

THYROID AND ELEMENTS PROFILES

Profiles Offered

Essential Thyroid Profile in Dried Blood Spot

Tests included: TSH, Free T4, Free T3, TPO antibodies

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.

Elements Profile in Dried Urine

Tests included: Iodine, Bromine, Selenium, Arsenic, Mercury (optional add-on)

Allows doctors to see if an individual has too little, or too much, of the essential nutrients iodine and selenium, or if they have been exposed to too much of the iodine/selenium antagonists bromine, arsenic, and mercury.

Comprehensive Elements-Thyroid Profile in Dried Blood Spot and Dried Urine

Tests included: TSH, Free T4, Total T4, Free T3, TPO antibodies, Thyroglobulin in dried blood spot; Iodine, Bromine, Selenium, Arsenic in dried urine

Allows doctors to get to the root problem of thyroid disorders and to determine possible effects of nutritional deficiencies or exposures to environmental pollutants on thyroid function and other health issues.

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 2000¹ 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. This suggests 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 it². 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. But 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 elderly³.

Elements that Affect Thyroid Function

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, and mercury. Levels of these elements in the food we eat is determined by soil levels and other environmental exposure of plants and animals that end up in the food chain and ultimately on our own dining tables. We can also be directly exposed to elements through environmental pollution of the air we breathe, as well as exposure through our skin.

How does exposure to these elements affect health? Iodine is an essential component of T3 and T4, so its deficiency has a serious impact on thyroid hormone synthesis, while bromine is in the same chemical family as iodine and excessive amounts will compete with iodine in the thyroid. Selenium is a component of the selenoproteins, including the iodothyronine deiodinases, which 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

Thyroid and Elements Testing.

Minimally-invasive home test kit.

deficiency including a disruption to thyroid health. While bromine, arsenic, and mercury are known biological toxins, even iodine and selenium can potentially be toxic if dietary intake, including excessive supplementation, is too high.

Tests in Dried Blood Spot

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

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-protein-bound fraction of the T4 circulating in the blood, representing about 0.04% of the total circulating T4, which is available to tissues. Low TSH combined with low T4 levels indicates hypothyroidism, while low TSH and high T4 levels indicate hyperthyroidism. High TSH and low T4 indicate a thyroid gland disease, such as autoimmune thyroiditis (Hashimoto's).

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.

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 hyperthyroid 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.

TPO – 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.

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 weeks⁴: 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.

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

Tests in Dried Urine

Urine dried on filter paper strips is a convenient and practical way to test iodine, bromine, selenium, arsenic and mercury 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 $\mu\text{g/g}$ 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 function⁷. 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 testing⁸.

Bromine

A common component of flame proofing agents, fumigants, medications, food products, and pool/spa

sanitizers. Bromine has no known function in the body but high environmental exposure can lead to excess accumulation⁹. 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 the selenoproteins in the body, which include glutathione peroxidases, thioredoxin reductases, iodothyronine deiodinases, and the extracellular glycoprotein, selenoprotein P¹⁰. These selenoproteins play vital roles in thyroid hormone synthesis, free radical scavenging, DNA synthesis, and cancer prevention¹¹. 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 T3¹². 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 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 systems¹³. 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 function¹⁴. Dried urinary arsenic is a good indicator of recent arsenic exposure, since around 80% of dietary arsenic is excreted into urine within 3 days¹⁵.

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 vaccinations¹⁶. Mercury toxicity can cause nervous system damage,

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 (see page 5)
- children who have Down's Syndrome
- people with autoimmune disorders, especially those with history of autoimmune thyroiditis

Elements Profile

People experiencing symptoms of thyroid dysfunction (see back page) 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.

Comprehensive Elements-Thyroid Profile

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.

leading to symptoms such as paresthesia, mood changes, and sensory disturbances, while very excessive exposure can also lead to renal toxicity, respiratory failure and death¹⁷. Mercury and selenium have a very high affinity for each other and form a tight complex¹⁸; 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 bioavailability¹⁹. 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 mercury²⁰.

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, and mercury results are therefore expressed in $\mu\text{g/g}$ creatinine to allow for urine dilution.

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

- 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, and creatinine in dried urine are exceptionally stable for weeks at room temperature allowing more flexibility in collection, shipment, testing, and storage
- Iodine, bromine, selenium, arsenic, and mercury results expressed in $\mu\text{g/g}$ creatinine allows normalization of results when problems exist with urine that is very concentrated or dilute
- Iodine testing allows for determination of iodine status based on CDC and WHO guidelines for thyroid sufficiency, as well as extra-thyroidal sufficiency

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 normal²¹. 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, and mercury. Management of thyroid dysfunction requires an understanding of these interactions and careful monitoring of treatment with thyroid hormone testing²². 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 levels²³⁻²⁵, 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 infertility²⁶⁻²⁹.

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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