonal states in women who lie outside the "normal" hormonal cycles described previously. There are many unique hormonal states that women experience but exploring the impact of stress on all of them is beyond the scope of this paper. Instead, I will touch briefly on how stress impacts women during pregnancy, in and around menopause and women who experience PCOS.

Pregnancy marks a change in the regular cycles of progesterone, estrogen, FSH and LH. During pregnancy reproductive hormones aid the complex process of providing nutrients, space and time for healthy fetal development. We can tell that hormones are dysregulated by the effect they have on fetal development, the timeline of gestation and symptoms during pregnancy. There is a relatively rich body of work relating to the impact of stress on fetal development and discomfort during pregnancy. According to a paper published in the Royal Society of Medicine Journals, even prenatal stress levels can affect pregnancy outcomes. The paper explains that "prenatal stress increases the risk of adverse pregnancy outcomes by disrupting adaptations in the maternal immune, endocrine and nervous systems that support healthy pregnancy" (Coussons-Read). During pregnancy, stress can impact fetal development, can contribute to preterm labor and can increase the risk of gestational diabetes and preeclampsia. According to a study out of the University of California Los Angeles (UCLA), stress can also lead to lower birth weights for newborns (Wolpert). Stress can also worsen the discomforts of pregnancy like nausea, challenges sleeping and body aches.

Stress can also affect women at the other end of their reproductive lifespans. Women going into menopause experience radical changes to their natural hormonal cycle. Stress can often increase the discomforts of menopause similarly to how stress can worsen discomfort for pregnant women or the symptoms of menstruation in normally cycling women. Additionally, stress can impact and sometimes even alter the process of perimenopause and menopause. A study conducted between 2010 and 2012 in Korea during a national health survey of 1,941 women between the ages of 40 and 70 years old discovered that women with higher chronic

stress levels had a lower age at natural menopause than those who did not report high levels of stress (Choi). This finding is in alignment with other literature in its conclusion that stress levels can impact the natural course of menopause.

The last unique hormonal state in women that I'll briefly explore in its relationship to chronic stress is PCOS. According to a paper written by Mary P McGowan of the National Lipid Association Foundation Board and the American Heart Association, PCOS "is the most common endocrinopathy among women of reproductive age, impacting 5-10% of premenopausal American women" (McGowan). PCOS is a unique disease because it is directly related to female reproductive hormones and can be very clearly impacted by stress. In a study conducted in India with 100 PCOS patients and 60 age-matched controls, researchers found that "increased salivary cortisol level and α-amylase activity were seen in the PCOS population as compared to age-matched controls suggesting [a] sustained stress scenario in their system" (Basu). Another study conducted in India between 2019 and 2021 with 100 PCOS patients and 150 healthy controls measured serum levels of DHEA and cortisol (Benjamin). Researchers found that stress hormone levels were significantly higher for PCOS patients and concluded that "interventions to reduce stress among these women can considerably help to reduce the severity of existing symptoms as well as onset of dicey complications" (Benjamin).

How can yoga be a successful intervention for managing chronic stress?

The suggestion above from researchers in India leads us to the culmination of this paper. There is substantial anecdotal evidence that yoga can reduce stress and the impact of stress on the body's systems. Many doctors, medical organizations and health journalists suggest yoga as an effective tool for managing and reducing stress. There is also relatively robust research showing that yoga can impact the biomarkers of chronic stress. For the sake of this paper, I'll present four separate studies that demonstrate the impact of various forms of yoga on stress. It's important to note that each study uses a different mix of yogic tools and not all are movement-based (asana) practices. However, most are tools that could be utilized by a yoga therapist.

The first study that warrants attention was conducted in Germany. In this study, 24 women with a mean age of 37.9 who all reported themselves to be "emotionally distressed" signed up for three months of Iyengar yoga (Michalsen). The control group consisted of 8 women and 16 of the women practiced two 90-minute Iyengar yoga classes per week for three months (Michalsen). Several different stress assessments were administered before the 3-months and after the three months (Michalsen). According to the study, the women who did yoga experienced "significant improvements in perceived stress,.. anxiety, well-being, vigor, fatigue and depression" (Michalsen). A second study utilized a waiting list as the control group and was conducted in Iran using larger experimental groups. In this study, 34 women participated in two 90-minute yoga classes a week while 31 women were placed on a waitlist (Javnbakht).

Participants were assigned randomly and evaluated using a personal evaluation questionnaire both before and after a two-month period (Javnbakht). When compared to the control group, the women who participated in the twice weekly yoga sessions over the period of two months reported significantly reduced levels of anxiety (Javnbakht).

The final two studies of note used more unconventional options for their yoga tools. A study conducted in Germany introduced 102 adults with elevated stress levels and symptoms of chronic stress to various forms of yoga. The adults were randomly assigned to "integrative yoga classes which combined physical exercises, mindfulness training, and ethical/philosophical aspects of traditional yoga [or] Iyengar yoga classes which focused on physical exercises or to mindfulness training without any physical exercises" (Fischer). Each group attended one 90-minute class for twelve weeks and individuals were reassessed 12 weeks following the classes (Fischer). All three forms of yoga showed significant improvement in stress and anxiety levels, with a marginally increased reduction of anxiety over the other two modalities from the group participating in mindfulness-only training (Fischer). The final study of note was conducted at UCLA and included 45 family dementia caregivers. The caregivers were randomized into two groups. One would practice Kirtan Kriya every day at the same time for eight weeks (Wheeler). The other group "was asked to relax in a quiet place with their eyes closed while listening to instrumental music on a relaxation CD" for 12 minutes a day over the course of eight weeks (Wheeler). The goal of the study was to determine if meditation would affect the activity of inflammatory and antiviral proteins. (Wheeler). The researchers found at the end of the study that there was a reduced activity of proteins related to inflammation within the stress response for participants who took part in the yogic meditation (Wheeler).

These studies are by no means the most well-funded or complex of available studies, but taken as a whole group they demonstrate that yoga can be a meaningful tool for reducing stress, anxiety and the side effects of stress. The aforementioned studies show that people from various backgrounds, ages and preexisting knowledge of yoga can benefit from various forms of yoga. Leading researchers in Melbourne Australia concluded, after conducting an in-depth review of 42 other studies regarding yoga and stress management that;

"Interventions that included yoga asanas were associated with reduced evening cortisol, waking cortisol, ambulatory systolic blood pressure, resting heart rate, high-frequency heart rate variability, fasting blood glucose, cholesterol and low-density lipoprotein, compared to active control…Practices that include yoga asanas appear to be associated with improved regulation of the sympathetic nervous system and hypothalamic-pituitary-adrenal system in various populations" (Pascoe).

This conclusion is in alignment with common knowledge, with what is generally accepted by the medical profession and the findings of previously presented studies. Yoga is an effective form of stress management and can impact the body's stress response mechanisms.

Conclusion

In this paper we have explored the mechanisms of the stress response, investigated how stress impacts hormones in naturally cycling women, learned how stress can affect women in unique hormonal states and found that yoga is a data-supported tool for stress management. If yoga can reduce stress the logical understanding would be that yoga may also be used as a tool to reduce stress-induced hormonal imbalances. Additionally, if general yoga classes, Iyengar classes and even something as simple as 12 minutes of Kirtan Kriya can be seen to reduce the impact of stress on the body and mind, it stands to reason that a biomedically informed therapeutic yoga approach would be even more impactful. If we can surmise that yoga will reduce stress-induced hormonal imbalances, yoga therapy (a more thorough, personalized and robust application of yoga) should be even more effective. Yoga therapy is unique in that it is widely adaptable and personalized so that a woman in any degree of hormonal imbalance and any stage of unique hormonal cycling should be well served by one-on-one sessions. A healthy therapeutic relationship, innate in yoga therapy, can also contribute to the stress-reducing benefits of yoga. I would conclude that a woman experiencing hormonal imbalance brought about by chronic stress would likely find reduced stress and possibly restore hormonal equilibrium with the assistance of a competent yoga therapist.

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