The OAT Axis

This paper is based simply on books, websites, and podcasts I have gone through. I have zero expertise in dealing with hormonal issues and this is merely an attempt to offer you a little more background on the glands so that you can talk to your healthcare professionals about anything that may be of concern to you. This paper should be not used to diagnose or treat your condition without input from healthcare professionals who can look at your personal issues.

If you have a 3-legged stool it can be rock solid stable. What happens if one leg is weak, cracked, or missing altogether?

Pretty obvious, right?

There is a 3-legged axis within women's bodies abbreviated OAT – ovarian, adrenal, thyroid. As much as 3-legged stools are dependent on each leg so are these hormones. They influence and support each other. If one or two are weak the others will falter and the body's stability will be impacted. If all 3 legs are weak, well, that leads to another very obvious end point as to extreme instability.

When under too much stress the hypothalamus sends a signal to the pituitary which then signals the adrenal glands to release hormones like cortisol. Medical personnel talk about the HPA (hypothalamus-pituitary-adrenal, HPA,) axis and it becoming disordered if it is over used. This is basically the same as what some people call 'adrenal fatigue' entails. In this paper adrenal fatigue will be used as a less technical/medical phrase.

One example of how they all affect each other involves a number of steps. Cortisol has a feedback loop to the hypothalamus and pituitary and its presence in the blood signals these two to slow down so as to not trigger more stress hormones. These glands also regulate the thyroid so that slows down. Stress hormones act on the enzymes that convert inactive thyroid (T4) into the active form T3. The T3 that is available to act for us ('free T3') acts as a gas pedal. When stress is high the body needs to conserve energy and a 'brake pedal' is applied to the thyroid system through what is called 'reverse T3.' This slows down metabolic processes and causes hypothyroid symptoms. High levels of cortisol over longer periods of time cause excess estrogen to accumulate which increases levels of thyroid-binding globulin (TBG) which does what it sounds like, binding up thyroid hormone so it cannot be used. Complicated, but it hopefully illustrates that 'everything affects everything' in the human body.

If the above process is brief your body returns to normal function after the acute stress event is over. If you are under chronic stress, which many people are these days, merely treating one leg of the stool such as 'low thyroid function' and not looking at the other two legs misses a lot and is less than effective.

Explaining the OAT axis

The ovaries make estrogen and progesterone. Estrogen has many roles such as creating curves, strong bones, cardiovascular benefits, lubrication, and a good memory.

Too much estrogen ('estrogen dominance') can result from too much stress. Xenoestrogens, chemicals in the environment that look like estrogen and can fit into those receptor sites, are another possible cause of estrogen dominance. Effects of them can include

- heavy periods, clots
- long periods
- painful periods, PMS, PMDD
- water retention
- migraines
- acne
- fibroids
- fibrocystic breasts
- tender breasts
- hair loss
- low libido
- ovarian cysts
- endometriosis
- anemia
- breast, uterine and ovarian cancer risks
- mood swings

Too little estrogen can be involved with

- amenorrhea (missing periods)
- premature ovarian insufficiency
- PCOS (polycystic ovarian syndrome)
- perimenopause/menopause
- sleep issues
- mood swings
- dry skin
- menstrual migraines
- UTIs
- infertility
- cardiovascular disease
- poor concentration, memory
- bone loss

Progesterone is a hormone that like any other hormone has widespread effects on the human body. Beyond affecting fertility and pregnancy which it is probably best well-known for, it also impacts psychological well-being and various physical health functions.

https://www.shecares.com/hormones/progesterone/role-effects

These functions include preparing the breasts to produce milk as well as preventing the development of cancer by controlling the effects of high estrogen. It also inhibits ovulation during pregnancy. For women who are not pregnant it helps shed the endometrial lining and prevent the development of ovarian cancer. It also makes the endometrium more receptive for the implantation of an embryo. And once pregnant it inhibits contractions to help maintain the pregnancy. It can also reduce the likelihood of endometrial cancer for postmenopausal women on estrogen therapy.

In the brain it has a calming effect and may improve memory. It can also aid the brain in repairing itself if it has been injured. Bone density is increased with the help of progesterone which reduces the risk of their being fractured. It also has the ability to reduce inflammation and support the immune system. Impacts on the kidneys include aiding with sodium excretion, and stabilizing the levels of copper and zinc which promotes liver health.

It is produced in the ovaries, adrenal glands, and placenta. After ovulation progesterone is released in that it helps prepare the body for pregnancy. If the egg is not fertilized progesterone levels drop and the beginning of a period occurs. If pregnancy does occur progesterone continues to be produced and stimulate blood vessels to supply the endometrium and also to provide nutrition to the developing embryo. Once the placenta is formed it becomes the primary producer of progesterone. Progesterone levels are said to drop by half by age 40.

High progesterone can lead to

- vaginal dryness, itchiness, swelling
- scantier and longer periods along with spotting
- drowsiness
- headaches
- migraines
- depression
- anxiety and mood swings
- change in appetite
- joint pain, muscle aches
- heart attack like symptoms

Low progesterone can

- impact menstruation and cause PMS
- reducing fertility as to making it less than ideal for egg fertilization or for one to develop
- missed periods
- miscarriage
- tender and cystic breasts
- ovarian cysts including the development of PCOS
- frequent and heavy periods
- increased risk of endometrial cancer
- bone loss
- PMDD including depression, mood swings, anger and anxiety
- perimenopause may occur 2-10 years before menopause

After menopause low progesterone can lead to UTIs, fibrocystic breasts, fibroids, low magnesium levels, endometrial or breast or uterine cancer, cardiovascular disease, thyroid problems, allergies, asthma, or arthritis. The good news is that it can also produce a calming effect as to reducing anxiety, enhance memory, help maintain bone mass, lower blood pressure and prevent breast, endometrial and ovarian cancers.

The adrenals are on top of the kidneys and are involved with stress response and help regulate blood sugar. They make adrenaline and cortisol, along with estrogen, pregnenolone, progesterone, and DHEA. All of these are made from cholesterol and so women on low fat diets tend to have amenorrhea and other hormonal problems. Too much stress in a woman's life – along with too much cortisol can lead to inflammation, lower immunity and fertility problems which can be part of adrenal fatigue.

There are four types of stressors that can impact us and our adrenals, being: inflammatory, circadian, nutritional, and psychological.

Inflammatory

Inflammation exists in different forms. This can include the obvious such as twisting an ankle and it becoming inflamed and sore. It can be not so visible but apparent, such as having irritable bowel syndrome (IBS), or sore joints that might result from eating too much sugary food. It can be unknown to us such as having SIBO (small intestine bacterial overgrowth). But whatever form inflammation takes it can have adverse consequences on our health, and how our body responds to it such as through cortisol with its own side effects.

Circadian/sleep

Circadian rhythms can be thrown off by shift work, jet lag, irregular bedtime hours, sleep apnea, etc. Cortisol wakes us up in the morning and gradually decreases over the course of the day to allow us to fall asleep at night. When sleep patterns are distorted so is cortisol release and we may have trouble waking up, be fatigued during the day, and have trouble falling and/or staying asleep at night. We can have digestive issues that result such as sugar cravings, night hunger, and are more vulnerable to infections. And circadian problems have been tied to seasonal affective disorder ('winter blues') where lack of adequate sunshine during the day leaves us feeling more depressed. All of these can lead to adrenal fatigue.

Nutritional

Nutritional imbalance - what we do or do not eat can put our bodies under stress. We understand the purpose of eating as to refueling ourselves with needed nutrients and this in turn affects our adrenals. Without an adequate supply of the right nutrients the adrenals can struggle to keep up with hormone production.

But the food industry in this country has become increasingly motivated not by insuring good health but by high profits for themselves. Consequently, 'ultra-processed' food (stuff loaded with chemicals) have come to predominate and which have adverse consequences for our health. They can be inflammatory and also tend to have a lot of good nutrients stripped out of them leading to their 'junk food' status.

Even when eating seemingly good foods the question can be raised if they are doing all that is needed for optimal health. One reason for this arising is that various meds can impact our absorption of nutrients. One of the greatest offenders are acid-blocking drugs (e.g. Prilosec). By changing the pH of the stomach to a more alkaline state food is not digested as well and nutrients are not broken down and absorbed as needed. This impacts many nutrients such as vitamins, minerals, and proteins. A lack of digestive enzymes can also cause problems with absorbing food, and this can occur for a variety of reasons including simply getting older. Moreover, the gut microbiome requires a lot of fiber for them to stay healthy and keep us so as well on a symbiotic level. If you do not eat enough fiber the gut bacteria suffer and so does your overall health, such as with inflammatory processes (e.g. IBS). Without sufficient nutrients being obtained for the body's need - including the adrenals, the body starts breaking itself down to get them such as metabolizing muscle and this ratchets up stress to a higher level.

Beyond nutrient deficiencies that can arise there are also blood sugar imbalances. Common symptoms of blood sugar imbalances include fatigue, anxiety, hormonal imbalances, depression, insomnia, chronic pain, poor cognitive function/brain fog, and light headedness. Having too much sugar be it in foods like desserts (cookies, ice cream, etc.) or just from starchy veggies (e.g. French fries) can cause a surge in insulin release. In some people blood sugar can then drop too low, a hypoglycemic reaction. This is where blood sugar goes from 'too high' to 'too low' and a person then craves more sugar, and the cycle repeats. Over time insulin resistance results as to glucose not being able to get into tissues. The pancreas compensates by putting more insulin into the blood stream to try to normalize blood sugar levels. The adrenals are stressed through this cycling. They then release more cortisol and the liver gets the message to release yet more glucose. Excess cortisol also causes more inflammatory proteins that are associated with a greater immune response and autoimmune conditions result like Hashimoto's, celiac disease, PCOS, IBD (inflammatory bowel disease), rheumatoid arthritis, and lupus. Imbalances in the blood sugar have been said to 'add fuel to the fire' of auto immune diseases. Consequently, stabilizing blood sugar is important to protect the adrenals from excess stress and healing from autoimmune conditions. Another possible sign of blood sugar imbalance is awakening in the middle of the night such as around 2-3 AM with anxious thoughts and needing a snack to fall back asleep.

<u>Psychological Stressors</u>

Past and present psychological stress: there are innumerable sources of stress in our lives. It can be from family, marriage, friends, work, school, news of what is happening around us and in the world, financial, our health issues, etc. There are also internal sources of stress we can create for ourselves for various reasons. A simple example is 'seeing ourselves as half empty rather than half full' perhaps from messages we received as kids from our parents or friends. 'I'm going to fail!' is something that might be thought to ourselves every time we are faced with some challenge, be it speaking in front of a classroom of classmates, or applying for a job, or doing our duties at work. Whether such failure occurs or not, simply having such persistent fears and doubts creates a chronic level of stress such as a pounding heart, or sweaty palms, or worrying a lot which revs up our bodies and minds with fears. Such thoughts and feelings might be viewed in a positive light, such as striving for perfectionism which on some level is good. But the underlying result, of not being satisfied with ourselves, of pushing ourselves so hard and never achieving such perfection, ends up causing us stress.

Past trauma such as from being assaulted or being in combat can cause a sustained 'fight or flight' response for us. Until such past trauma is healed or resolved, our bodies will likely have adrenal dysfunction persisting. There are ways to recover from such past traumas and to heal such as from counseling, what is called neurofeedback, or relaxation techniques (e.g. meditation, yoga).

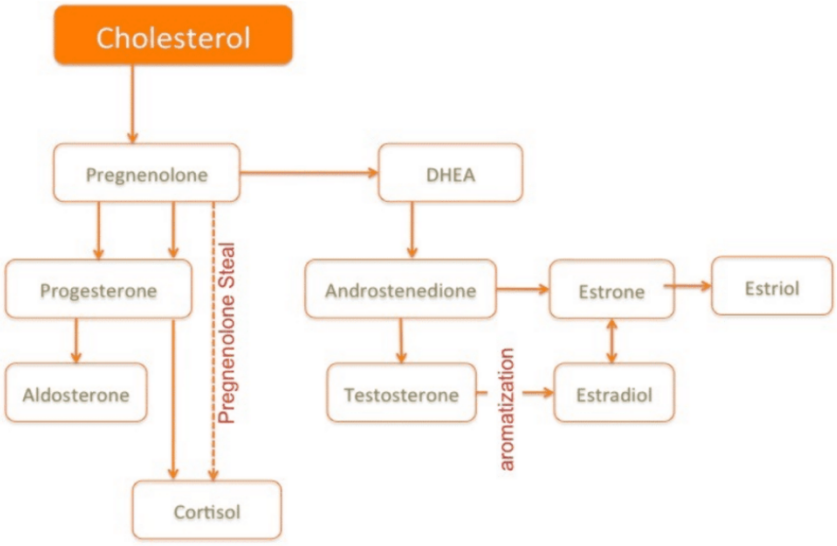
Healing past sources of psychological stress might be the hardest part of fixing the adrenals but it is very important. What are called 'adverse childhood experiences' (ACEs, for which there is a short quiz illuminating which you may have such as from different types of abuse and neglect) have been linked to adult chronic conditions like auto immune diseases, heart disease, diabetes, substance abuse, depression, and most notably risk of suicide. ACEs cause chronic activation of

the stress response – the HPA system which can over time cause problems with the immune, nervous and endocrine systems.

The thyroid has multiple functions including

- metabolism
- heart function
- muscle function
- digestion
- bone maintenance
- sexual function. Roughly 60% of men and 22-46% of women who are hypothyroid experience sexual dysfunction according to some research.

<u>The effects of these hormones out of balance</u>
High cortisol/stress levels can lead to



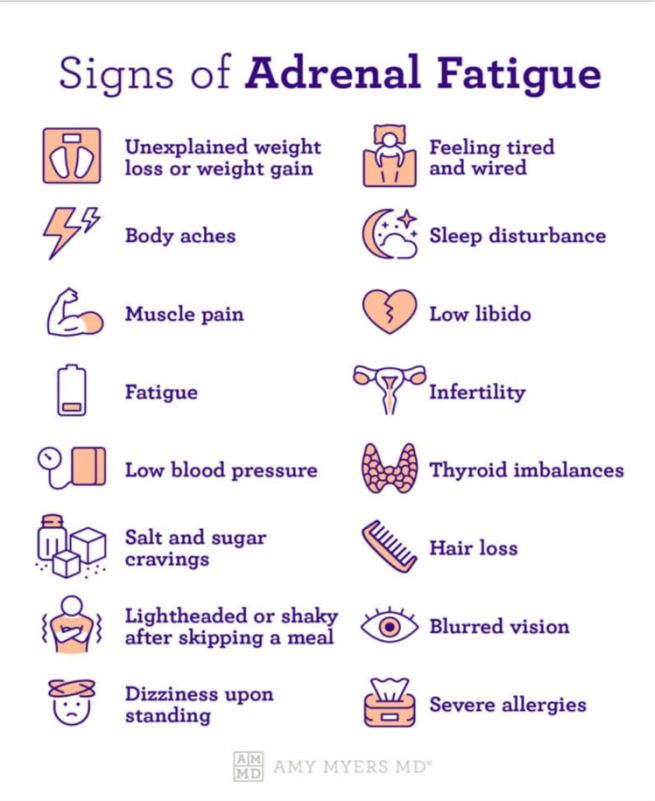
www.hormonesbalance.com/articles/how-adrenal-fatigue-causes-weight-gain-fluid-retention-and-exhaustion/ 1/31/2017

- engaging in what some call the 'pregnenolone steal' which has blood sugar imbalances being the most common factor for this occurring. Pregnenolone is a building block from which other hormones are made including estrogen, progesterone, and cortisol. When stress is high the body's emphasis is on fight or flight and not on 'making babies.' So pregnenolone, which comes in limited amounts, is shifted into making more cortisol and not the sex hormones. If such stealing occurs over a longer period of time hormonal imbalances can result such as PMS, infertility, PCOS, and male menopause. (High cortisol can also lower the production of thyroid and growth hormones, as well as melatonin.)
- belly fat
- restlessness, especially at night
- trouble staying focused or feeling fatigued in the morning

- lower thyroid production along with inhibiting the conversion of T4 to T3, the latter being the active form of thyroid hormone we need. High cortisol also increases antibody production which can then damage the thyroid on an autoimmune basis.

Low cortisol can result from being in a state of high stress for too long and burning out the adrenals in the process. Cortisol can be measured such as through a saliva test where you spit into four little test tubes over the course of a day (morning, noon, dinner, bedtime hour) and you can see the results as a curve as to how it rises and falls over the day.

Symptoms of adrenal fatigue can include:



- aches and pains. Cortisol is used to help synthesize protein, carbs and fats and turning them into cellular energy so they can be used by muscles. Low cortisol=low energy leading to soreness and joint pain. Cortisol is also an anti-inflammatory and again, if there is not enough of the hormone aches and pains can persist for a longer period of time.
- fatigue. Adrenal insufficiency can leads to weakness, sleepiness, and general malaise. One may wake up feeling tired and not rested even though they may have slept for 8-12 hours.
- cravings for salty food. One of the hormones made by the adrenals is called aldosterone which regulates electrolytes like sodium and potassium and in the process your blood pressure. When there is adrenal fatigue the kidneys may produce less aldosterone which impacts the regulation of such electrolytes. Sodium is lost in the urine, potassium is held on to and excessive fluid loss results leading to dehydration and salt cravings.

- overuse of stimulants like sugar and caffeine. Caffeine can lead to an increase in cortisol levels, meaning, if your body is not making it on its own to a sufficient degree, you are trying to force the issue. Sugar also can spike cortisol.
- feeling light headed or dizzy upon going to an upright position. Cortisol and aldosterone are involved in blood pressure regulation and if they are taking a hit from adrenal fatigue then they do not kick in quickly enough to increase b/p to the level needed for you to be standing, and inadequate blood gets to your brain resulting in such symptoms.
- feeling 'wired but tired.' People may be tired all day, turning to caffeine to make it through, but then lay in bed at night unable to sleep. Cortisol levels tend to be elevated

especially at night which impairs sleep; cortisol and melatonin ('the sleep hormone') have an inverse relationship to each other.

- reduced fertility. Large amounts of adrenaline being released is a signal to the body that conditions are not good for conceiving a child. Adrenaline inhibits the utilization of progesterone which can contribute to infertility. Higher cortisol can also suppress ovulation.

- low thyroid function. If the body is under high stress with elevated cortisol there is a need to slow it down and conserve energy for survival. This happens by making cells throughout the body less responsive to thyroid hormone. Cortisol also triggers what is called reverse T3 which is effectively a brake pedal that occupies thyroid receptors so that the thyroid hormone cannot bind there. If this occurs briefly it's not a problem. If it is chronic such hormone suppression turns into hypothyroidism. You may have normal thyroid hormone levels but that does not mean they are working on the receptor sites as needed.
- lower libido. Although the ovaries get all the attention for making sex hormones, the adrenals have a role too such as in making testosterone, DHEA, and estrogen.
- depression. There can be numerous factors causing this due to adrenal fatigue. One is that cortisol has an impact on the sleep/wake cycle. Impaired sleep patterns can trigger depression. Low blood pressure from insufficient cortisol can also lead to fatigue and depressive feelings. Cortisol impacts glucose levels and allocates where it goes between the brain, muscles and organs. Mess up this allocation and weakness, lower energy and mental fatigue may result. Cortisol also is involved with mediating inflammatory cytokines. Lower serotonin results with increased cytokine production and so this is another possible cause of depression with adrenal fatigue.
- hair loss. This may occur especially when there is an autoimmune attack on the adrenals. The adrenals release male hormones that influence the growth of hair. With adrenal insufficiency there is an insufficient amount of such hormone released and hair loss results along with dryness to the skin. Androgen shortage can also delay puberty in teens.
- weight loss can occur from insufficient cortisol due to the appetite not being stimulated. Half of people with autoimmune adrenal problems also have complications like nausea, vomiting and diarrhea which takes a toll on weight too.
- weight gain can occur due to weak adrenals causing the thyroid to slow leading to a lower metabolism. Eat the same number of calories and burn fewer, what happens?
- blurred vision can result due to a number of possible factors. These include
    - hyperventilation. There are breathing techniques that can help.
    - hypoglycemia (low blood sugar)
    - tired ciliary muscles which are involved with focusing the eye. When they are tired they can cause blurry vision, being slow to focus, or double vision.
- allergies. Most allergies cause a release of histamine and other substances that produce inflammation. Cortisol is anti-inflammatory and so when there is more histamine being released the adrenals have to work harder to manage the resulting inflammation. With

adrenal fatigue the histamine can run amok and the allergic reaction becomes more severe and the adrenals weaken even more and a downward spiral can result.

- sensitivity to bright light. The pupils staying more dilated when in bright light can be due to high stress making the sympathetic nervous system more dominant which leads to such dilation.

Thyroid

The thyroid is located in the neck and is connected to the ovaries and adrenals. It is involved with body temperature, mood, metabolism, and energy levels. It also ties into a woman's monthly cycle and immune system. Many women have autoimmune hypothyroidism (Hashimoto's). It has been said that 90% of people who are hypothyroid have some adrenal dysfunction. Thyroid function can be impacted by other factors such as

- Iodine is of critical importance to thyroid function, and is also used by every other cell in the body. Selenium and iodine are synergists and work together. Iodine can be found in seafood including sea vegetables (e.g. nori). The best source of selenium is Brazil nuts. How much they contain varies widely depending on the soil in which they are grown. Amounts can range from something like 5-150 mcg/nut, and an average is said to be around 90 mcg. Too much selenium is dangerous so there is a need to be careful.
- how much chlorine gets into the body (such as from chlorinated city water), given that it competes with iodine
- fluoride (found in many toothpastes, mouthwash, many drugs, and foods), another competitor to iodine
- bromine (in many breads, along with cleaners), again, a competitor to iodine
- nutrient deficiencies, including carnitine, an amino acid. Deficiencies in it have been associated with both hypo- and hyperthyroidism.
- Potassium is important in that it sensitizes cells to thyroid hormone. People who are hyperthyroid often have too much potassium and not enough calcium.
- heavy metals (e.g. lead, cadmium, mercury) can be checked through a urine test, or preferably a hair analysis (which captures how much of such metals may have been passing through your body over a month or two, and not just the last day or so that a urine test captures. These metals can accumulate in the brain and liver and elsewhere, but also into thyroid receptor sites.
- gut issues, such as leaky gut which can cause problems with poor nutrient absorption. Iron and selenium are two nutrients needed for good thyroid health, including converting T4 into T3. Gluten is one of the potential causes of leaky gut because of a chemical called zonulin that is triggered and released. Zonulin leads to a leaky gut.
- progesterone. Use of birth control/hormone pills shuts down progesterone - a hormone that boosts the thyroid. Lack of progesterone can lead to an increase in anxiety. Birth control pills also deplete various nutrients such as magnesium, selenium, zinc, and vitamin C.

Hypothyroidism symptoms can include

- weight gain
- constipation
- cold intolerance (increased sensitivity to cold)
- cold hands and feet
- menstrual irregularities, heavier periods than normal
- dry skin
- brittle nails
- fatigue
- anxiety and/or depression
- slower pulse
- thinning hair, hair loss
- weakness and achiness in the joints and muscles
- trouble concentrating and remembering
- puffy face

Hyperthyroidism symptoms can include

- sensitivity to heat
- hyperactivity
- hand tremors
- rapid and inexplicable weight loss
- loose stools
- excessive sweat
- hair loss
- rapid pulse
- heart palpitations, irregular heartbeat
- insomnia
- agitation
- anxiety
- menstrual irregularities
- eating excessively

An imbalance in the OAT axis can include symptoms such as

- finding it hard to fall or stay asleep
- having late, missing or irregular periods
- being tired all the time
- feeling cold especially in the hands and feet
- recurrent miscarriages especially in the first trimester
- digestive problems

Then there is something that looks like hypothyroidism but is not. It is called hypothalamic obesity disorder. And thyroid treatment may make the condition worse. The condition is unrelated to the thyroid and instead obviously involves the hypothalamus, the master gland in the brain. People with this disorder have hypothyroid symptoms but normal labs. They are unresponsive to thyroid treatment and can gain weight in the process. This disorder involves the gland becoming dysregulated as to sensing if the body has extra fat and what happens is it wrongly assumes the body is in a state of starvation. So the hypothalamus slows down the metabolism, increases appetite, lowers body temperature, reduces heat and energy production, and cause the body to store fat. This obviously leads to weight gain. The disorder can arise from severe trauma to the brain but other factors can cause it too, including

- repeated yo-yo dieting and calorie restricted dieting
- untreated hypothyroidism
- binge eating or eating disorders
- leptin resistance
- chronic stress
- constant and persistent lack of sleep

The most common symptoms of hypothalamic obesity disorder include (in decreasing frequency according to at least one study. Medpage Today, "'Thyroid' issues may really be hypothalamic" Kristina Fiore, 5/15/2014).

- weight gain
- mood disorders
- fatigue
- dizziness, lightheadedness, inability to exercise
- pain
- changes in sleep
- temperature dysregulation
- libido issues

The disorder can be diagnosed with four or more of the above symptoms, and three is suggestive, according to some. There are meds that are said to help with this disorder; talk to your doctor. A Mediterranean style diet may also be beneficial. Daily exercise to tolerance meaning doing it to your limit.

One obvious example of the OAT axis becoming impaired is during menopause. Female sex hormones obviously take a hit. Estrogen levels may affect thyroid receptors and vice versa. Thyroid problems like hypothyroidism and goiter are especially frequent in postmenopausal women.

There is research that has found that treating women with a thyroid disorder and severe menopause had improved symptoms after treating the thyroid. i.e. Treating the thyroid can improve menopausal symptoms. (Journal of Obstetrics and Gynecology, "Can thyroid

dysfunction explicate severe menopausal symptoms?" A. Badawy et al. July 2007). Conversely, thyroid disorders increase the risk of menopause complications such as osteoporosis. Hypothyroidism can also reduce bone density. Another impact of menopause and low thyroid is an increased risk of heart disorders. Treating thyroid problems in postmenopausal women is different than in younger females. Thyroid hormone can lead to cardiac arrhythmias and cause increased 'bone turnover.' Talk to your doctor about such concerns.

Symptom	Low Thyroid	High Thyroid	Perimenopause	Menopause
Menstruation changes	√	√	√	√
Low energy	√		√	√
Insomnia		√	√	
Weight gain	√		√	
Mood changes		√	√	
Depression	√			√
Temperature changes	√	√	√	√
Digestive issues	√	√	√	√

This chart captures some of the overlap between thyroid issues and being in the (peri)menopausal phase of life, making it more obvious why it is can be hard to sort out what issue is causing what symptom.

https://www.verywellhealth.com/thyroid-disease-menopause-link-3231797

Another example of the OAT axis impacting each other are the adrenals and the thyroid. They have similar symptoms such as fatigue, weakness, changes in weight, mood and menstrual cycle. Autoimmune disorders can affect both glands leading to autoimmune thyroid dysfunction along with adrenal insufficiency. e.g. One study in Norway found that 41% of people who had primary adrenal insufficiency also had hypothyroidism. (Journal of Clinical Endocrinology and Metabolism, "Clinical, immunological and genetic features of autoimmune primary adrenal insufficiency: observations from a Norwegian registry" Martina Erichsen at al, Dec. 2009.) Another study found that 5% of people with autoimmune thyroid dysfunction also had underlying primary adrenal insufficiency. (European Thyroid Journal, "Comorbid latent adrenal insufficiency with autoimmune thyroid disease) Toshihide Yamamoto, et al, June 2015).

What to do

Ways to lower estrogen include eating cruciferous veggies (e.g. broccoli, cauliflower, Brussels sprouts, bok choy) can help. Having bowel regularity also helps; fiber helps remove the hormone. Excess estrogen is excreted through the bowel and if a woman is constipated the estrogen is re-absorbed and raises her level of it which can lead to PMS, cramps, heavy periods, and tender breasts. There is also a greater risk for breast or uterine cancer in the future.

Avoid phthalates, a xenoestrogen meaning they behave like that hormone when they get into the body. They are seemingly everywhere. They make plastic flexible and so avoiding plastic overall (e.g. water bottles) is a good first step. They are also in a lot of cosmetics and personal care products especially those containing 'fragrance.' Some of the common abbreviations for these chemicals are:

- BBP
- DEP
- DIDP
- DINP
- DMP
- DEHP
- DNOP
- DBP

A study by Environmental Working Group (www.EWG.org) looked at 72 name-brand beauty products for the presence of phthalates and found almost three-fourths of them contained some including 9/14 deodorants, all 17 fragrances, 6/7 hair gels, 4/7 mousses, 14/18 hair sprays, and 2/9 hand and body lotions in concentrations ranging from trace amounts to nearly 3% of the product's formulation. None listed phthalates on the ingredient label. Loopholes in federal law allow the chemical to be put into many such products without testing, labeling, or monitoring of health effects. The EU has restricted 1,200 chemicals in such products since the 1970s vs. 11 removed from cosmetics in the U.S. since 1976.

They are also found in prescription and OTC meds, including very commonly proton pump inhibitors (e.g. Prilosec, Protonix) in which they are considered 'inactive' ingredients in them. They can be used to create long-term stability, and as plasticizers for plastic products and packaging. Other functions they can serve include regulating the release and delivery of the drug.

One phthalate is called DBP, and women of child-bearing age appear to receive the highest exposures so that fetuses can be exposed to it. The CDC found that DBP exposure for over 2 million women of this age may be 20 times greater than is average for the overall population. Plus, such exposure in this group of women was above the federal safety standard. Popular nail care products contain DBP such as polishes, topcoats and hardeners, and include brands like L'Oreal, Maybelline, Oil of Olay and others. An EWG study found 67% of nail polishes contain DBP.

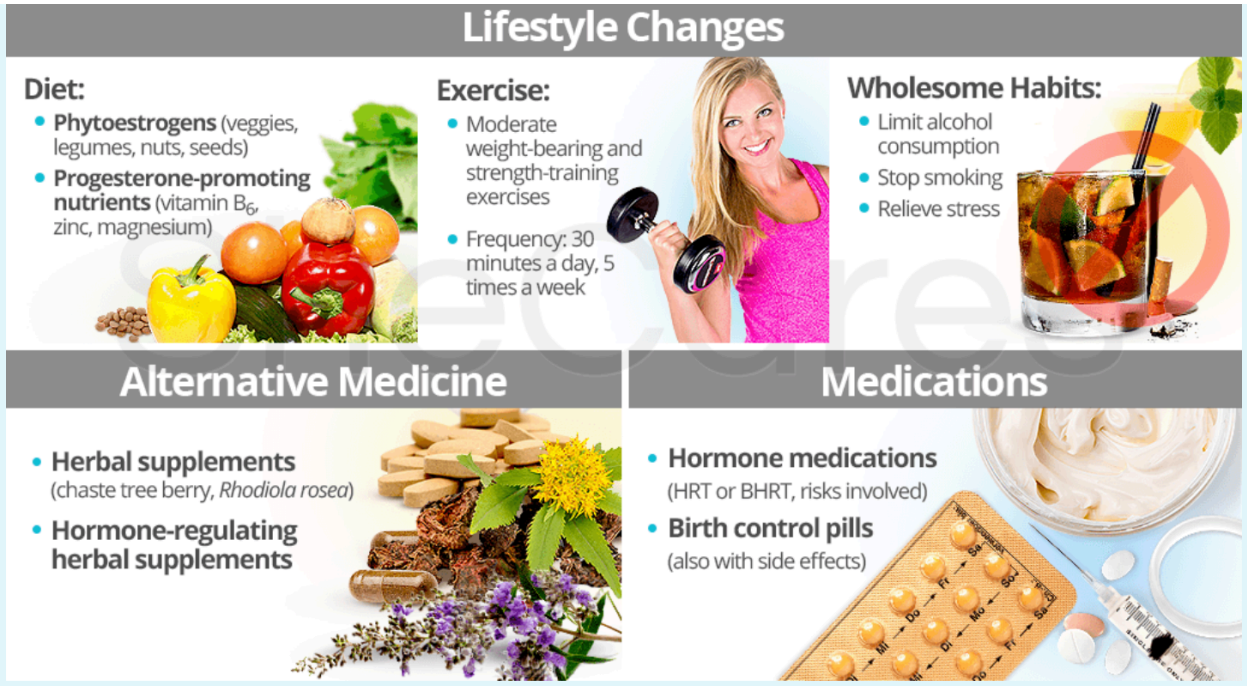
One phthalate in particular, DiNP was 39% higher in the urine who ate the most fast foods (at least 35% of their calories) compared to people who had not eaten any fast food recently. DEHP was about 24% higher. For more modest fast food consumption, less than 35% of their calories, the two chemicals were higher by about 25% (DEHP) and 15.5% (DiNP).

There was research done through the HNANES study of 2007-2008 looking at 1,346 adults who were 20 years and older, and 329 adolescents ages 12-19 (Environmental Health Perspectives, "Relationship between urinary phthalate and BPA concentrations and serum thyroid measures in U.S. adults and adolescents from the NHANES 2007-2008" John Meeker et al, 711/2011). The strongest inverse relationship was between DEHP (another phthalate with exposure to it primarily through diet) and total T4, free T4, T3, and thyroglobulin, and a positive relationship with TSH. Those with urine samples in the highest 20% of exposure to DEHP were associated with as much as a 10% decrease in certain thyroid hormones compared to those with urine samples at the lowest 20% of exposure.

EWG has compiled a list of beauty products that are phthalate free.

Ways to boost estrogen include soybeans and their products (e.g. tofu, miso) as to phytoestrogens. They mimic estrogen and there is research that a higher soy intake was linked to a lower risk of breast cancer death. Ground flax seeds and sesame seeds are other phytoestrogens. The B-vitamins are important for creating and activating estrogen in the body. One study found that higher levels of B-2 and B-6 were associated with a lower risk of breast cancer perhaps due to the impact of them on estrogen metabolism. Vitamin D also has a role in estrogen synthesis. Boron, a trace mineral, influences estrogen receptors to let the body more easily use estrogen.

Ways to increase progesterone include:



https://www.shecares.com/hormones/progesterone/increasing-levels

'Eat the rainbow' of plant foods like fruits and veggies can help by getting their phytoestrogens. Such foods include:

- apples
- cherries
- papaya
- peaches
- plums
- pomegranates
- strawberries
- tomatoes

- black eyed peas
- garbanzos
- lentils
- soybeans
- split peas

- almonds
- flaxseeds
- sesame seeds
- sunflower seeds
- barley
- brown rice
- oats
- wheat
- alfalfa
- carrots
- celery
- eggplant
- parsley
- sprouts
- yams

You can also attack the problem from the other direction, by lowering or inhibiting estrogen production by eating various foods. These include:

- broccoli
- corn
- figs
- grapes
- green beans
- melons
- pineapple

Avoiding inflammatory foods can increase progesterone by reducing inflammation that impedes ovulation. Such foods include sugar, wheat, hydrogenated oils (e.g. margarine), fried foods, processed foods, artificial sweeteners, and cow's milk.

Moderate intensity, weight-bearing, and strength-training exercises for at least 30 minutes/day 5 days/week can also increase progesterone levels.

Use of hormones to increase progesterone may be the highest risk method. There is bioidentical hormone replacement therapy (BHRT) that uses lab produced hormones that are derived from plants. They are identical to the hormones produced by your body vs. the traditional HRT that are synthetic, and can be made from other sources like Premarin – an abbreviation for where it came from – pregnant mare urine. Because they are chemically different how the body reacts to them can vary from those made by your system. Some of the more common BHRTs are for estrogen, progesterone, and testosterone. They can come in various forms such as pills, creams, patches, implanted pellets, gels, and IV injections. There is even sublingual progesterone that is dissolved under the tongue that may be more effective for brain symptoms including sleep disturbance that are associated with progesterone deficiency.

Ways to lower cortisol/stress/stop taxing the adrenals so much include

- getting good sleep. Sleep apnea, insomnia, or working night shifts are associated with higher cortisol levels. Sleep deprivation is the fastest way to cause adrenal fatigue and so getting good sleep is one of the most helpful tools to fix it. The primary factor that controls sleep and the circadian rhythm is light. Bright blue (as in the sky) light in the morning wakes us up. Having varying levels of light over the course of a day (e.g. sunrise, mid-day, sunset) tells our bodies that time is passing and what to do next such as making us more alert or setting the stage for falling asleep. Reddish-orange light (sunset colors) and darkness triggers melatonin to prepare us for falling asleep. Consequently, getting exposed to morning light helps get us going. Varying our light exposure over the course of a day – and not having the same level at home-office/school-and home again, helps our body understand the passage of time. Avoiding/reducing blue light exposure at night from electronic screens such as by wearing blue blocker glasses will prevent melatonin from being turned off and cortisol turned on. And 'sunsetting' the amount of light in our homes at night by dimming the lights we are exposed to in the last few hours before going to sleep can also help. Fixing other problems that impair sleep such as apnea or drinking too much caffeinated beverages that leave us too alert at our bedtime hours are also important.
- regular exercise can help with sleep and reduce stress, which lowers cortisol over time. However, doing intense exercise shortly before sleep, perhaps within 1-2 hours, raises cortisol and can interfere with falling asleep. More relaxing exercise in the evening before bedtime such as yoga will likely be okay to do.
- limiting stress and how you think about stress. Recognizing stress such as through your pulse and breathing pattern can help. Neurofeedback is a form of biofeedback where brain waves are monitored and anxiety can be picked up by a computer. Audio-visual

feedback is then given to make you aware of it and you can learn to relax better through such feedback. Research into this technique dates back several decades and it can be very helpful to many people.

- practice deep breathing exercises. This stimulates the parasympathetic nervous system which is the 'rest and digest' system that helps lower cortisol.
- enjoy yourself and laugh. Laughing promotes the release of endorphins that suppress cortisol. Engaging in fun hobbies and activities also promotes feelings of well-being and t this too may lower cortisol.
- having good relationships. Being in tense and unhealthy relationships with people in your personal and/or work lives can elevate stress and raise your cortisol.
- caring for a pet. There is published research on the value of pet ownership as to reducing stress and cortisol
- eating a healthy diet, to 'rest and digest' and get the body into a parasympathetic, relaxed state. Elevated sugar intake raises cortisol levels, although it can also suppress cortisol during stressful events. Diets high in refined grains and saturated fat also led to higher cortisol levels vs. those that have whole grains, fruits, veggies, and polyunsaturated fat. Foods with trans fats (e.g. frozen pizza, fried chicken, stick margarine, pies, non-dairy creamers, cookies, microwave popcorn, cakes) increase inflammation and can add cortisol. Plant fiber also supports the gut microbiome that can help reduce anxiety and stress. Foods that can be helpful in managing cortisol include
    - dark chocolate. They contain a lot of flavonoids that have been shown to buffer stress reactivity in the adrenals leading to lower cortisol release
    - whole grains
    - legumes and lentils (good for the gut and managing blood sugar levels)
    - whole fruits and vegetables
    - green tea
    - probiotics and prebiotics (the former are the bacteria in food like yogurt and sauerkraut, and the latter are the fibers that feed the gut bacteria)
    - healthy fats, especially omega-3 which are linked to brain health and reduced stress. Good sources include fatty fish, nuts, and seeds. Having omega-3 at dinner can help reduce cortisol levels and promote rest and relaxation.
    - water. Dehydration has been linked to a temporary increase in cortisol levels.

There are some who say that we should eat when the sun is out, which would include not having late night snacks before going to bed, which helps support circadian rhythm balance. This shortened period for eating is sometimes called intermittent fasting.

Ways to raise cortisol levels/boost the adrenals when they are too low include:

- getting bright light in the morning and afternoon

- avoiding stress
- having a good sleep schedule as to going to bed and waking up at the same time every day
- avoiding caffeine and alcohol
- exercising
- doing yoga, meditation
- eating avocados, fatty fish, nuts, olive oil
- avoiding sugar, processed food
- getting medical treatment if there is primary or some forms of secondary adrenal insufficiency
- eating grapefruit and citrus. They break down enzymes that limit cortisol production, and so having them on a regular basis can help the adrenals boost cortisol production.
- licorice. It contains glycyrrhizin that inhibits the enzyme that breaks down cortisol. Inactivating this enzyme helps raise cortisol levels gradually. There are licorice supplements in tablets or capsules. However, glycyrrhizin can cause loss of potassium, fluid retention, increased blood pressure, abnormal hearth rhythms, and lethargy. Do not use the licorice candy; it doesn't contain enough glycyrrhizin to be useful.
- the B vitamins. They are needed to deal with stress and also get used up by it. B-1 (thiamine) is involved with how the body processes glucose. Having too much or too little glucose can cause problems in people with adrenal fatigue. B-2 (riboflavin) is important for the functioning of the mitochondria (the power center of cells) and for the adrenals. B3 (niacin) is essential for the production of adrenal hormones. B5 (pantothenic acid) might be the most important B-vitamin for the adrenals. It can boost adrenal hormones including cortisol and progesterone. It also helps regulate the adrenal's receptors so that they do not become hyper sensitive. B6 (pyridoxine) and B12 (cyanocobalamin) are also important for the production of adrenal hormones.
- vitamin C. The adrenals contain a lot of C, and this vitamin is needed to produce cortisol. So when under high levels of stress more vitamin C will be needed. Vitamin C supplementation has been shown to help lower cortisol levels such as after intense stress. Look out for supplements that contain sugar.
- magnesium. This mineral has hundreds of functions in the human body including handling of stress and the release of cortisol. Having too much cortisol released depletes magnesium. Estimates vary as to how many Americans have insufficient levels of magnesium and range from about 40-80%. Estimates range as high as 95% of people with ADHD having low magnesium. Diabetics often have low magnesium intake and higher than normal loss of the mineral through the urine.
- sodium and potassium. One hormone made by the adrenals is aldosterone. When the adrenals are fatigued the amount of it being released can fall leading to more sodium being excreted by the kidneys leading to frequent urination, electrolyte imbalance and

dehydration. Electrolytes have many key roles including the functioning of our nervous and cardiovascular system so deficiencies with them can have major consequences to our well being. Sodium may be the most important electrolyte as to adrenal balance. Eating potassium-rich foods can be done. There is no shortage of sources of sodium since processed foods such as packaged products have a lot in it. There are some people who recommend specialized salts (e.g. Himalayan, Celtic, etc.) because they have some tiny amounts of trace minerals. All of them will provide lots of sodium. Be careful about your sodium intake if you have high blood pressure. And be careful about potassium intake if you have kidney problems.

- digestive enzymes. Chronic stress causes the digestive system to slow down and with it the amount of digestive enzymes. Remember there is 'rest and digest' or 'flight or fight' and stress activates the latter.
- stomach acid. Again, chronic stress is slowing down the digestive system which can reduce the production of stomach acid. This can result in acid reflux, heartburn, indigestion, bloating, trouble digesting meat and protein, and having food sensitivities.
- help the mitochondria. High stress can damage the mitochondria so they are not making the energy and adrenal hormones we need. Vitamin A and C can help, along with other nutrients like magnesium and the B-complex.
- zinc and selenium also are important for adrenal function. They also help chelate out heavy metals that may be affecting the thyroid. Vitamin C, chlorella (an algae in tablet form), cilantro, glutathione, and garlic also can help remove heavy metals.

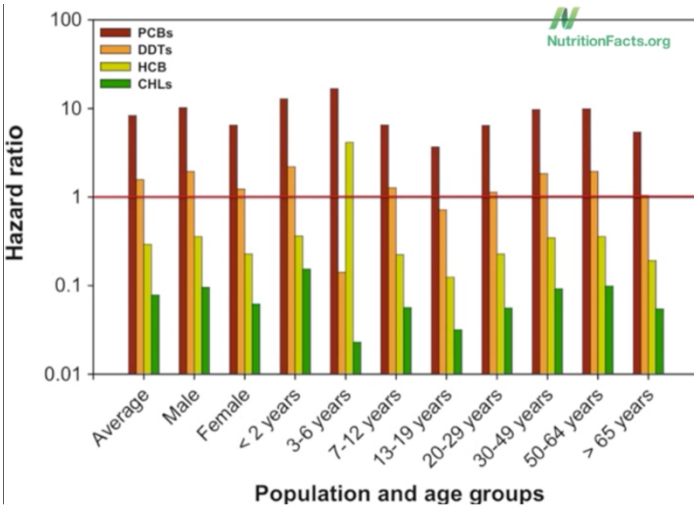
Ways to boost the thyroid includes insuring getting enough nutrients that are supportive of it (e.g. iron, selenium, vitamin D). Carnitine can be helpful too, but it can also raise the level of a chemical called TMAO which increases the risk of atherosclerosis. i.e. Too much of anything, including iron, selenium and vitamin D can cause problems. Talk to your healthcare provider as to what is appropriate for your personal needs.

Improving one's diet by having less of certain stuff can also help with thyroid function. This can include avoiding gluten along with ultra-processed foods (e.g. those that have a lot of chemicals that you cannot pronounce, do not know what they are, how to use them, or what they do). Some studies suggest that cutting out grains and dairy may help those with Hashimoto's.

Having a lot of fruits and vegetables is good. Having a deficiency in nutrients including vitamin D, zinc, thiamine (B1), B6 (pyridoxine), iodine, magnesium, and selenium can worsen hypothyroidism such as fatigue, anxiety, and low mood. Vitamin B-12 and iron are also important. Healthy fats (e.g. olive oil, avocados and its oil), seeds, nuts and nut butters, beans and lentils, and spices and herbs (e.g. basil, rosemary, paprika, saffron, turmeric, mustard, salsa) are good to have. Losing weight can also boost the thyroid.

Avoiding chemicals that are harmful to the thyroid is also important. One chemical that causes thyroid problems by lowering their level is PCBs (polychlorinated biphenyls). These were banned in the 1970s but are still in the environment and people are still contaminated with them. Their

half-life at least in animals is estimated at 2-10 years, and they are stored in fat tissue. Because of their long-life persistence and being stored in fat they accumulate up the food chain. Farmed salmon contain 5-10 times the PCB levels of wild salmon. PCBs are especially dangerous to fetus' health and development and can pass through the placenta and also concentrate in the fat of breast milk. Women who ate PCB-contaminated fish from Lake Ontario were found to have a shortened menstrual cycle. PCBs are not excreted and so accumulate over the years. They can also be passed on to an infant through breast milk.



This is a graph from a recent study. The red horizontal line is where the EPA says there's a significantly increased risk of cancer. What it shows: every age group is at a PCB level roughly 10 times higher than what is considered safe.

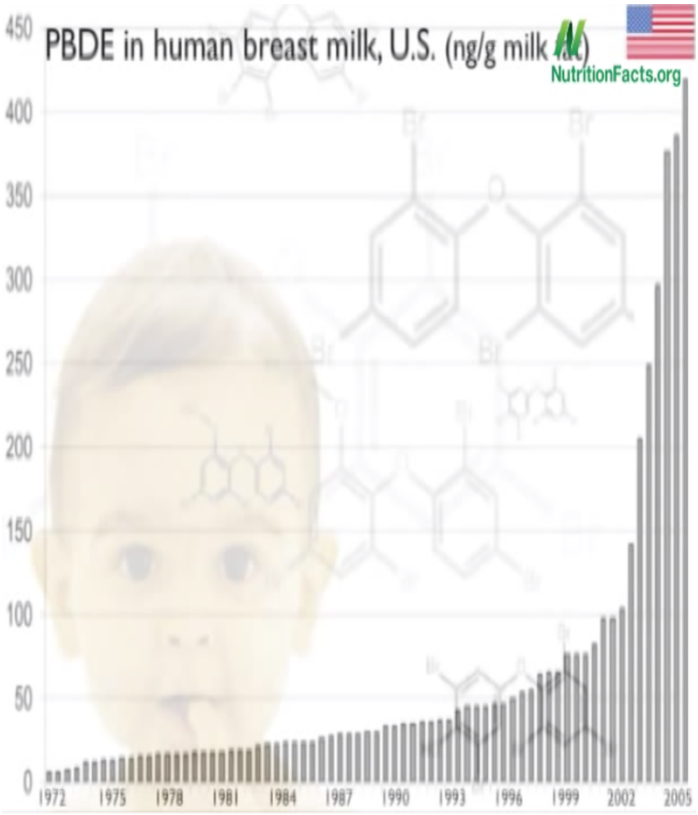
https://nutritionfacts.org/video/dioxins-in-the-food-supply/

Another chemical that is harmful to the thyroid is PFAS (among a group known as 'forever chemicals' because they are thought to persist in the environment and human body for a period of time measured in centuries) and found in products like Teflon, and many others including those that boast being 'water' or 'stain repellant.' An interactive map showing PFAS contamination can be found at https://www.ewg.org/interactive-maps/pfas_contamination/map/. Simply put: PFAS is thought to have contaminated approximately 57,412 sites in the U.S., with every state involved.

If you live by an airport or a military base the water may well be contaminated (from firefighting chemicals), and so use of a water filtration system is advised. Duke University did one study on a number of water filtration systems as to their ability to remove PFAS chemicals. (Environmental Science & Technology Letter, 'supporting information for:' "Assessing the effectiveness of point-of-use residential drinking water filters for Perfluoroalkyl substances (PFAS)" Nicholas Herkert et al, Nicholas School of the Environment, 2020.) Reverse osmosis and two-stage filters performed better at eliminating PFAS.

- One study on sports bras found PFAS in 65% of them especially in the breathable mesh adjacent to the breast and nipples. https://www.mamavation.com/product-investigations/sports-bras-pfas-forever-chemicals-purchasing-guide.html.
- Active wear and yoga pants also have been found to contain PFAS in 25% of items tested https://www.mamavation.com/product-investigations/non-toxic-activewear-guide-pfas-workout-leggings-yoga-pants.html

- tampons. Mamavation and Environmental Health News (https://www.mamavation.com/beauty/pfas-tampons.html#Mamavations_Investigation_of_Tampons_Indications_of_PFAS_Forever_Chemicals_Raw_Data) found 22% of samples tested having organic fluorine present which is an indicator for PFAS. Those found to be positive for it were
  - Maxim hygiene organic cotton cardboard applicator
  - organYc complete protection
  - Playtex SPORT regular and super
  - Tampax cardboard applicator unscented
  - Up & Up (Target brand) regular

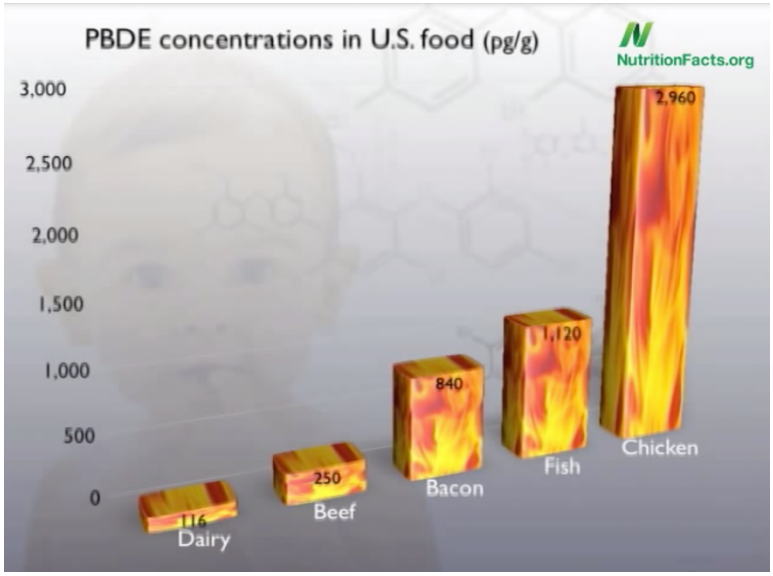


PBDE (polybrominated diphenyl ethers) that are in flame retardants such as for carpets or foam in furniture, along with clothing for workers such as firefighters, and they are known to 'off gas' into the air, attach to dust, and then are breathed in by people. The amount of this chemical found in human breast milk has doubled every five years since 1972. American women have more than those from any other nation in the world. They build up over time in the human body and can impact the thyroid, cause cancer, reproductive problems, and lower IQ. Getting a good air filter to remove such contaminated dust is one means to reduce inhaling the stuff. An estimated 80-93% of toddlers' exposure to flame retardants comes from dust. The CDC found this chemical in 97% of adult Americans in a nationally representative sample (NHANES).

You are now allowed to buy furniture that does not contain flame retardants. PBDE replacements like triphenylphosphine and tetrabromo bisphenol A are obesogens (causing weight gain). Effects of PBDEs include thyroid dysfunction, girls getting their periods earlier, lower sperm count, disrupting the development of the brain in young kids, infertility, and breast and testicular cancers. Firefighters being exposed to burning home furnishings with this chemical have elevated rates of multiple myeloma, non-Hodgkin's lymphoma, prostate and testicular cancer.

Where is the PBDE coming from? Fire retardants in food! Dairy, beef, bacon, fish and especially chicken. Vegans have lower levels, and the longer one stays vegan the lower PBDE levels can fall. It can take 20 years to get to something like an 85% reduction, but eventually one's body can cleanse itself of this chemical.

Both graphs above and to the side come from: https://nutritionfacts.org/video/flame-retardant-chemical-contamination-2/



Mercury (such as from eating fish that contain it) also damages various hormones. It is ranked third by the US government's Agency for Toxic Substances and Disease Registry (behind lead and arsenic). It may disrupt the pituitary, thyroid, adrenal glands, and pancreas. There is no safe level for it in the human body. Hormones most affected by it are thought to be insulin, estrogen, testosterone, and adrenaline. Toxic levels of the metal in the pituitary can lead to low function of the gland and subsequent mood disorders so that it appears to be a major factor in teens and others committing suicide. It can cross the placenta and blood brain barrier. It can get into a fetus' brain where it can accumulate and cause brain damage and delays. It binds in particular to a hormone regulating the menstrual cycle and ovulation. It may contribute to Addison's disease. It gets concentrated in muscle.

Exposure to high levels of mercury can cause permanent brain damage, memory loss, heart disease, kidney failure, liver damage, loss of vision, loss of sensation, and tremors. It is also considered an endocrine disrupting chemical, impacting the adrenals, thyroid, hypothalamus and pituitary gland.

<u>Home Tests</u>

There are two tests you can do at home that I am aware of. You can buy a small bottle of 2% tincture of iodine at a local drug store. After your morning shower use the applicator and paint a 3 inch square patch on your inner forearm, upper inner thigh or lower abdomen and observe it every 1-2 hours. It should still be there after 24 hours. A significant lightening or complete disappearance in less than 18 hours is said to indicate a moderate to severe deficiency. The quicker it is absorbed the greater the deficiency of iodine. Since the thyroid uses up the most iodine in the body it is likely to point to a hypothyroid condition. This test is not 100% accurate because of evaporation from ambient temperatures.

There is another test you can do at home which is much more accurate for determining if an iodine deficiency exists, but it costs around $80 (as of 2023). It involves catching 100% of your urine output for 24 hours, after taking a 50 mg iodine tablet. The more deficient you are in iodine

the more your body absorbs and the less that comes out in the urine. The lab does all the interpretation for you. Contact Hakalalabs.com for more information.