# 1 INTRODUCTION

## 1.1 DEFINITION OF HEALTH

"A physical, mental and spiritual state where life flourished"

Aristotle

There are different definitions for health, and each definition portrays health differently. The primary absence of disease and impairment was considered healthy, but complete health is achieved where daily life demands are fulfilled. Health is a state of balance where the equilibrium is established between social and physical environments. Society faces enormous challenges to improve health (Svalastog et al., 2017). Optimal health is the fundamental requirement of the body where it helps to achieve the four essential objectives of human life they are, acquisition of religious merits (*dharma*), comfort living and generosity (*artha*), the gratification of permissible pleasures, and fulfilling of all the desires (*kama*) and achieving liberation from the shackles of mundane cycles of birth and deaths (*mokśa*) (Behere et al., 2013). The World Health Organisation (WHO) defines health as, "A state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity." Later WHO has understood the importance of spiritual health, and considered it as the most important scope of health. The WHO also describes that it is time to combine the spiritual and religious factors of health that have directed human wellbeing and behaviour over the centuries. Some of the general objectives of spiritual health are developing the self-administrated spiritual health scale and identifying the domains and constructs of spiritual health (Irvine et al., 2020).

*सम दोश समग्नि समधतु मलक्रियह् प्रसन्नत्म इन्द्रिय*

*मनह् स्वस्थ इत्यभिधियते (ष्ुश्रुत ष्ुत्र* || १५| ३*)*

*sama dośa samagni samadhatu mala kriyāha prasannatma*
*indriya manah svastha ityabhidhiyate (Ṣusruta Ṣutra 15/3)*

Perfect health is achieved only when there is a balanced state of biochemical, body constituents, metabolism, proper elimination of waste, and the mind, senses, and soul are blissful. According to the Indian culture, health and healing are entirely spiritual. A human is considered whole only when there is a connection between mind, body, and soul. An appropriate lifestyle should be chosen to balance the *tridoṣāṣ*. Healthcare professionals realized the importance between lifestyle and holistic health. Health offers energy, fitness

and reduces the risk of diseases. Everything depends on the lifestyle habits that one chooses (Shilpa & Murthy, 2012).

## 1.2 THYROID GLAND

The thyroid gland is located at the bottom of the neck, above the trachea and bellow larynx that controls the body metabolism and through the bloodstream the thyroid gland releases the thyroid hormones that was stored (Dua, 2005). Thyroid hormones are responsible for regulating essential activities, such as breathing, heart rate, nervous response, menstrual cycles, and cholesterol level (Dua, 2005; Núñez et al., 2017; Nussey & Whitehead, 2001; Shahid et al., 2021; Shikha & Sartaj, 2021; Sorisky, 2016; Unnikrishnan & Menon, 2011). As a part of the endocrine system, thyroid glands produce hormones that reach each cell through the bloodstream. Thyroid follicles are the main components, and the central cavity of follicles is filled with sticky fluids called colloids. A colloid is a centre where the thyroid hormones are produced, and the entire production is dependent on one single content called iodine. The food we eat that contains iodine is the primary source of the thyroid. Production of thyroid hormones is carried out in colloids when iodine atoms attach to a glycoprotein called thyroglobulin. Colloid secrets thyroglobulin through follicle cells, and the colloid enzyme links the iodine to thyroglobulin to produce two intermediate hormones triiodothyronine (T3) and thyroxine (T4) (Nussey & Whitehead, 2001; Shahid et al., 2021; Unnikrishnan & Menon, 2011). These two hormones must be proper rather than too high or too low. Good hormone level depends on the connection between the hypothalamus and the pituitary glands. The hypothalamus produces Thyrotropin Realising Hormone (TRH), which aids in the generation of Thyroid Stimulating Hormone (TSH) by the pituitary gland and regulates thyroid hormone production. The TRH indicates that the pituitary glands instruct the thyroid gland to produce both T3 and T4 levels can be increased or decreased by increasing or decreasing TSH levels (Shahid et al., 2021). When T3 and T4 are less, high TSH is released by the pituitary gland in the blood, and when there is high T3 and T4, pituitary gland releases less TSH. That is how there is slow production of thyroid hormones in thyroid glands. The T3 and T4 hormones spread into every cell in the body. The working of cell metabolism is regulated with these hormones (Dua, 2005; Núñez et al., 2017; Shahid et al., 2021; Singh & Sandhu, 2021; Sorisky, 2016; Unnikrishnan & Menon, 2011).

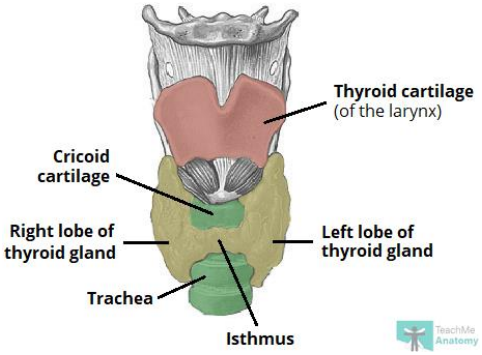


Figure 1: Framework of thyroid gland

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T3 and T4 control heart rate, and low T3 and T4 levels slow down heart rate causing Weight gain or constipation. High T3 and T4 levels cause rapid heart rate resulting in diarrhea or Weight loss. The synchronization between T3, T4, and TSH is shown in below figure.

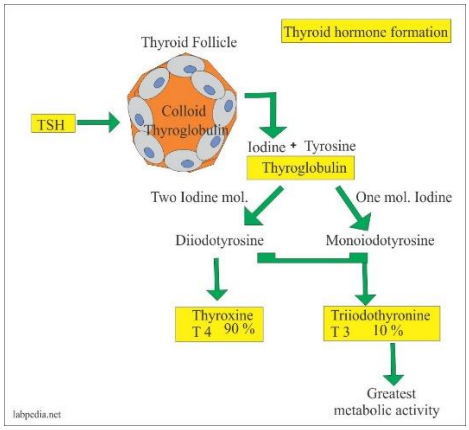


Figure 2: Synthesis of the Thyroid Hormone

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Thyroid hormones and formation of neurological system in utero are critical for foetal development and growth, childhood tissue, and protein synthesis. Early childhood entirely depends on thyroid hormones as they support the adult's neurological functions (Bernal, 2007). There is a connection between thyroid hormones, reproductive hormones, and deficiencies, influencing libido and fertility. Thyroid hormones enhance the sensitivity inside the frame to catecholamines from the adrenal medulla via regulating the blood vessels receptors. Excessive T3 and T4 hormones accelerate the heart rate by strengthening the heartbeat and increasing blood pressure as the thyroid hormone controls metabolism, protein synthesis, heat production, and other body functions (Shahid et al., 2021). Dietary iodine is one of the important contents for the synthesis of T3 and T4. Sadly, most of the world's population fails to intake food rich in iodine because the iodine levels in the food vary according to the soil, irrigation, and the fertilizers used to produce

foods, marine fish and shrimp contains high iodine level because they are seawater foods as well, people in land lock lack in iodine because they are less access to seafood. Deficiency in dietary iodine results in impaired ability to synthesize T3 and T4 and the TSH is secreted more, resulting in hyper stimulation. Due to hyper stimulation, Thyroglobulin accumulates in the follicles of the thyroid gland, increasing colloid deposits and hence the overall thyroid gland size increases and goiter is the medical term for this ailment (Chung, 2014). Impaired boom and improvement of fertility, and neonatal death, are all signs and symptoms of iodine deficiency. Iodine deficiency is one of the most common causes of preventable mental impairment and brain damage in the industry. Hyperthyroidism is characterised by excessive hormone secretion, while hypothyroidism is characterised by insufficient hormone secretion. The reason for the production of TSH by the pituitary gland is to deliver messages to the thyroid gland. Thus, it directly targets the thyroid gland to produce the thyroid hormone. Intake of thyroid medication hits the bloodstream and instructs the brain to produce less TSH. When the standard feedback loop is blocked from expected functioning results in both positive and adverse effects, it is good if the thyroid gland does not produce hormones. However, it is terrible, as it creates confusion in interpreting the thyroid lab test due to a decrease in average thyroid production. Intake of thyroid medication will not change the natural thyroid production, but it decreases as the intake increases. Many recent studies have shown that TSH always does not perform well in predicting the case of sufficient thyroid hormone in the body (Gullo et al., 2011). Any thyroid medicine taken orally stimulates the TSH level as it is absorbed into the body. Cytomel, Levothyroxine, Synthroid and Armour Thyroid are all thyroid medications, in India Eltibio, Eltroxin, Pregnavit, Roxin, Synox, and Thyrobest are used as a thyroid harmone medications. Thyroid Stimulating Hormone is not suggested frequently, as it is not good to use (Soldin et al., 2013)**.** People with low TSH and intake thyroid medication may experience normal, high, or low free T3 (FT3) or free T4 (FT4) that differentiates the common TSH condition caused due to over production by the body. Due to the hyperthyroid spectrum, people with low level TSH intake of thyroid medication and the following symptoms such as feeling hot, heart palpitations, jittery, anxiety, and hair loss are experienced. People have low TSH while in taking thyroid medication; if they share the following symptoms: gain Weight, fatigue, hair loss, depression, and constipation, it may be due to biochemical hypothyroid. Thyroid Stimulating Hormone is the general word to evaluate thyroid used by physicians. However, many other tests are further suggested by physicians to assess the thyroid. Specific information on pituitary gland are provided by

TSH but it does not provide information on the free thyroid hormone circulating in the body or how well the thyroid hormone is converted and used by the body (Patil et al., 2021). All these factors are quickly evaluated with the help of additional examinations. The following tests beyond TSH include Free T3, Thyroid Antibodies, SHBG, and Free T4 (Dua, 2005; Núñez et al., 2017; Shahid et al., 2021; Singh et al., 2011; Sorisky, 2016; Unnikrishnan & Menon, 2011).

## 1.3 THYROID DISORDER IN INDIA

Thyroid disease is the ninth most prevalent ailment, according to a survey performed by the Indian Thyroid Society, when compared to other common diseases such as depression, asthma, heart problems, and insomnia (Unnikrishnan et al., 2013). Women are highly prone to thyroid disease, resulting in Weight gain or loss, weakness, and hormonal imbalances compared to men. The prevalence of hypothyroidism has been studied in Indian adults in Cochin. Nine hundred seventy one adults were chosen, and the prevalence rate of hypothyroidism was 3.9%, and 9.4% subclinical hypothyroidism and females had a higher prevalence rate of 11.4 percent than men, who had a total prevalence rate of 16.2. The prevalence of subclinical hypothyroidism rose with age, and anti TPO antibodies were found in roughly 53% of subclinical hypothyroidism patients. The study was based on population, and a cluster sampling strategy was used. Thyroid disorder in pregnant women results in placental abnormalities and increases the fetus wellbeing risks (Unnikrishnan et al., 2013). The hypothyroidism prevalence rate globally is estimated to be about 45% ((Núñez et al., 2017)). In India, one in ten adults suffers from hypothyroidism. Moreover 42 million people suffer from thyroid disease, based on various studies conducted across India (Singh & Sandhu, 2021). Data from a leading thyroid diagnostic centres and surveys show that thyroid abnormalities are present across various forms (Unnikrishnan et al., 2013). The findings also indicate that hypothyroidism is the most widely spread dysfunction however remains clinically undetected without regular testing (Udovcic et al., 2017). Thyroid disorders interrupt the normal thyroid gland functioning and result in abnormal hormone production leading to hypothyroidism. Hypothyroidism increases cholesterol levels, blood pressure, cardiovascular complications, depression, and decreased fertility if it is untreated. The survey states that thyroid disease is more prevalent among people in 46 to 54 years of age groups (Lazarus, 2016; Nussey & Whitehead, 2001).

## 1.4 SUBCLINICAL HYPOTHYROIDISM PREVALENCE

Subclinical hypothyroidism, also known as mild thyroid dysfunction, is a common health issue that affects 3% to 8% of the population, however the majority of people are unaware of it. Due to their age, women have a higher prevalence than men. Men begin to experience the same prevalence as women from the 1960s. Antithyroid antibodies were identified in 80% of patients with subclinical hypothyroidism, and serum thyroid stimulating hormone levels were less than 10 ml U/L (Vahab, 2009).

## 1.5 HYPOTHYROIDISM

Hypothyroidism (underactive thyroid) is a disorder where thyroid gland produces thyroid hormones in an inefficient and sluggish manner. Thyroid hormones assist in the generation and utilization of energy in the body for daily activities. The thyroid gland regulates the heart beat and digestive functions, among other things. The normal functioning of the human body would become sluggish if thyroid hormones are not created adequately. These days hypothyroidism is common in all age groups especially 30 and above. Women, especially over the age of 60 years, are most commonly affected by hypothyroidism. With routine blood checkups, hypothyroidism is discovered, or it is discovered once the symptoms begin (Kim Mi, 2020; Pearce et al., 2003). Mild hypothyroidism or subclinical hypothyroidism is the beginning stage and the symptoms include weakness, insufficient sleep, fatigue, depression, sudden and modest Weight gain, dry, coarse hair, dry skin, poor memory, delayed relaxation of the tendon reflexes and concentration, irregular menstrual cycle, constipation, and cold intolerance. According to medical experts, all the symptoms of hypothyroidism are curable once the thyroid hormones are replaced. According to medical research, both myxedema and hypothyroidism create hypoxic ventilator depression, further responsive to the replacement therapy. The alteration in the ventilator control results in hypoventilation seen in myxedema and hypothyroidism. Hypothyroidism affects the respiratory muscles strength and as results the lung functioning becomes poor finally the subject suffering from hypothyroidism starts experiencing symptoms such as fatigue, decreased physical activities, and shortness of breath (Pearce et al., 2003). If the person with hypothyroidism is not treated at the right time, the symptoms may get worse. Sleep apnea becomes familiar even with normal lung functions. The thyroid glands' main function is to control the metabolic levels of the human body. The pituitary glands release thyroid stimulating hormones, which are responsible for thyroid stimulation. The T3 and T4 hormones play a vital role in metabolic regulation (Shaheed et al., 2021) and it's called an underactive thyroid when the thyroid glands don't release enough hormones.

## 1.6 GENERAL TYPES OF HYPOTHYROIDISM

Primary, secondary, and tertiary hypothyroidism are the three most frequent kinds of hypothyroidism. Primary hypothyroidism is a condition where the blood thyroid hormones are produced at a low level due to the obliteration of the thyroid glands. The main reasons for the obliteration are autoimmunity, for example, Hashimoto's thyroiditis, and some other reasons may be radiation, surgery, radioiodine, iodine deficiency, drugs, and congenital hypothyroidism. Hypothyroidism generated by the exterior portions of the thyroid glands is known as secondary hypothyroidism. A deficiency in the pituitary gland is usually the cause of this illness. Pituitary hypothyroidism is a disorder in which one or both of the pituitary gland's hormones are not produced. Due to lack of hormone production, the person may suffer from pituitary gland diseases. This condition may affect both adults and children (Pearce et al., 2003). Tertiary hypothyroidism is a situation in which the thyroid gland fails to generate enough thyroid hormones, with the hypothalamus as the major source of the problem. Here the hypothalamus is unable to produce sufficient level of thyrotropin releasing hormones, further this results in lower level production of thyroid stimulating hormones. All together stimulated the thyroid gland to produce insufficient hormones (Gupta & Lee, 2011; Shahid et al., 2021). Thyroid disorders are caused due to hormonal imbalance, balanced thyroid hormones are crucial for the human body to function correctly. Some of the human body's function ultimately depends on balanced thyroid hormones. The functions are energy regulation, Weight control, growth, tissue restoration, fat, carbohydrate, protein metabolism, digestion, hormone secretion, body temperature regulation, and sexual functions. That is why it is considered that the thyroid hormones are essential for bodily functions to perform are an optimal level. Thyroid hormones are thought to play a role in brain chemistry abnormalities, according to scientists. Thyroid hormone levels that are out of balance can have a significant impact on the subject's behaviour and emotions (Bernal, 2007).

## 1.7 IMPORTANCE OF THE THYROID HORMONES

There are a wide variety of physiological processes in the adult human body. Each process influences each organ system. To perform all these processes perfectly, there is a great need for an appropriate number of thyroid hormones. Thyroid hormones have an effect on every cell and organ in the body. Thyroid hormones have an important role in the growth of an immature person. Thyroid hormones must be present in sufficient levels for the neurological system to grow properly. Thyroid hormones control the energy usage by the body. The

thyroid hormones monitor metabolism, brain functioning, heart functioning, liver, and other functions (Mullur et al., 2014).

## 1.8 FUNCTIONS OF THE THYROID HORMONES

The iodine content from the food is used to produce the thyroid hormones by the thyroid glands. The two hormones are triiodothyronine and thyroxine, which are stored in the thyroid glands and released when the body demands them. The pituitary gland and hypothalamus keep an eye on the thyroid gland. The TRH is a hormone produced by the hypothalamus and TRH also activates the pituitary gland, which releases thyroid stimulating hormones. If the hypothalamus and pituitary gland are working well, they can immediately detect whether thyroid hormone is working properly or not; if hormone levels are high, they emit less TRH and TSH. Thyroid hormone production may be reduced as a result of this. (Pirahanchi et al., 2021). The thyroid hormones regulate the burnt calorie rates and affect the Weight loss or gain process. The process is simple, the thyroid hormones control the metabolism cells and regulate the body's oxygen consumption. The physical and brain development of the fetus entirely depends on the thyroid hormones produced by the mother's thyroid gland. The fetus is developed with the help of the mother's thyroid hormones until the twelfth week. Later the fetus's thyroid glands are produced after the twelfth week. The fetus with fewer thyroid hormones will develop slowly, and more hormone production will grow faster. The heart, muscles, bones, and fat are all affected by thyroid hormones. Thyroid hormones are released into the circulation and distributed throughout the body (Bernal, 2007).

## 1.9 SYNTHESIS, SECRETION, AND METABOLISM OF THYROID HORMONES

Thyroid hormones are entirely different from the endocrine system. The thyroid hormones are synthesized differently, and they perform the role of both production and storing the thyroid hormones. Thyroxine, triiodothyronines, TRH generated by the hypothalamus, and TSH produced by the anterior pituitary gland are hormones produced and released by thyroid glands (Shahid et al., 2021). The calcitonin is secreted from parafollicular cells. Compared to the T4, the T3 hormones are active further the T4 hormones are converted into T3 in the peripheral blood tissues. In this entire process, T4 is considered a critical pro hormone. The crucial things required for thyroid iodine synthesis are iodine and tyrosine (Farhana. & Yusuf, 2021).

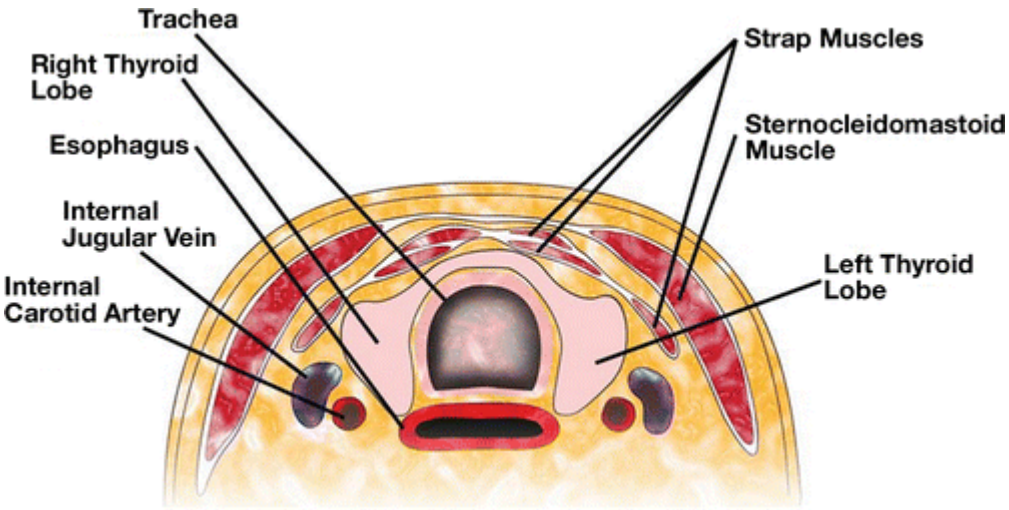


Figure 3: Cross sectional anatomy of thyroid gland

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Iodine is a mineral, and tyrosine is an amino acid. Iodine and tyrosine play a significant role in supporting average thyroid hormone production and optimizes thyroid gland functioning. Iodine insufficiency is one of the most common causes of thyroid dysfunction. Hypothyroidism is caused by damage to the hypothalamus in the brain. (Chung, 2014).

## 1.10 HYPOTHYROIDISM AND METABOLIC DEFECTS

Thyroid hormones have a direct effect on mitochondria, regulating energy conversions and allowing body cells to use oxidation. As the hormones have direct control over mitochondria, it also indirectly controls the protein synthesis rate. The thyroid hormone action is one of the important reasons for excess production or deficiency; in hypothyroidism, slow fuel consumption is the reason for less energy production. The physical and chemical features of the diseases are reduced (Harper & Seifert, 2008). Thyroid dysfunction is characterized as changes in lipids, lipo protein metabolism, and carbohydrates. Hypothyroidism in a subject is associated with increased plasma cholesterol, low density lipoprotein, and a positive association with premature atherosclerosis. The patient with the myxoedemic has decreases low density lipoprotein rates (Rizos et al., 2011). A person suffering from hypothyroidism may experience many symptoms that show severe effects on metabolism. Some of the physical symptoms of hypothyroidism include fatigue, decreased metabolism rate that decreases the amount of heat generated by the body, slow heart rate, muscle pain, and inhibited sweating. Depression is one of the most crucial symptoms of hypothyroidism, and these psychological consequences slow down the metabolism rate (Pearce et al., 2003). Women with decreased metabolism may experience

increased menstruation and impair fertility. It is an undeniable truth that Weight gain and metabolism are directly connected. Hypothyroidism causes a sluggish metabolism, which reduces the body's capacity to burn fat, resulting in Weight gain in hypothyroid women. When hypothyroidism damages the metabolic function, the entire muscle functioning is disturbed, and body temperature goes out of control. Weight gain further leads to obesity; this may result in serious health issues. Obesity also causes diabetes, some types of cancers, and heart diseases. On the other hand, the subject with hypothyroidism may even experience impaired memory, swollen feet, hands, and face, impaired cognitive functions, reduced heart rate, poor smelling and tasting, hair loss, anemia, sluggish reflexes, higher serum cholesterol, breathing issues, sleepy, regular hypoglycemia, impaired renal functions (Sanyal & Raychaudhuri, 2016).

## 1.11 DIAGNOSIS IN PRIMARY HYPOTHYROIDISM

The diagnosis of hypothyroidism is carried out after reviewing the subject's complete history, including personal and family. Apart from this review, any other risk factors are found out in the physical examination. Many hormone types are examined through a blood examination to know thyroid status. The most important one is TSH and the free thyroxine to support the diagnosis. However, it is challenging for the physician to treat the subject only based on the symptoms because most symptoms are common in people with normal thyroid functioning (Pearce et al., 2003). The T4 hormones are usually replaced 10 to 15 ug/kg/day to maintain the average plasma level in the subject. Hashimoto's thyroiditis is a long lasting or chronic form of autoimmune thyroiditis. This is the condition where the antibodies are against thyroglobulin and thyroid peroxidase (Clement et al., 2019). Finally, the thyroid cells are damaged and result in hypothyroidism. The conventional treatment is Allopathy is the process of regular blood level restoration of the thyroid hormones. Levothyroxine is a synthetic hormone drug used to treat hypothyroidism, and it replaces the missing hormone. The dosage is adjusted with continuous monitoring. With this process, the patient will be able to return to their everyday lifestyle. It is challenging to treat hypothyroid because normalizing the hormone production is very important, and the treatment involves drug therapy and radioactive iodine treatment. Even thyroid surgery is suggested to remove the entire gland in advanced cases. Radioactive iodine is the popular thyroid treatment, but this treatment results in hypothyroidism, so consumption of levothyroxine is suggested to restore normal thyroid functioning (Tabish, 2008). Complementary and Alternative Treatment (CAM) is a medical system that is used to treat

hypothyroidism and is considered part of mainstream medicine. Complementary medicine refers to the use of both non-traditional and traditional medications, and it is classified into several categories, including natural medicines such as vitamins and minerals. Mind and body medicine include meditation, *yoga,* hypnotherapy, progressive relaxation, acupuncture, tai chi, body based practices such as spinal manipulation, massages, movement therapies, pilates, and whole medical systems, such as *Āyurvedic* medicine and traditional Chinese medicine (Sengupta, 2012). Majority of patients use CAM as an alternative to conventional medicine. People choose CAM for various reasons, there are fewer chances of controlling symptoms through conventional medicine. People wish to undergo natural treatment that helps them to feel comfortable and controlled. People are more concerned about the side effects of conventional treatments, and CAM is less toxic and natural. Some herbal supplements are proposed as therapies for hypothyroidism, and the herbals include bugleweed, alphalipoic acid, lemon balm, and motherwort (Jonklaas et al., 2014).

## 1.12 SUBCLINICAL HYPOTHYROIDISM

Subclinical hypothyroidism is a situation in which the thyroid system's effectiveness is lowered yet it still generates enough thyroid hormones for the body to function. According to the study (Peterson et al., 2016) it is shown that TSH level does not make much difference whether or not there are good T3 and T4 circulating levels of the thyroid hormone in serum. Studies described (Gullo et al., 2011) that equal T4 to T3 conversion has not happened in all subjects in peripheral tissues. Some of the facts also proved that (Bianco & Kim, 2006) pituitary tissues have different deiodinases to peripheral tissues. So, it was concluded that each reacts in a different form to the thyroid hormone. Here are some reference ranges that doctors use to diagnose both subclinical hypothyroidism and hypothyroidism. The TSH level ranging from 5-10uU/ml falls under the category of subclinical hypothyroidism. The TSH ranging from 5-10 should recheck the lab test in six months. TSH level more significant than 10uU/ml falls under hypothyroidism, which is treated with levothyroxine monotherapy. According to the newer study, the reference range needs (Fatourechi, 2009; Wartofsky & Dickey, 2005) a tighter parameter due to different factors. One of the complicated facts is that many studies have shown that subjects treated with levothyroxine and synthyroid (Peterson et al., 2016) to normalize TSH levels are spotted with low Free T3 compared to those with normal thyroid functioning subjects. Analyzing the above facts concludes that lab tests including TSH and Free T4 levels are not adequate to assess thyroid

function. Most doctors solely depend on the blood test to assess the TSH level and conclude that the thyroid is functioning well if the TSH is normal. However, TSH is not an accurate way to examine thyroid function. Many newer studies highlight TSH and suggest that tighter reference ranges are in order (Wartofsky & Dickey, 2005), and TSH is not the right way to assess thyroid function (Samuels et al., 2016). It is not uncommon for patients under thyroid medication but suffer hypothyroidism symptoms and different reasons, maybe treated with levothyroxine, they are diagnosed based on TSH levels, nutrient deficiencies are noted that have not been treated, not focused on T4 to T3 conversion or reverse the T3 levels (Pearce et al., 2003).

### 1.13 TRIIODOTHYRONINE (T3)

The TSH directly influences the production of triiodothyronine (T3). T3 hormone is produced by around 20% of the thyroid gland (Sapin & Schlienger, 2003). The T3's scientific name or lab examination name is triiodothyronine and inadequate production of T3 hormones causes low T3, resulting in hypothyroidism or Hashimoto's thyroiditis, and experience hypothyroid symptoms, thyroid gland inflammation, and obesity. Decreased production of T4 or T3 will harm Thyroid function. When the conversion of T4 into T3 is not carried out acceptably, the T3 level is reduced. Through this process, the body uses the circulating T4 to convert it into T3 through some crucial enzymes. If the body has a low supply of T4 or reserves T4, the amount of T4 used to convert into T3 will be reduced and results in low T3 serum, which is found out through lab examination (Larsen & Zavacki, 2013).

### 1.14 THYROXINE (T4)

The plentiful T4 hormone is produced naturally by the body under appropriate working conditions. Thyroxine is the scientific and the lab examination name of the T4 hormone. Once the TSH is stimulated from the pituitary gland, it instructs the thyroid gland to produce the T4 hormone. Later the T4 hormones are circulated throughout the body and converted into T3 thyroid hormones by the cells when there is demand. When there is low circulating T4 thyroid hormone, it results in low circulating T3 hormone, which will cause hypothyroid symptoms. The T4 accounts for about 80% of the thyroid's hormone production. Remaining 20% of hormones produced by the thyroid is T3. Thyroxine gives complete information about thyroid gland functions. If the thyroid fails to produce T4, then it responds to the TSH amount and stimulates the glands to make a more significant number of hormones. There is

an idea about the conversion mechanism of T4 into T3 is understood. Free T4 examination helps identify the conversion process issues and whether the medications are absorbed by the body taken orally (Sapin & Schlienger, 2003).

### 1.15 FREE T3

The Free T3 is a single but most important hormone that sticks to the surface and cell nucleus to create genetic changes. The entire process seems simple, but this makes the thyroid energetic, regulates the cycle, and manages Weight. If the body does not produce a significant amount of T3, the hypothyroidism symptoms are experienced because T3 is the thyroid's main functions' game maker (Marsili et al., 2011). The Free T3 examination provides crucial information about how the body processes the thyroid hormone and the hormones responsible for activating cells and turning genes. All these basic levels are examined and combined with other thyroid lab examinations to provide a clear cut analysis of thyroid functioning in one's body. The Free T3 gives an idea of how to active thyroid at the cellular level. The body's need for free and active thyroid hormones for proper functioning are found out through the examination of Free T3 measurement. Examining the Free T3 helps understand whether the body activating thyroid hormone is used with lab assessments such as Free T4 and TSH (Abdalla & Bianco, 2014).

### 1.16 FREE T4

Free T4 is not an active hormone compared to Free T3. Free T4 level helps determine how the thyroid is converting T4 to T3 efficiently and explains low TSH. Newer studies have shown that subjects with hypothyroidism need higher Free T4 to normalize the TSH levels (Iverson & Mariash, 2008). According to the basic thyroid physiology, the Free T4 level acts as a reservoir when the body requires to create the active thyroid hormone Free T3. Therefore, the more accessible the T4 level, the more can be drawn from the pool to create the active hormone. Unfortunately, 15% of the population is not (Panicker et al., 2009). Therefore, when there is a high level of T4 equivalent to low levels of T3, there is a greater need to improve the T4 to T3 conversion. The Free T4 level is examined since, in comparison to Free T3, it is not free and active. The efficiency with which T4 is transformed into T3 by the thyroid gland is determined by free T4 classes. Aside from the conversion state, Free T4 also explains why the body has a low TSH level. Many recent studies have concluded that subjects with hypothyroidism must need higher Free T4 to achieve normal TSH. According to elementary thyroid physiology, the Free T4 levels are the reservoir and

distributed when there is a need for the body to create active thyroid hormone Free T3. Therefore, when the Free T4 level is raised, the body can take it from the reservoir to convert it into an active hormone (Iverson & Mariash, 2008).

## 1.17 AUTO ANTIBODIES

The patients with autoimmune thyroid disease are not frequently detected with thyroid auto antibodies in the thyroid dysfunction subjects. In Grave's Diseases and Hashimoto's thyroiditis, changes in the antigen's cellular location, circulating antibodies titers, antibody experience length, and immunological mechanisms are associated to antithyroid antibody activities. (Fröhlich & Wahl, 2017). The presence of antithyroid peroxidase antithyroid stimulating hormones receptor (TSHR) antibodies, and anti thyroglobulin results in autoimmune thyroid (Marcocci, 2005). According to the research data conducted in two areas data from North America, Europe, New Zealand, Australia (area 1) and the Middle East, Asia and South America Caribbean (area 2) (Cooper et al., 2009) concludes that autoimmune thyroid disease includes numerous inflammatory thyroid disorder with Grave's disease and Hashimoto's Thyroids (McLeod & Cooper, 2012).

## 1.18 ANTI TPO ANTIBODIES

TPO antibody is a protein that is present in thyroid cells. The critical function of TPO antibodies is to help the body to create thyroid hormones (Shui-Boon & Tar-Choon, 2019). Various reasons for low TSH and what is happening in the body are found through anti TPO lab examination. Presence of anti TPO antibody levels reveals that the thyroid is working sub optimally. If the examination confirms positive anti TPO antibodies, it indicates an inflammatory state which needs medical guidance. Anti TPO antibodies in the blood stream also indicate the autoimmune condition where the immune system does not function properly. The anti TPO antibodies stay in a misconception that the thyroid gland is an enemy tissue and attempt to destroy the thyroid gland tissues. That is how it is known as auto means a self, and immune means immune system. Some of the important reasons for the increase in anti TPO antibody levels are low vitamin D, increased intestinal permeability, poor diet, inflammation, and increased stress levels (Fröhlich & Wahl, 2017). The patients with increased anti TPO antibody levels are treated with supplements, hormones, medication, diet, and avoiding endocrine disruptors. If the anti TPO antibody is left untreated, it may cause severe damage to the thyroid gland. There might be many differences between autoimmune thyroiditis and hypothyroidism, and it is also challenging to diagnose. The anti

TPO antibody condition should be considered different from chronic hypothyroidism, and the treatment should be given accordingly. The treatment for anti TPO antibody is entirely different, and the patient should be offered as much as a possible effective treatment to reduce the inflammation and autoimmunity (Schroeder & Privalsky, 2014). When the inflammation is not treated correctly, it may lead to severe and permanent damage to the thyroid gland. When there is a presence of anti TPO antibodies, it is assumed that there are many other health issues in the body. That should be addressed immediately because these issues can easily trigger the autoimmune component. Once the treatment is started and successful, it improves thyroid functioning and reduces the symptoms. Therefore, anti TPO antibodies are never a typical sign and, when combined with hypothyroid symptoms, may result in autoimmune thyroiditis (Fröhlich & Wahl, 2017). Complete thyroid lab tests, including antithyroid antibodies, should be examined if the patient is experiencing hypo thyroid symptoms. There are more chances of experiencing thyroid abnormalities, so it is mandatory to understand how to diagnose and manage the condition. Therefore, it is essential to suggest various supplements, hormone replacement to reduce inflammatory state, diet, and stress reduction to the patients and it is necessary to act in the early stage to protect thyroid functioning. Thyroglobulin is also found in the same place, but the working mechanism of thyroglobulin is slightly different. The most exciting part is that these antibodies negatively target various thyroid parts, leading to hypothyroidism. So, when the antibody is examined, it is imperative to investigate others too. Specific changes including improving diet, sleep, intake of supplements, exercising more, and using Low Dose Naltrexone (LDN), will drop the level of hypothyroidism within few months. Anti thyroglobulin antibodies imply a weakened immune system and dysfunctional thyroid gland. If there is a suspicion of thyroid illness, anti thyroid antibodies must be tested. Once the immune system is improved, again the antibody level should be evaluated. It is also necessary to know whether there is a connection between elevated thyroglobulin antibodies and the development of thyroid cancer (Nussey & Whitehead, 2001).

### 1.19 ANTI TG ANTIBODY

Thyroglobulin is an essential protein present in the thyroid gland. Thyroglobulin helps the body to create, store and release the thyroid hormone, anti thyroglobulin antibodies with their immune system attack this protein (Shahid et al., 2021). A doubt arises about how the thyroid gland's problem is created if its body is attacking it. If the anti thyroglobulin antibody is present, it indicates both the immune problem and thyroid problem. The immune

system should not destroy both bodies, which is the reason for immune problems and thyroid problems. All these antibodies float around the blood to target the thyroid as both inflammation and damage are experienced. Further, the damage blocks the release of thyroid hormones that causes hypothyroidism or decreases thyroid functioning. The good thing is that examining these antibodies provides complete knowledge about what is happening in both the immune system and thyroid gland (Dua, 2005; Núñez et al., 2017; Shahid et al., 2021; Singh & Sandhu, 2021; Sorisky, 2016). The body manufactures the antibodies to own tissues if the immune system is functioning correctly. If there is the presence of thyroglobulin antibodies, it indicates the autoimmune disease of the thyroid gland. The thyroglobulin antibodies also increase in the case of Graves' disease. There are people with increase in anti thyroglobulin antibodies with normal thyroid gland functioning (Mehran et al., 2013). Increases level of thyroglobulin antibody sometimes spotted an autoimmune condition such as vitiligo (Yang et al., 2014) cancer, and even during pregnancy (Balucan et al., 2013). Antibodies do not create health issues directly, for instance, presence of antibodies but experiencing low thyroid functioning or hypothyroidism. On the other hand, people may have antibodies and hyperthyroidism. It is essential to note that both hypo and hyperthyroid symptoms are different.

## 1.20 SEX HORMONE BINDING GLOBULIN (SHBG)

The SHBG is a sex hormone that binds to the globulin, and the serum blood test is useful for determining hormone levels. When there is a low level of SHBG, it is linked with low thyroid function, and estrogen with high levels binds up the testosterone, results in Weight gain and depression, so why are the bind sex hormones essential? The hormones that float around the serum are of two primary forms bound to proteins and unbound to protein (Mendel, 1989)**.** When the binding of hormones to specific proteins will leave inactive, it will not be available to use if the hormone is bound to protein. Unbound hormone to the protein is free and actively enters the cell to complete the job. Hormones in their natural state the cellular activity of free T4 and free testosterone assists in genetic modifications. When compared to the bound hormone in the blood, the amount of free hormone is negligible. This binding mechanism is used by the body to keep track of specific hormones that keep everything in check. Dihydro testosterone is preferred (DHT) (Hobbs et al., 1992) is the most capable androgen then estrogen, androstenediol, testosterone, and estradiol. Because of how SHBG impacts androgens and the symptoms that occur in both men and women, it is chosen to bind to and inactivate different androgens. Both testosterone and

DHT are inactivated by high SHBG levels; both men and women can have low testosterone symptoms. Weight gain, loss of muscle mass, sadness, and irritability are some of the symptoms. Low testosterone levels may activate more testosterone, resulting in symptoms such as facial hair growth, PCOS, acne, weight gain, and irritability in women. Two central hormone systems influence SHBG: thyroid hormone (Payne et al., 1997) and estrogen levels (Pasquali et al., 1997). When there is a circulating volume of sex hormone binding globulin in the blood, these two hormones are stimulated. Low SHBG levels have been linked to an increased risk of type 2 diabetes (Maggio et al., 2008). As a result, when the SHBG level is low, it should be normalised for this reason. The SHBG is a vital instrument for determining thyroid function at the cellular level, and inadequate thyroid function can lead to a decline in SHBG levels. When thyroid hormones are provided, the SHBG increases, and it's used to evaluate thyroid hormone absorption and cellular function (Yup et al., 2015). There should be increase in the SHBG levels with thyroid therapy and be monitored continuously once the dose is altered. SHBG helps assess thyroid function at the cellular level in low thyroid function, the SHBG level drops, and if the thyroid hormones are replaced, the SHBG rises. Therefore, the SHBG is used to evaluate thyroid hormone absorption and the thyroid hormone cellular action. Thyroid hormones are involved in the anabolism and catabolism of molecules, as well as the creation of a glycoprotein known as SHBG. Thyroid hormone levels and SHBG have a positive association. Hypothyroidism patients have lower SHBG levels than those with healthy thyroid glands, according to research. Thyroid drugs in hypothyroid individuals have been linked to elevated SHBG levels, according to the dosage, according to the specialists (Ford et al., 1992).

## 1.21 CORTISOL

Cortisol is a stress hormone produced by the adrenal glands (Yup et al., 2015) that affects essential organs such as bones, muscles, blood vessels, the brain, hormone-producing glands, the lungs, blood vessels, and the heart (Yaribeygi et al., 2017). Cortisol is a hormone that governs and responds to stress, fights infection, maintains blood sugar levels, and regulates blood pressure in the body (Hakamata et al., 2017; Yaribeygi et al., 2017)**.** Either underactive thyroid or low thyroid increases the Cortisol levels in the blood. Cortisol causes two common conditions they are Addison's disease and Cushing syndrome. There is too much cortisol in Cushing's syndrome, and in Addison's disease, there is very little Cortisol (Habib et al., 2017; Hakamata et al., 2017; Iranmanesh et al., 1990; Yup et al., 2015). There are many ways to reduce Cortisol levels in the body that includes both physical

and mental factors, it is beneficial to include *yoga*, creating art, and spending time with the natural environment because these have proven to reduce Cortisol levels (Ewert & Chang, 2018; Kaimal et al., 2016; Thirthalli et al., 2013).

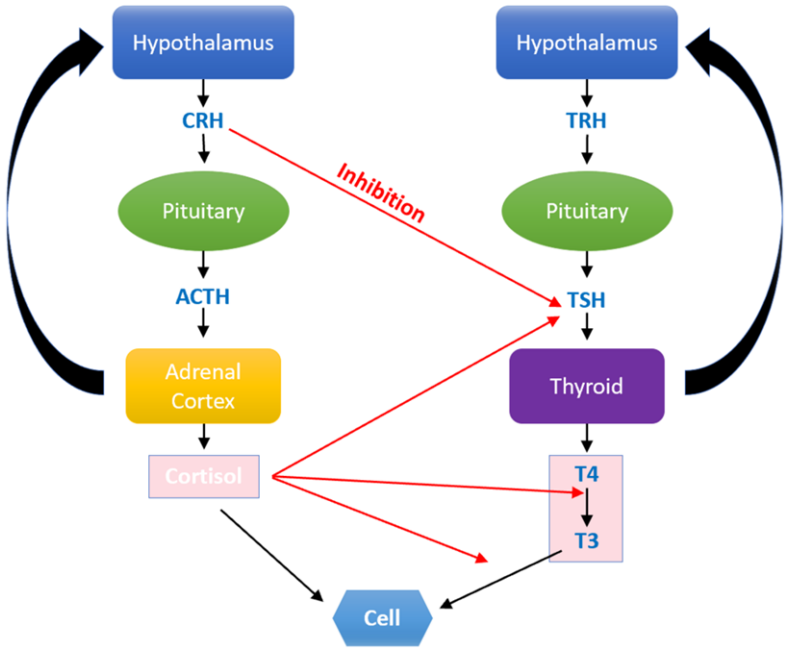


Figure 4: Source: Chronic stress Vs thyroid health

Source: Click Here

In addition, stress stimulates the adrenal hormone Cortisol, which results in a flight or fight response. When the Cortisol reduces the TSH automatically, the thyroid hormones production is lowered and Cortisol blocks T4 to T3 conversion as results it reverses T3 when T4 transformation happens. Significant but indirect effects of adrenals on thyroid functions have occurred through blood sugar, lower or higher levels of Cortisol result in hyperglycemia or hypoglycemia, or both. When the blood sugar levels are imbalanced, it results in hypothyroid symptoms. The participants undertaking *yoga* activities had reduced serum Cortisol levels, according to cross sectional observations among the three groups. (Katuri et al., 2016). According to the seven *yoga* instructors' the blood levels of serum Cortisol and brain levels during *yoga* exercise, the alpha waves are increased, and there is a decrease in serum cortisol (Kamei, 2000). The *yoga* studies in depression have improved depression symptoms, serum Cortisol levels, and cognitive mood functions (Cramer et al., 2013; Woolery et al., 2004). *Yoga*, mind body health, and meditation have increases the

Cortisol awakening response, Brain Derived Neurotrophic Factor (BDNF), and transformed inflammatory marker expression after practicing *yoga* and meditation retreat for three months (Cahn et al., 2017)**.** According to one of the recent studies, after practicing *yoga* and meditation for three months, only 55% of stress levels were observed compared to the starting point (Rani et al., 2021)**.** An investigation on *yoga* concerning antidepressant effects and serum cortisol in the study (Vedamurthachar et al., 2006) and *yoga* is proven to lower Cortisol (Jayakumar, 2021).

## 1.22 C-REACTIVE PROTEIN

The C-Reactive Protein is another way to measure the systemic inflammation in the body (Dhingra et al., 2007). There are two versions of CRP, HSCRP-high sensitivity CRP and the standard CRP. Inflammation is one of the severe health issues, and everyone is aware of it, but it is one of the diseases that nobody cares (Sung et al., 2003). Any inflammation can be a severe danger and create many health issues. Inflammation develops severe illnesses, including heart attack, cancer, hormone system disruption, thyroid and stroke. The C-Reactive Protein is a severe stage reactant. It is not necessary to know more beyond this. However, it is imperative to know what if there is inflammation in the body. The liver will start pumping specific proteins. One of these proteins is CRP, this is the basic and earliest proteins pumped out from the liver; when inflammation in the body liver turns on and starts pumping out specific proteins and enzymes such as CRP. The liver indicates that there is an inflammation in the body. Still, it does not tell where the inflammation is coming from. Examination of CRP is associated with severe illnesses such as cardio attacks and other cardiovascular diseases (Sproston & Ashworth, 2018).

## 1.23 WEIGHT AND HYPOTHYROIDISM

Hypothyroidism and obesity has close relationship with each other and hyperthyroidism and Weight loss has close relationship (Prego et al., 2019). The thyroid hormones have great contribution in most of the physiological processes in the body. Thyroid hormones help the neurological system generate heat in response to cold exposure by regulating the basal metabolic rate (BMR), gluconeogenesis, lipolysis, and lipogenesis. (Mullur et al., 2014). When comparing body Weight loss, BMI and serum lipid profile improvement, and serum thyroid profile improvement in both case and control groups, it was shown that naturopathy

and *yoga* had therapeutic and protective benefits in the treatment of obese hypothyroid patients. (Shetty et al., 2020)**.** Obesity and hypothyroidism are intimately related, and obesity is a secondary symptom in thyroid dysfunction patients. Many recent studies have described that obesity and thyroid autoimmunity are linked, and adipocyte leptin is the key factor that links these conditions and have demonstrated the exciting relationship between obesity and hypothyroidism (Sanyal & Raychaudhuri, 2016).

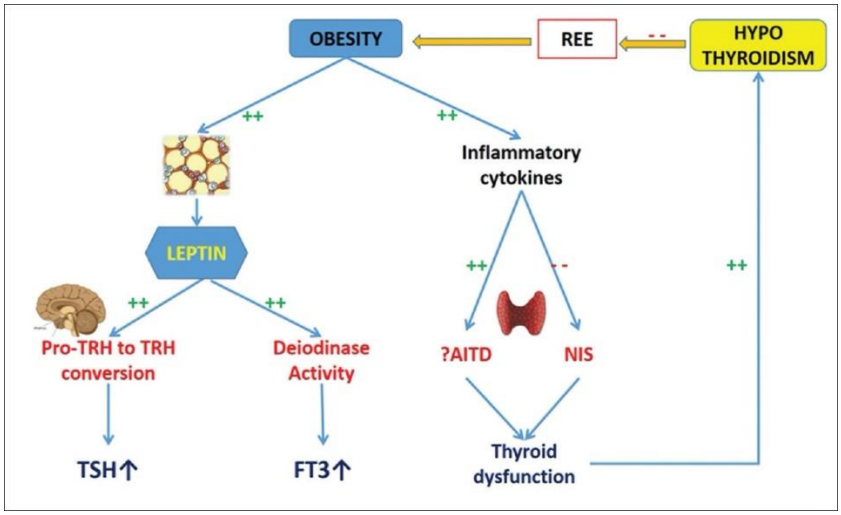


Figure 5: Interrelationship between obesity and thyroid dysfunction

Source: Click Here

Hypothyroidism is linked to a decrease in thermogenesis and metabolic rate, as well as a higher body mass index (BMI) and obesity prevalence. (Danforth et al., 1979; Sanyal & Raychaudhuri, 2016). The majority of clinical data shows that even a little change in thyroid function within laboratory reference ranges causes Weight gain; however, not all clinical investigations back this up. In the normal range, however, there has been evidence of an inverse relationship between BMI and Free T4 (Knudsen et al., 2005; Sanyal & Raychaudhuri, 2016). Obesity and thyroid failure are some of the most common diseases that frequently coexist. According to a research on obese participants done in India, over 33% of the obese population had overt hypothyroidism, whereas 11% of the obese population had subclinical hypothyroidism. Obesity was also shown to be a prevalent issue in overt hypothyroidism (46 percent vs. 34 percent) but not in subclinical hypothyroidism, according to the research (Verma , 2008; Sanyal & Raychaudhuri, 2016)**.**

## 1.24 BODY MASS INDEX (BMI)

The body mass index is metric that defines the height and Weight characteristics in the adults. On the other hand body mass index is calculated to estimate the risk of development

of other ailments especially hypothyroid and obesity. Through BMI the body fat percentage is calculated (Nuttall, 2015). In his study Nilkantan noted some substantial reduction in sTSH levels, BMI, and lipid profile after following six months of $yoga$ intervention in the earlier study (Swami et al., 2010), but one of the studies directed by Nilakantan has confirmed there is a significant decrease in BMI. As a result, even little changes in thyroid function have an influence on body mass index and obesity in the general population.

### 1.25 DIET

Iodine is one of the essential minerals that hypothyroidism patients should consume. The different foods with rich iodine content are seafood, kelp, oat meal, parsley, and beetroots. Patients with hypothyroidism should include these foods in their diet. Including high fiber, low calorie foods, minimal salt intake, and less sugar in the diet. Consuming coconut oil improves the sluggish metabolism, and the patients should follow an active lifestyle. Practicing $yoga$, aerobics, and other physical exercises are helpful to fight hypothyroidism (Atkinson & Permuth-Levine, 2009; Nitin et al., 2015). Avoiding the dairy products, refined foods, processed foods gives good benefits and dairy products are entirely not advisable for thyroid patients (Singh & Sandhu, 2021). Goitrogenic foods such as broccoli, soybean and soybean products, sweet potatoes, cassava, turnips, and pears should be strictly restricted (Atkinson & Permuth-Levine, 2009). Minimal intake of caffeine drinks is good (Woodyard, 2011). Soy products intake is not advisable as it influences hormones and impacts the thyroid negatively (Dua, 2005). Consuming organic foods, drinking plenty of water, intake of balanced ratio of proteins, vitamins, healthy fats, and carbohydrates are advisable. Most importantly, foods that boost metabolism are highly beneficial. Choosing a diet that helps sustain for a long time in a day is essential, and just following a diet for a few weeks will not help. Therefore, following a proper whole food diet specially prepared for hypothyroidism and Hashimoto's thyroiditis is suggested. Following the diet regularly increases the energy level and aids in Weight loss (Paoli et al., 2021). Obesity and hypothyroidism are closely linked to two clinical conditions. Obesity is secondary symptom to the patients with thyroid dysfunction. Many recent reviews have described that obesity and thyroid autoimmunity are linked to each other, and the adipocyte leptin is the key factor that links these conditions. Most of the studies has demonstrated the interesting relationship between obesity and hypothyroidism (Sanyal & Raychaudhuri, 2016). Hypothyroidism is linked to a decrease in thermogenesis and metabolic rate, as well as a greater body mass

index and obesity prevalence (Danforth et al., 1979; Sanyal & Raychaudhuri, 2016)**.** The majority of clinical data shows that even a little change in thyroid function within laboratory reference ranges correlates to weight gain; however, not all clinical investigations back this up (Knudsen et al., 2005; Sanyal & Raychaudhuri, 2016). Obesity and thyroid failure are some of the most common diseases that frequently coexist. Including gluten food products in diet results in inflammation, avoiding gluten in diet decreases inflammation, and adiposity. These foods shows negative impact on the hormones and thyroid health (Messina & Redmond, 2006).

## 1.26 QUALITY OF LIFE

Complete impression on health and health care changed time to time as most of the different factors affect the concept health every now and then. The recognition of medical participation, which tries to increase people's life span and quality of life, and the social implications of illnesses are the two most significant causes driving the developments. Because it is so closely linked to health, it is impossible to adequately explain or define Quality of Life. The term "Quality of Life" refers to a patient's physical, mental, and social well-being following treatment for a condition (Carr et al., 2001). Most of the studies have described advancement in pulmonary function checkups and the Quality of Life of women with hypothyroidism following *yoga* intervention (Halder, 2012; Swami et al., 2010). A study by Michelsen reported an essential reduction in anxiety, bodily complaints, mood swings, depression, and psychological Quality of Life among distressed women by following the *yoga* intervention three months (Iyengar, 2014; Michalsen et al., 2005).

Improve essential Nutrients, gut health should be improved to treat the gut imbalance, T3 reverse should be reduced, liver function should be examined, enhance iron and ferritin, enhance the adrenal function and stress management, ensure adequate iodine absorption, balanced diet, exercise, and *yoga*. Modest Thyroid hormone homeostasis is affected by weight reduction, and peripheral conversion is inhibited (Agnihothri et al., 2014). Taiwanese researcher Chien-Yu Lin in the journal of clinical endocrinology and metabolism concluded cosmetics and other household products containing chemicals such as per fluorinated chemicals changes the normal thyroid functioning in both women and men. According to one of the research per fluorinated chemicals increases the risk of mild hypothyroidism (Mughal et al., 2018).

Most of the primary care providers suggest only TSH examination to know the thyroid status of the patients but apart from TSH the other different biochemical tests such as T3, Free T3, T4, Free T4, Weight and BMI, SHBG, Anti Tg, Anti TPO, Quality of Life, Cortisol, and C-Reactive Protein are very impportant to know the thyroid status of the patients. Most of the doctors do not order above biochemical tests but the above parameters are equally important to come to the conclusion on thyroid status (Alevizaki et al., 2005; Sheehan, 2016).

Regular *yoga* practice provide amazing health benefits as it starts healing from mind to body fianly ensures the overall fitness. Therapeutic *yoga* offers best cure for different ailments, *yoga* postures and regular practice is the best treatment for all most of the health conditions. The Integrated Approach of Yoga Therapy (IAYT) is the professionally designed *yoga* program for curing most of the ailment. The IAYT is one of the effective and amazing alternative treatment method that gives effective results without adverse effects (Woodyard, 2011).

The current chapeter covered the detailed insight on thyroid gland and its function with all the thyroid hormones and other related parameters. The next chapter provides ancient literature evidences on hypothyroidism. Critical Review of Hypothyroidism According to Ancient Indian Scriptures. This chapter also explains the related symptoms of thyroid diseases that were described in ancient Indian literature.