Thyroid Profiles

Thyroid Hormone Imbalance

Thyroid disease or dysfunction can explain a wide variety of symptoms (see list on page 5), yet it is notoriously under-diagnosed. The Colorado Thyroid Disease Prevalence Study published in 2000[1] found that 9.9% of the study population consisted of people who were not being treated for thyroid problems yet had abnormal thyroid function test results, suggesting that their thyroid disease was previously undiagnosed. This study also found a significantly greater incidence of thyroid dysfunction in women than in men in each decade after the age of 34.

The American Thyroid Association estimates that over 12% of the US population will develop thyroid disease during their lifetime, and that as many as 60% of people with thyroid disease are not aware of it[2]. Overt hypothyroidism, with its characteristically high TSH and low circulating T4 levels, and hyperthyroidism, with low TSH and high T4 levels, are easy to recognize clinically. Yet an elevated TSH associated with normal thyroid hormone (T3 and T4) levels, defined as "subclinical" hypothyroidism, is thought to be present in 4-10% of the general population and in up to 20% of women over 60 years old; and a low TSH with normal T3 and T4 levels, subclinical hyperthyroidism, occurs in about 2% of the population and is most common in women, blacks, and the elderly[3].

Elements that Affect Thyroid Function

Thyroid function can be affected by nutritional deficiencies, particularly iodine and selenium, and by environmental exposure to bromine, arsenic, selenium, mercury and cadmium. We are all, to varying degrees depending on our dietary choices, our supplementation routine, or our lifestyle, exposed to the elements iodine, bromine, selenium, arsenic, mercury, and cadmium. These elements are present in the food we eat, air we breathe, and water we drink, as a result of pollution as well as natural occurrence, and are generally tasteless, odorless, and impossible to detect without sophisticated instrumentation.

Available Tests

Essential Thyroid Profile

Tests: TSH, fT4, fT3, TPOab (blood spot)

Allows doctors to screen for hypo- or hyperthyroidism, determine Free T4 levels as well as Free T3 levels, test for autoimmune thyroid disease, and monitor thyroid replacement dosages.

Note: Serum thyroid testing is only offered as part of the Male Serum Profile and the Female Serum Profile.

Comprehensive Thyroid Profile

Tests: Tgbn, TSH, T4, fT4, fT3, TPOab (blood spot); Iodine, Selenium, Bromine, Arsenic, Mercury, Cadmium, Creatinine (dried urine)

Allows doctors to see if an individual has too little, or too much, iodine and selenium, and/or exposure to the iodine/selenium antagonists bromine, arsenic, and mercury; full assessment of thyroid health, including screening for hypo or hyperthyroidism, determines Free T4 and Free T3 levels, testing for autoimmune thyroid disease, and monitoring thyroid replacement dosages..

How does exposure to these elements affect health? Iodine is an essential component of thyroid hormones T3 and T4, so its deficiency has a serious impact on thyroid hormone synthesis. Bromine is in the same chemical family as iodine and excessive amounts will compete with iodine in the thyroid, producing inactive thyroid hormone. Selenium is a component of selenoproteins, including the iodothyronine deiodinases that convert inactive T4 to its active form in the body (T3), and glutathione peroxidase, which prevents free radical damage to the thyroid by destroying the hydrogen peroxide that is a by-product of thyroid hormone synthesis. Arsenic and mercury are toxic heavy metals that form tight complexes with selenium and therefore reduce selenium's bioavailability, resulting in biological effects similar to selenium deficiency including a disruption to thyroid health. While bromine, arsenic, and mercury are known biological toxins, iodine and selenium can also potentially be toxic if dietary intake, including excessive supplementation, is too high.

For a more in-depth discussion of the biochemical impact of these elements on thyroid function, see the Provider Data Sheet "Heavy Metals & Nutrients Testing in Dried Urine and Dried Blood Spot".

Tests in Dried Blood Spot or Serum

TSH – Thyroid Stimulating Hormone

Produced by the pituitary, TSH acts on the thyroid gland to stimulate production of the thyroid hormones T4 and T3. Higher than normal TSH can indicate a disorder of the thyroid gland, while low TSH can indicate over-production of, or excessive supplementation with, T4 and/or T3, which acts in a negative feedback on the pituitary to reduce TSH production. Low TSH can also be caused by problems in the pituitary gland itself, which result in insufficient TSH being produced to stimulate the thyroid (secondary hypothyroidism).

Free T4 – Thyroxine

T4 (thyroxine) is the predominant hormone produced by the thyroid gland. It is an inactive hormone and is converted to its active form, T3 within cells. Free T4 is the non-bound fraction of the total T4 circulating in the blood. Free T4 is available to the issues and represents 0.04% of the total T4 levels. High TSH combined with low free T4 levels indicates hypothyroidism while low TSH and high free T4 levels indicates hyperthyroidism.

Free T3 – Triiodothyronine

The active thyroid hormone that regulates the metabolic activity of cells. Free T3 is the non-protein-bound fraction circulating in the blood, representing about 0.4% of the total circulating T3, which is available to tissues. Elevated T3 levels are seen in hyper-

WHO SHOULD TEST?

Essential Thyroid Profile

Individuals requiring thyroid screening.
Routine screening is recommended for:

- individuals over the age of 50
- anyone with a family history of thyroid disorders
- people experiencing symptoms of thyroid dysfunction
- children who have Down's Syndrome
- people with autoimmune disorders, especially those with history of autoimmune thyroiditis

Comprehensive Thyroid Profile

- People experiencing symptoms of thyroid dysfunction but who have been told their thyroid was OK; this may be a result of nutritional deficiencies or excessive exposure to environmental pollutants that block thyroid synthesis and function.
- Anyone with known thyroid problems, whose thyroid medication has been difficult to stabilize or dosages have fluctuated frequently, or those looking for the cause of their thyroid dysfunction.

Hormone Testing

Minimally-invasive home test kits

thyroid patients, but levels can be normal in hypothyroid patients because it does not represent the intracellular conversion of T4 to T3, which comprises about 60% of all T3 formed in tissues.

TPOab – Thyroid Peroxidase Antibodies

Thyroid peroxidase is an enzyme used by the thyroid gland in the manufacture of thyroid hormones by liberating iodine for attachment to tyrosine residues on thyroglobulin. In patients with autoimmune thyroiditis (predominantly Hashimoto's disease), the body produces antibodies that attack the thyroid gland, and levels of these antibodies in blood can diagnose this condition and indicate the extent of the disease.

Tests in Dried Blood Spot Only

Thyroglobulin

A protein which is rich in tyrosine and synthesized only in the thyroid gland. When bound to iodine, tyrosine residues in thyroglobulin become the source material for the synthesis of the thyroid hormones T3 and T4. When iodine levels are low, high levels of thyroglobulin can be found in the blood as iodine-poor thyroglobulin builds up and leaks from the thyroid into the bloodstream. Levels of thyroglobulin are an indicator of a person's average iodine exposure over a period of weeks[4]: the greater the iodine exposure, the lower the thyroglobulin level. An elevated thyroglobulin, in the absence of more serious thyroid diseases such as thyroid cancer, which results in very high blood thyroglobulin levels, indicates low iodine status.

Total T4 – Thyroxine

Total T4 includes both free T4 and protein-bound T4, and therefore represents the thyroid gland's capacity to synthesize, process, and release T4 into the bloodstream. In contrast, free T4 represents only the circulating hormone that is bioavailable and not tightly complexed with thyroid binding globulin (TBG). Certain conditions, like oral estrogen usage or pregnancy, can cause total levels to change due to liver-induction of TBG. This can result in no change in free T4 or lower bioavailable levels of free T4, even though total T4 increases.

Advantages of a Simple Blood Spot Test

- No phlebotomist or centrifugation required, therefore less expensive and more convenient than conventional blood draws
- Nearly painless finger stick is used to collect the few drops of blood required
- Private and convenient for both patient and healthcare provider—collection at home or provider's office
- Hormones and other analytes are stable in dried blood spot at room temperature for weeks, allowing for worldwide shipment
- Safe handling and transport of samples, as infectious agents are destroyed by drying

Advantages of Simple Serum Testing

- Better for patients who prefer not to collect their own sample at home with a finger stick
- Preferred by some providers who are less familiar with blood spot testing

Tests in Dried Urine

Urine dried on filter paper strips is a convenient and practical way to test iodine, bromine, selenium, arsenic, mercury, and cadmium to assess deficient, adequate, and toxic intakes. ZRT Laboratory is a pioneer in commercial testing for elements using a simple, two-point (morning and night) urine collection, into which a filter paper strip is dipped and allowed to dry.

Our research[5,6] has shown the dried urine test to be accurate and comparable to full 24-hour liquid collections, which are cumbersome and inconvenient for patients. To correct results for hydration status, creatinine is also measured and element test results are expressed in μg/g creatinine.

Iodine

An essential component of the thyroid hormones T4 and T3. Iodine is an essential nutrient, commonly found in dairy products, seafood, iodized salt, and grains. Iodine deficiency compromises thyroid hormone production and leads to serious diseases including irreversible cretinism, pregnancy complications, goiter, and decreased cognitive function[7]. Iodine deficiency has also been associated with breast cancer. Since over 90% of dietary iodine is eliminated in urine, adequacy of recent iodine intake can be accurately assessed with dried urine testing[8].

Bromine

A common component of flame proofing agents, fumigants, medications, food products, and pool/spa sanitizers. High environmental exposure can lead to excess accumulation[9]. If iodine status is low, bromine competes with iodine for tyrosine binding sites within thyroglobulin and thereby impedes thyroid hormone synthesis. Bromine is mostly excreted in urine, so dried urine analysis can indicate excessive bromine exposure.

Selenium

An essential dietary element that is incorporated into selenoproteins in the body, which include glutathione peroxidases, thioredoxin reductases, iodothyronine deiodinases, and the extracellular glycoprotein, selenoprotein P[10]. These selenoproteins play vital roles in thyroid hormone synthesis, free radical scavenging, DNA synthesis, and cancer prevention[11]. Foods such as brazil nuts, seafood, eggs, and grains are significant selenium sources. The optimal therapeutic range for selenium is narrow: excess selenium intake can result in toxicity, while inadequate selenium affects thyroid function because of impaired synthesis and conversion of T4 into the active T3[12]. Urine is the major route of selenium elimination, therefore dried urinary selenium is an indicator of dietary selenium intake.

Arsenic

An environmental toxin, found in well water as well as some foods such as fish, shellfish, seaweed, rice, and fruit. Arsenic is a heavy metal with multiple toxic effects in the body including carcinogenesis, goiter, diabetes, skin diseases, and damage to the liver, kidney, and the cardiovascular, nervous, and endocrine systems[13]. It also competes with selenium, preventing its incorporation into the selenoproteins. This reduces the levels of selenium-containing antioxidants and also the selenoenzymes that are essential for thyroid hormone production, thereby severely compromising thyroid function[14]. Dried urinary arsenic is a good indicator of recent arsenic exposure, since around 80% of dietary arsenic is excreted into urine within 3 days[15].

Mercury

A highly toxic heavy metal that can accumulate in body tissues including the brain. Besides occupational exposure, most human exposure to mercury is through dental amalgams, seafoods, and vaccinations[16]. Mercury toxicity can cause nervous system damage, leading to symptoms such as paresthesia, mood changes, and sensory disturbances, while very excessive exposure can also lead to renal toxicity, respiratory failure and death[17]. Mercury and selenium have a very high affinity for each other and form a tight complex[18]; as a result, mercury reduces the biological availability of selenium and may inhibit the formation of selenium-dependent enzymes, affecting thyroid function in the same way as selenium deficiency or arsenic exposure. This is particularly problematic in people with inadequate selenium intake and consequent low selenium levels. Selenium can protect against mercury toxicity by sequestering mercury, reducing its bioavailability[19]. There are three forms of mercury in the environment: elemental, found in batteries, thermometers, and dental amalgams; inorganic compounds, primarily mercuric chloride, present in skin-lightening creams; and organic compounds, primarily methylmercury, found in sea foods. Elemental mercury is most commonly breathed in as a vapor and absorbed through the lungs, while inorganic and organic compounds are ingested and absorbed through the intestine. The predominant form of mercury in urine is inorganic mercury. Urinary mercury level is an excellent biomarker for whole body exposure to both elemental and inorganic mercury[20].

Cadmium

Cadmium is rated the 4th most toxic heavy metal after arsenic, lead, and mercury on the priority list of hazardous substances issued by the CDC's Agency for Toxic Substances and Disease Registry (ATSDR)[21]. Occupational exposure arises mainly from smelting and battery manufacturing. Cadmium gets into the atmosphere as a result of this industrial activity, as well as via fossil fuel combustion and waste incineration, and is deposited in the soil where it is taken up by plants and thus eventually enters the human food supply[22]. Tobacco leaves are particularly efficient at accumulating high levels of cadmium from soil, and so smoking is a major source of human cadmium exposure. Smokers have about twice the body burden of cadmium compared to non-smokers. In non-smokers, the primary source of exposure is through the food supply. Once inside the body, cadmium binds to albumin and metallothionein in the circulation, and is filtered by the kidneys where it accumulates in the kidney cortex. In the kidneys, the half-life of cadmium is more than 10 years; urinary cadmium correlates with tissue levels in the kidneys and is thus accepted as an accurate measure of long-term total body burden of cadmium[22]. Cadmium can also accumulate in the thyroid gland, resulting in damage to thyroid tissues with chronic exposure[23]. An overall positive association

has been observed between urinary cadmium and levels of total T4, total T3, free T3, and thyroglobulin in the National Health and Nutrition Examination Survey (NHANES)[24].

Creatinine

A metabolic by-product that is excreted at a relatively constant rate as long as kidney function is not impaired. It is measured to correct dried urinary element levels for hydration status; the greater the fluid intake, the lower the creatinine level. Iodine, bromine, selenium, arsenic, mercury, and cadmium results are therefore expressed in μg/g creatinine to allow for urine dilution.

Advantages of Dried Urine for Testing Iodine, Bromine, Selenium, Arsenic, Mercury, and Cadmium

- Urine collection and shipment of the dried filter strips are simple and convenient for the patient and practitioner
- Dual collections of urine directly on a filter strip, upon awakening and just before bed, are far more convenient and less subject to the inherent inaccuracies of a 24 h urine collection, yet correlate well with 24 h urine collections
- Iodine, bromine, selenium, arsenic, mercury, cadmium, and creatinine in dried urine are exceptionally stable for weeks at room temperature allowing more flexibility in collection, shipment, testing, and storage
- Elements test results expressed in μg/g creatinine allows normalization of results when problems exist with urine that is very concentrated or dilute

Clinical Aspects of Thyroid Dysfunction

Thyroid hormones are primarily involved in directing the metabolic activity of cells, and a properly regulated thyroid is therefore essential to a wide array of biochemical processes in the body. Functional hypo- and hyperthyroidism can also result in symptoms even when hormone levels appear to be normal[25]. Thyroid function can be affected by interactions between thyroid hormones and other hormone systems, particularly estrogens and cortisol, by some nutritional deficiencies, particularly iodine and selenium, and by environmental exposure to bromine, arsenic, selenium, mercury, and cadmium. Management of thyroid dysfunction requires an understanding of these interactions and careful monitoring of treatment with thyroid hormone testing[26]. The presence of thyroid peroxidase (TPO) antibodies has been found to help diagnose thyroid disease in patients with abnormal TSH and/or thyroid symptoms with normal thyroid hormone levels[27-29], and is used to indicate the presence of autoimmune thyroiditis. Hashimoto's disease is the most common cause of overt hypothyroidism and 95% of patients are positive for TPO antibodies. Thyroid dysfunction, including thyroid autoimmunity, is also strongly linked with infertility[30-33].

Symptoms of thyroid problems include:

- Weight gain or inability to lose weight even with exercise and diet
- Feeling cold all the time when others don't
- Low energy and stamina (mostly in the evening)
- Irregular bowel habits – constipation/loose stools
- Dry, thinning, and itchy skin
- Hair loss
- Insomnia
- Water retention
- Menstrual irregularities
- Low sex drive
- Infertility
- Memory lapses or slow/fuzzy thinking
- Dry/brittle hair and nails
- Depression
- Osteoporosis
- Weight loss
- Muscle and joint aches and pains
- High blood pressure
- Increased cholesterol levels
- Heat or cold intolerance

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