CHAPTER I

INTRODUCTION
1.1 The Tribal Land Bastar

1.1.1 The geographical location of Bastar

Bastar is the tribal district of Chhattisgarh. It was one of the largest districts in India before being split into three districts. It remained a district of the state Madhya Pradesh till 2000, with an area of 39171 sq. k.ms. Bastar region is situated between 17° 45' and 20° 34' North latitude and 80° 15’ and 82° 15' East longitude and at an altitude of 2000 ft. It was a vast kingdom inclusive of the present Kotpad and Malkangiri in Orissa, Upper Godavari district in Andhra Pradesh and Sihava in Dhamtari district of Chhattisgarh. The present Bastar region covers an area of 39,171km$^2$. As per the recent political developments Bastar division consists of five southern most districts of the newly formed state of Chhattisgarh: Bastar, Kanker, Dantewada, Bijapur and Narayanpur. Bastar region has four borders: that of Andhra pradesh, Maharastra, Orissa and of Chhattisgarh itself. (1) Though the cultures of all borders make much impact on Bastar.

1.1.2 The Name Bastar

Bastar is a small village situated 20 km away to the north of Jagdalpur. The etymology of the name "Bastar" is always a matter of dispute among scholars. According to a mythical tradition the goddess "Danteswari helped Annam Dev to establish a new kingdom by spreading her garment (vastra) over a vast area. This mythical story tells that the name
Bastar originated from the word "Vastra" (garment). According to some scholars the name Bastar is originated from the word "Bansthari" (Land of bamboo) because bamboo is seen all over Bastar in abundance and some others attribute its origin to the word "vistrit" (vast) since it is a vast area. The name of a small village Bastar happens to be applied to the whole district because of its historical importance. (2)
Figure 1.1. Geographic location of Bastar in map of India.
1.1.3 Population of Bastar

It is one of the major areas in the tribal map of India. The population of Bastar region according to 2011 census is 1411644. The district has a population density of 140 inhabitants per sq km. Its population is mainly tribal and growth rate over the decade 2001-2011 was 17.83 %. Bastar has a sex ratio of 1024 females for every 1000 males. The tribal population in Bastar is mainly rural, 98% of them live in rural areas. This tribal population is not a single homogenous society. There are seven major scheduled tribes in Bastar: Gonds, Muria, Maria, Dhorla, Bhatra, Halba, Dhurva. (3) It has been observed that the tribal communities possess considerable degree of heterogeneity. They tend to live in homogeneous groups covering distinct and defined territories. In interior villages they live a very primitive life style having agriculture as the main source of income. They employ very primitive methods of agriculture; hence the agricultural outcome is very low. They are forced to depend also on forest for their livelihood.

1.1.4 Nutritional and Health status

Food is a pre-requisite not only for attaining good health but also for maintaining adequate growth and body equilibrium. The food habits of tribes are greatly influenced by thought, beliefs, notions, and traditions of the society and largely depend upon their socio economic condition. (4) Bastar is a region where both agriculture and forest contribute to the economy.

The staple diet of Bastar tribes is rice or pej ( a semi liquid food drink prepared by boiling the millets, cereals and rice) yet almost all of them supplements their cultivated foods with seeds, leaves, roots and tubers of wild growing plants with sometimes wild or domestic animals. Leafy or the non leafy and tuberous vegetables are regularly eaten. Few vegetables and almost no fruits are grown by them, for supply of these; tribes look mainly for the natural forest production. (5,6) The general notion that the tribes living in
forest consume very large quantities of meat is not correct for Bastar. Meat and fish consumption here is only about 5.6 g per consumption unit. The average intake of animal protein, therefore per day per consumption unit is only 1.2 g whereas consumption of vegetable protein is 78.4g. It is important to note that milk intake is negligible among the tribes, than of cereals and millets consumption is higher than the recommended dietary allowances. Among cereals their diet is confined to Maize and Jowar. To the extent they denied to give milk to infants and small children. No healthy foods are being consumed during pregnancy.\(^{(6,7,8)}\) Drinking of indigenous liquor, "Mahua" is a popular practice among the tribes. Men and women are found to be habitual drinker and consume liquor daily in a good measure. The liquor is such an integral part of tribe's life that every rite and ritual begins and ends with it.\(^{(4,9)}\)

Health is important for human development and is an essential component for the well being if the mankind. Health status of the tribes is very poor and worst because of their isolation, remoteness and being largely unaffected by the developmental processes going on the country.\(^{(10)}\) A study reveals that, nutrient intake in the food consumed by individuals were calculated using Food composition tables from Nutritive Value of Indian Foods and then compared with recommended dietary allowances to know the inadequacy in diet. It was found nutrients was lower than recommended allowance, protein intake was also not closer.\(^{(11)}\) Nutritional status of tribes of Bastar is very deficient in all essential food elements. Micronutrient deficiency is closely linked with nutritional disorders and diarrhea. Deficiency of essential dietary components leads to malnutrition, protein calorie deficiency and others like Vitamin A, B complex, iron, iodine etc.\(^{(12,13)}\) Because of their dependence on primitive agricultural practices, they often face uncertainty of food supply and thus tend to suffer from under-nutrition. In}
addition lack of proper health and educational facilities, and prevalence of certain irrational belief systems, in respect to health and nutrition aggravate the situation.

Studies have suggested that tribes living in different eco-systems have varying degree of nutrition and health status. Though the tribal communities constitute nearly 8% of the total population of the country, they contribute 25% of the total malaria cases and 15% of total *p.falciparum* cases. Water borne communicable disease like gastrointestinal disorders, acute diarrhea are responsible for higher morbidity and mortality due to poor sanitation, unhygienic conditions and lack of safe drinking water. The diarrhoeal disease including cholera was found to occur throughout the year attaining its peak during the rainy season. Intestinal protozoan and helminthes infestations are mainly observed in children aged 0-14 years because of indiscriminate defecation in the open field, bare foot walking and lack of hygiene. Tuberculosis, yaws, leprosy and other skin problems like scabies is frequently seen.¹⁰,¹⁴,¹⁵

### 1.1.5 Status of Thyroid Dysfunction and its causes

Thyroid dysfunction is very common health problem in Bastar region. It is commonly noticed in women.¹⁶ The Bastar plateau is situated at a height of 2000 ft above the sea level, with red –sandy soil. It is a heavy rainfall region with annual rainfall of 1509 mm and during rainy season (june - october) 1397mm.¹⁷ Because of heavy rainfall frequent flooding occurs which is particularly likely to wash away the superficial layer of the soil in which iodine is present and therefore decrease the iodine content of the soil. The problem of iodine deficiency further gets aggravated by deforestation and subsequent soil erosion.¹⁶,¹⁸ In upper part of the pleateau the soils are shallow, young with less developed features and are highly eroded. Down the slope, the soils have more developed features.¹⁷ Food crops and water derive iodine from the soil. In areas with no iodine deficiency, 60-75% of the iodine needs are met by the iodine present in the diet
and the rest through the iodine content of water. Consumption of crops and plants grown
on iodine deficient soils leads to iodine deficiency in population solely dependent on
these diets, for their iodine requirements. The food grown in iodine deficient regions can
never provide enough iodine to the population and livestock living there. \(^{(18,19)}\)

As mentioned earlier, tribes depend mainly upon forest for their living and mostly
vegetarian in nature. National institute of Nutrition conducted studies showed that the
foods of animal origin had more iodine as compared to plants. High percentage of
crystalline salt is used in the families as compared to powdered salt, which had nil or less
than 15 ppm of iodine, due to cheaper prices. Crystalline salt is often stored outside the
shops where it is exposed directly to sunlight and rain which could lead to loss of
iodine. \(^{(18,20)}\)

Dietary iodine deficiency stimulates thyroid stimulating hormone (TSH) secretion which
results in thyroid hypertrophy. The enlargement of the thyroid gland due to iodine
deficiency is called endemic goiter. Iodine intakes consistently lower than 50µg per day
usually results goiter. The daily intake of iodine sufficient to prevent iodine deficient
goiter in adults is 150µg per day. Additional iodine is required during pregnancy and
lactation. With severe and prolonged iodine deficiency, the effects of deficient supply of
thyroid hormones may occur. This condition is referred to as hypothyroidism. Its severity
can range from mild intellectual blunting to frank cretinism, a condition that include
gross mental retardation, deaf mutism, short stature and various other defects. \(^{(16,18)}\)

Iodine deficiency in pregnant women may cause irreversible brain damage and retard
psychomotor defect in fetus.
1.2 Diabetes Mellitus (DM) and Insulin

1.2.1 Diabetes

DM is a group of metabolic diseases characterized by high blood sugar glucose levels that result from defects in insulin secretion, or action, or both. Elevated levels of blood glucose produce classical symptoms of polyuria, polydipsia, and polyphagia. Normally, blood glucose levels are tightly controlled by insulin, a hormone produced by the pancreas. Insulin lowers the blood glucose level. When the blood glucose level elevates, for e.g. after eating food, insulin is released from the pancreas to normalize the glucose level.

1.2.2 Types of Diabetes

There are two main types of diabetes.

Type 1 diabetes: Insulin-dependent diabetes mellitus (IDDM) and juvenile diabetes.

Type 2 diabetes: Non-insulin-dependent diabetes mellitus (NIDDM) and adult-onset diabetes.

1.2.2.1 Type 1 Diabetes (IDDM or juvenile diabetes)

It is a form of diabetes mellitus that results from autoimmune destruction of insulin-producing beta cells of the pancreas. The subsequent lack of insulin leads to increased blood and urine glucose. In the long run, type 1 diabetes is generally fatal unless treated with insulin. Injection is the most common method of administering insulin; insulin pumps and inhaled insulin have been available at various times. Environmental factors can influence expression of type 1 diabetes. The pathophysiology in diabetes type I is basically a destruction of beta cells in the pancreas. Still, a process that appears to be common to most risk factors is an autoimmune response towards beta cells, involving an expansion of auto reactive CD4+ and CD8+ T helper cells, autoantibody-producing B cells and activation of the innate immune system.
1.2.2.2  **Type 2 Diabetes** (NIDDM or adult-onset diabetes)

A metabolic disorder that is characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency.\(^{32}\) Long-term complications from high blood sugar can include increased risk of heart attacks, strokes, amputation, diabetic retinopathy where eye sight is affected, and kidney failure. For extreme cases, circulation of limbs is affected, potentially requiring amputation. Loss of hearing, eyesight, and cognitive ability has also been linked to this condition.\(^{33,34,35,36,37,38}\) A number of lifestyle factors are known to be important to the development of type 2 diabetes. In one study, those who had high levels of physical activity, a healthy diet, did not smoke, and consumed alcohol in moderation had an 82\% lower rate of diabetes.\(^{39}\) Obesity has been found to contribute to approximately 55\% of cases of type 2 diabetes, and decreasing consumption of saturated fats and trans fatty acids while replacing them with unsaturated fats may decrease the risk.\(^{40}\) Dietary fat intake is linked to diabetes risk. There are many factors which can potentially give rise to, or exacerbate, type2 diabetes. These include obesity, hypertension, elevated cholesterol, acromegaly, cushing's syndrome, thyrotoxicosis, pheochromocytoma, chronic pancreatitis, cancer, and drugs. Additional factors found to increase the risk include aging, high-fat diets and a less active lifestyle.\(^{41,42,43}\) Subclinical Cushing's syndrome may be associated with type 1 diabetes. Severe complications including renal failure, erectile dysfunction, blindness, slow healing wounds, cardiovascular disease and retinal damage. The onset of type 2 diabetes has been most common in middle age and later life, although it is being more frequently seen in adolescents and young adults due to an increase in child obesity and inactivity.\(^{44,45}\)
1.2.3 Insulin

All forms of diabetes have been treatable since insulin became available in 1921. Insulin is the principal hormone that regulates uptake of glucose from the blood into most cells. Therefore deficiency of insulin or the insensitivity of its receptors plays a central role in all forms of diabetes mellitus. Insulin is released into the blood by beta cells (β-cells), found in the Islets of Langerhans in the pancreas, in response to rising levels of blood glucose, typically after eating. Insulin is used by about two-thirds of the body's cells to absorb glucose from the blood for use as fuel, for conversion to other needed molecules, or for storage. It is also the principal control signal for conversion of glucose to glycogen for internal storage in liver and muscle cells. Lowered glucose levels result both in the reduced release of insulin from the beta cells and in the reverse conversion of glycogen to glucose when glucose levels fall. This is mainly controlled by the hormone glucagon which acts in the opposite manner to insulin. Glucose thus forcibly produced from internal liver cell stores (as glycogen) re-enters the bloodstream; muscle cells lack the necessary export mechanism. Normally liver cells do this when the level of insulin is low. When the amount of insulin available is insufficient or the insulin itself is defective, then glucose will not be absorbed properly by the body cells that require it nor will it be stored appropriately in the liver and muscles. The net effect is persistent high levels of blood glucose, poor protein synthesis, and other metabolic derangements, such as acidosis. When the glucose concentration in the blood is raised beyond its renal threshold (about 10 mmol/L), reabsorption of glucose in the proximal renal tubuli is incomplete, and part of the glucose remains in the urine (glycosuria). This increases the osmotic pressure of the urine and inhibits reabsorption of water by the kidney, resulting in increased urine production (polyuria) and increased fluid loss. Lost blood volume will be replaced osmotically from water held in body cells and other body compartments,
causing dehydration and increased thirst. In addition to insulin's effect on entry of glucose into cells, it also stimulates the uptake of amino acids, again contributing to its overall anabolic effect. When insulin levels are low, as in the fasting state, the balance is pushed toward intracellular protein degradation.\(^{(49,51,52,53)}\)

### 1.2.4 Insulin Receptor and Mechanism of Action

The receptor for insulin is embedded in the plasma membrane and is composed of two alpha (α) subunits and two beta (β) subunits linked by disulfide bonds. The extracellular alpha chains have the insulin binding domains, while the beta chains penetrate through the plasma membrane. The insulin receptor is a tyrosine kinase and functions as an enzyme that transfers phosphate groups from ATP (adenosine tri-phosphate) to tyrosine residues on intracellular target proteins. Binding of insulin to the alpha subunits causes the beta subunits to phosphorylate themselves, thus activating the catalytic activity of the receptor. The activated receptor then phosphorylates a number of other intracellular proteins, in order to convert them to an active state.\(^{(50)}\)

### 1.2.5 Insulin and Carbohydrate Metabolism

Glucose enters the blood stream after the small intestine hydrolyzes carbohydrates such as starch and sucrose to form glucose. High concentrations of glucose in the blood stimulate insulin secretion. This insulin then acts on various cells throughout the body to stimulate uptake, utilization and storage of glucose.\(^{(49)}\) Two important effects are:

1. **Insulin facilitates entry of glucose into muscle, adipose and several other tissues:**

   The only mechanism by which cells can take up glucose is by facilitated diffusion through a family of hexose transporters. In many tissues, such as muscle, the major transporter used for uptake of glucose (called GLUT4) is made available in the plasma membrane through the action of insulin. In the absence of insulin, GLUT4 (glucose
transporter type 4) glucose transporters are present in cytoplasmic vesicles, where they are useless for transporting glucose. Binding of insulin to receptors on such cells leads rapidly to fusion of those vesicles with the plasma membrane and insertion of the glucose transporters, thereby giving the cell an ability to efficiently take up glucose. When blood levels of insulin decrease and insulin receptors are no longer occupied, the glucose transporters are recycled back into the cytoplasm.\textsuperscript{(54,55)}

2. Insulin stimulates the liver to store glucose in the form of glycogen: A large fraction of glucose absorbed from the small intestine is immediately taken up by hepatocytes, which convert it into the storage polymer glycogen. Insulin has several effects in liver which stimulate glycogen synthesis. First, it activates the enzyme hexokinase, which phosphorylates glucose, trapping it within the cell. Coincidentally, insulin acts to inhibit the activity of glucose-6-phosphatase. Insulin also activates several of the enzymes that are directly involved in glycogen synthesis, including phosphofructokinase and glycogen synthase.\textsuperscript{(56)} The net effect is clear: when the supply of glucose is abundant, insulin "tells" the liver to store as much of it as possible for use later.

People with an autoimmune disease are more likely than the general population to develop other autoimmune diseases. DM and thyroid disorders are due to common autoimmune origin (diseases in which the immune system attacks a gland or organ of the body) and are the two most common endocrinopathies (which is a group of glands that help regulate various aspects of the body’s metabolism) encountered in practice. Both conditions frequently co-exist, diabetes have higher chance of thyroid dysfunction than in general population. Unrecognized thyroid dysfunction may impair metabolic control in patients with diabetes, and additionally may amplify the risk of cardiovascular disease (CVD). Although recognition and treatment of thyroid dysfunction in diabetic patients
will benefit glycemic control, attenuate cardiovascular risk, and improve general well-being, there is no consensus regarding optimal thyroid screening strategies in routine diabetes care.\textsuperscript{(55, 56, 57)}

1.3 Thyroid and its Disorders

1.3.1 Thyroid

The thyroid gland is found in the neck, below the thyroid cartilage. The thyroid gland is a butterfly-shaped organ and is composed of two cone-like lobes connected via the isthmus. Organ is situated on the anterior side of the neck, lying against and around the larynx and trachea, reaching posteriorly the oesophagus and carotid sheath.\textsuperscript{(57)} Its primary function is production of thyroid hormones, the principal ones being triiodothyronine (T\textsubscript{3}) and thyroxine (T\textsubscript{4}) and calcitonin. T\textsubscript{3} and T\textsubscript{4} are synthesized from both iodine and tyrosine. These hormones regulate the rate of metabolism and affect the growth and rate of function of many other systems in the body. Calcitonin plays important role in calcium homeostasis. Up to 80% of the T\textsubscript{4} is converted to T\textsubscript{3} by peripheral organs such as the liver, kidney and spleen. T\textsubscript{3} is several times more powerful than T\textsubscript{4}, which is largely a prohormone.\textsuperscript{(57, 58)}

1.3.2 T\textsubscript{3} and T\textsubscript{4} production and action

The thyroid gland is the site for the production of thyroxine (T\textsubscript{4}) and a portion of the triiodothyronine (T\textsubscript{3}), which boosts the metabolic rate. Thyroxine (T\textsubscript{4}) is synthesised by the follicular cells from free tyrosine and the tyrosine residues of the protein, called thyroglobulin (TG). Iodine is captured with the "iodine trap" by the hydrogen peroxide generated by the enzyme thyroid peroxidase (TPO).\textsuperscript{(58)} Upon stimulation by the TSH, the follicular cells reabsorb TG and cleave the iodinated tyrosines from TG, forming T\textsubscript{4} and T\textsubscript{3}, and releasing them into the blood. Deiodinase enzymes convert T\textsubscript{4} to T\textsubscript{3}. Thyroid
hormone secreted from the gland is about 80-90% T₄ and about 20% T₃. Cells of the developing brain are a major target for the thyroid hormones. Thyroid hormones play a particularly crucial role in brain maturation during fetal development. In the blood, T₄ and T₃ are partially bound to thyroxine-binding globulin (TBG), transthyretin, and albumin. Only a very small fraction of the circulating hormone is free (unbound) - T₄ 0.03% and T₃ 0.3%. Only the free fraction has hormonal activity. As with the steroid hormones and retinoic acid, thyroid hormones cross the cell membrane and bind to intracellular receptors (α₁, α₂, β₁ and β₂), which act alone, in pairs or together with the retinoid X-receptor as transcription factors to modulate DNA (deoxy ribonucleic acid) transcription.⁵⁹
Figure 1.2. (a) Thyroid Gland, (b) Production of Thyroid hormones.
1.3.3 Mechanism of Regulation of Thyroid Hormone

The production of T3 and T4 is regulated by TSH, released by the anterior pituitary. The thyroid and the thyroid hormones T3 and T4, participate with the hypothalamus, secreting thyrotropin releasing hormone (TRH), and pituitary, secreting TSH in a classical feedback controlled loop.\(^{(59)}\) Iodide is transported into the cell by the sodium-iodine symporter (NIS) and oxidized by TPO. TPO also catalyzes the iodination of tyrosine residues on TG. All processes in the cell are stimulated by binding of TSH to the TSH receptor (TSH-R). In the circulation, thyroid hormones are bound to TBG, albumin and prealbumin, and in some cases transthyretin (TTR). T4 is deiodinated by deiodinases in the liver and target tissues. In the target cells, T3 binds to nuclear thyroid hormone receptor, and with the retinoid X receptor, it binds at specific sequences at the DNA string, forming the thyroid hormone response elements (TRE). In the liver, thyroid hormones are metabolized by UDP-glucuronyl transferase (UDPGT), and finally, the metabolites are excreted in the urine.\(^{(60)}\)

The most common problems of the thyroid gland consist of an overactive thyroid gland, referred to as hyperthyroidism, and an underactive thyroid gland, referred to as hypothyroidism.

1.3.4 Hypothyroidism

Hypothyroidism is a condition in which the thyroid gland does not make enough thyroid hormone. Iodine deficiency is the most common cause of hypothyroidism worldwide but it can be caused by other causes such as several conditions of the thyroid gland. It usually is a primary process in which the thyroid gland produces insufficient amounts of thyroid hormone. It can also be secondary i.e. lack of thyroid hormone secretion due to inadequate secretion of thyrotropin (i.e., thyroid-stimulating hormone) from the pituitary gland TRH from the hypothalamus.\(^{(60, 61, 62)}\)
1.3.4.1 Hashimoto's thyroiditis

It is an autoimmune disease in which the thyroid gland is gradually destroyed by a variety of cell and antibody mediated immune processes. It was the first disease to be recognized as an autoimmune disease. Hashimoto's thyroiditis very often results in hypothyroidism. Physiologically, antibodies against thyroid peroxidase or thyroglobulin cause gradual destruction of follicles in the thyroid gland. Accordingly, the disease can be detected clinically by looking for these antibodies in the blood. Symptoms of Hashimoto's thyroiditis include weight gain, depression, sensitivity to heat and cold, paresthesia, fatigue, panic attacks, bradycardia, tachycardia, high cholesterol, reactive hypoglycemia, constipation, migraines, muscle weakness, cramps, memory loss, infertility, and hair loss. Hypothyroidism caused by Hashimoto's Thyroiditis is treated with thyroid hormone replacement agents such as levothyroxine or desiccated thyroid extract.\(^{58,59}\)

1.3.4.2 Subclinical thyroid

Patients with subclinical thyroid disease have few or no symptoms or signs of thyroid dysfunction and thus by its very nature subclinical thyroid disease is a laboratory diagnosis. Subclinical hypothyroidism is defined as a serum TSH above the defined upper limit of the reference range, with a serum free thyroxine (FT4) within the reference range. It is therefore critically important that the reference limits for TSH be standardized. The TSH method used should have a high functional sensitivity although this is of most importance for the diagnosis of subclinical hyperthyroidism.\(^{63}\)

1.3.5 Hyperthyroidism

It is the term for overactive tissue within the thyroid gland causing an overproduction of thyroid hormones, T4 or T4. Hyperthyroidism is thus a cause of thyrotoxicosis, the
clinical condition of increased thyroid hormones in the blood. Hyperthyroidism and thyrotoxicosis are not synonymous. For instance, thyrotoxicosis could instead be caused by ingestion of exogenous thyroid hormone or inflammation of the thyroid gland, causing it to release its stores of thyroid hormones. High blood levels of thyroid hormones can occur for a number of other reasons like thyroiditis (a condition of thyroid inflammation). There are several different kinds of thyroiditis including Hashimoto's thyroiditis (immune-mediated), and subacute thyroiditis. These are initially associated with secretion of excess thyroid hormone, but usually progress to gland dysfunction and, thus, to hormone deficiency and hypothyroidism.\(^{(64)}\)

### 1.3.5.1 Grave’s disease

The most common cause of hyperthyroidism is Graves' disease. An abnormality of the immune system is the cause. A key element of the immune system is the antibody, produced by lymphocytes to kill a particular foreign agent. In Graves' disease, the immune system manufactures antibodies which behave like TSH and stimulate the thyroid uncontrollably. Graves' disease is more common in middle age, although children and adolescents can also be affected. Stress, both physical and emotional, is known to affect the responsiveness of the immune system and there appears to be some association between stress and the onset of autoimmune conditions - including Graves' disease. Autoimmune conditions have a distinct genetic element, with some family lines having multiple cases of Graves' disease and other autoimmune conditions. Another cause is excessive iodine intake.\(^{(63)}\)

Hyperthyroidism can be diagnosed with a simple blood test that measures thyroid hormone levels. A person with hyperthyroidism has high levels of thyroxine, but low levels of TSH. The presence of thyroid stimulating antibodies can also be checked and, if present, confirms a diagnosis of Graves’ disease.
1.4 Lipid Profile and its Correlation with Endocrinopathies

Lipid profile is the collective term given to the estimation of lipids and its derivatives lipoproteins. Lipoproteins contain fat and proteins and include free cholesterol, cholesterol esters, triglycerides (Tg), phospholipids and apoproteins. Lipoproteins may be classified as High density lipoprotein (HDL), Low density lipoprotein (LDL) and Very low density lipoprotein (VLDL). Lipid profile is used to identify the abnormally elevated levels of any or all lipids and lipoproteins in the blood, which are recognized risk factors for cardiovascular disease and sometimes pancreatitis. Individuals may also be screened using only a cholesterol test and not a full lipid profile. However, if the cholesterol test result is high, there may be the need to have follow-up testing with a lipid profile.\(^{65, 66}\)

Diabetes confers an increased risk of morbidity and mortality due to cardiovascular disorders, which appear to some degree related to glycemic control. Quantitative and qualitative lipid abnormalities have been observed in individuals with prediabetes who were identified and followed prospectively prior to clinical presentation. Insulin as a potent activator of lipoprotein lipase, and affects many sites of mammalian lipid metabolism. It stimulates synthesis of fatty acid in liver adipose tissue and in the intestine. The insulin has also been reported to increase the cholesterol synthesis. The activity of lipoprotein lipase in white adipose is also increased. From this point of view the assessment of various lipid fractions and lipid peroxide in the cases of DM may be of some help in the prognosis of patients and in preventing the possibilities of complications or secondary disorders.\(^{67}\) It has been suggested that the increase in Tg may be due to insulin deficiency which results faulty glucose utilization, causes hyperglycemia and mobilization of fatty acids from adipose tissue. In diabetes blood glucose is not utilized by tissue resulting in hyperglycemia. The fatty acids from adipose
tissue are mobilized for energy purpose and excess fatty acids are accumulated in the liver, which are converted to Tg. Insulin increases the number of LDL receptor, so chronic insulin deficiency might be associated with a diminished level of LDL receptor. This causes the increase in LDL particles and result in the increase in LDL-C value in diabetes mellitus. High level of cholesterol, Tg, LDL-C and low HDL-C may be due to the obesity, increase calorie intake and lack of muscular exercise in the patients of DM.\(^{68,69}\)

Thyroid dysfunctions have an important effect on lipid profile. Thyroid function regulates a wide array of metabolic parameters. Thyroid function significantly affects lipoprotein metabolism as well as some CVD risk factors. Thyroid hormones induce the 3-hydroxy-3-methylglutarylcoenzyme A (HMG-CoA) reductase, first enzyme in cholesterol biosynthesis. T3 up regulate LDL receptors by controlling their gene activation. Thyroid hormones can influence HDL metabolism by increasing cholesteryl ester transfer protein (CETP) activity, which exchanges cholesteryl esters from HDL to the VLDL additionally thyroid hormones stimulate the lipoprotein lipase (LPL), which catabolizes the TG-rich lipoproteins, and the hepatic lipase (HL). Another effect of T3 is the up-regulation of apolipoprotein AV (ApoAV), which plays a major role in TG regulation. Indeed, increased levels of ApoAV have been associated with decreased levels of TGs also this effect include the decrease of hepatic VLDL-TG production.\(^{70}\)

Beyond their effect on lipid profile thyroid hormones can equally affect a number of other metabolic parameters related to CVD risk. Hypothyroidism is a common metabolic disorder in the general population and patients have increased levels of total cholesterol (TC) and LDL-C and it is a common cause of secondary dyslipidemia. The incidence of hyperthyroidism is lower compared with hypothyroidism in the general population. A
decrease in HDL-C levels is also observed in hyperthyroidism and Tg levels remain unchanged.

Biochemical screening for thyroid dysfunction is critical in all dyslipidemic patients, as well as in all patients with unexpected improvement or worsening of their lipid profile. The American Thyroid Association recommends that adults be screened for thyroid dysfunction by measurement of the serum TSH concentration, beginning at age 35 years and every 5 years thereafter.\(^{(71)}\)