Original

Analysis on the Association of Prevalence, Gender Differences and Age with Thyroid Diseases

Mukhtar N.*[1] Abdalla O. M.[2]

[1]Department of Biochemistry and Molecular Biology, Napata College, Khartoum, Sudan

[2] Sudan Atomuc Energy Commission, Khartoum, Sudan

***Corresponding author:** Nada Mukhtar, Department of Biochemistry and Molecular Biology, Napata College, Khartoum, Sudan

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Abstract

Introduction

Diseases of the thyroid gland are manifested by qualitative or quantitative alterations in hormone secretion, enlargement of the thyroid (goiter), or both. Insufficient hormone secretion results in the syndrome of hypothyroidism or myxedema, in which decreased caloric expenditure (hypometabolism) is a principle feature. Conversely, excessive secretion of active hormone results in hypermetabolism and other features of a syndrome termed hyperthyroidism or thyrotoxicosis (1) .

Materials and Methods

The present study has been designed and conducted to investigate the significance of gender and age on thyroid diseases. Test results were taken from the records of the Radio Immunoassay Laboratory at the Nuclear Medicine Department of the Sudan Atomic Energy Commission. The results were of individuals that have undergone the thyroid function tests T4, T3 and TSH. The levels of T4, T3 and TSH in blood serum were measured using radioimmunoassay techniques. Results of the tests were analyzed using Statistical Package of Social Sciences (SPSS). The total number of respondents was 550.

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Results

The distribution of these respondents according to the levels of T_4, T_3 and TSH revealed that 12.18% of patients showed high levels of T4, 9.64% showed high levels of T3, and 5.09% showed high levels of TSH. Results also revealed that 3.82% showed low levels of T4, 3.45% showed low levels of T3 and 3.82% showed low levels of TSH. The present data indicates that 3.82 % of the patients were affected with hypothyroidism and 12.18% of the patients were affected with hyperthyroidism.

The data also revealed that the females outnumbered the male subjects in this study. The male respondents represented 11.09 % of the total number of respondents, while the females represented 88.91 %. The distribution of respondents according to age and sex revealed that the majority of patients from both sexes lied between the age of 20 and 40. The minority were found at less than 20 years.

Conclusion

Prevalence of hyperthyroidism is 3 times higher than in hypothyroidism.

Women are generally at higher risk of most types of thyroid disease than men. It has also been noticed that the severity of thyroid diseases manifests clearly in male respondents.

The risk of thyroid dysfunction increases with age and it is more prevalent in elderly males.

Keywords: prevalence, hypothyroidism, hyperthyroidism, radioimmunoassay techniques

Introduction

The thyroid gland is a discrete organ situated just caudal to the larynx and adherent to the front of the trachea. It is named after the shield since it approximately describes its gross morphology, which comprises two flat oval-shaped lobes joined by an isthmus. Its sole function is to produce thyroid hormones, which regulate the body's metabolism (conversion of oxygen and calories to energy). It produces two iodo amino acid hormones, 3, 5, 3′ -triiodothyronine (T3) and 3, 5, 3′, 5′ -tetraiodothyronine (T4, thyroxine). The production of these hormones is under the control of Thyroid Stimulating Hormone (TSH), which is produced by the pituitary gland. Under the influence of TSH, the thyroid will manufacture and secrete T3 and T4 thereby raising their blood levels (1).

The pituitary senses this and responds by decreasing its TSH production in a process termed 'Negative Feedback System'. Moreover, the TSH itself is regulated by TSH Releasing Hormone (TRH), which is produced by the Hypothalamus (1).

With the invention of the radioimmunoassay techniques it is possible to measure circulating hormones in the blood very accurately. A combination of three laboratory tests T4, T3 and serum TSH are used to detect the abnormality of the thyroid function (2-4). The thyroid gland is prone to several very distinct problems; those concerning the production of the hormone and those due to increased mass of the thyroid. The pathophysiology of many thyroid diseases relates to TSH, T3 and T4 (5).

The Basal metabolic rate is decreased in hypothyroidism as a result of insufficient free T3 or T4. Hyperthyroidism or Thyrotoxicosis is due to excessive production of thyroid hormone. In some cases such as Graves' disease it results from the production of thyroid-stimulating IgG (TSI) that activates the TSH receptor, which causes a diffuse enlargement of the thyroid and excessive, uncontrolled production of T3 and T4, since

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the production of TSI is not under feedback control (5).

Thyroid disorders in females

The thyroid diseases are more frequent in women, which is probably related to the fact that many thyroid diseases are of the autoimmune type, secondary to the effects of sexual steroids in the immunological system; although it had never been completely cleared up, it seems that estrogens and progestogens may modulate the lymphocyte differentiation as well as the induction of the autoimmune response. After delivery, the thyroid dysfunction of autoimmune type often occurs, even in women without previous history of thyroid disease. Some authors assume that the cytokines, produced by the mother, fetus or placenta, inhibit the autoimmune reaction during pregnancy. The subsequent reduction in the inhibiting cytokines, after delivery, allows the aggravation or the beginning of the autoimmune disease. Although autoimmunity is usually considered as a main cause for thyroid disease during pregnancy, recent studies indicate that the most common etiology of disturbance of thyroid tests during pregnancy is the hyperthyroidism due to the insufficient production of human chorionic gonadotropin (hCG) (6). However, from a medical viewpoint, the hyperthyroidism caused by Graves' disease is the most significant reason for maternal and fetal morbidity (6, 7).

Depending on the type of thyroid disease and the time of onset, high or low levels of thyroid hormone may cause either very early onset of menses (first menstrual period), also called precocious puberty, occurring before age 9, or delayed puberty, occurring after age 15. If hyperthyroidism occurs during childhood before puberty, the first menstrual period is usually delayed. However, when hyperthyroidism occurs during the early years of puberty, the first menses may begin early (8, 9).

After puberty, hyperthyroidism may cause infrequent and light periods, or they may cease altogether. In hypothyroidism, the periods often become too frequent and too heavy, sometimes with prolonged bleeding that may even result in anemia (8, 9).

During pregnancy in a female with a normal thyroid there is a tendency for the gland to enlarge. The cause is unknown but it might be related to a relative degree of iodine deficiency which develops due to the iodine uptake by the fetus from its mother. Iodine is also lost more than normal in urine in pregnant females. Another factor may be that certain hormones formed in the afterbirth (the

placenta) may mildly stimulate the thyroid gland (10).

Also, during pregnancy, some of the thyroid function tests change. The levels of total T4 and total T3 tend to rise due to the increase of the hormone binding globulin (TBG) as a result of the increase of the female hormone estrogen during pregnancy. However, the unbound, free T4 and free T3 do not increase, indeed during the last trimester of pregnancy they may actually fall. These changes might not be important in a female with normal thyroid, but they are in a female suffering from an overactive or an underactive thyroid gland before pregnancy or if either was first diagnosed during pregnancy (10, 11).

Hyperthyroidism affects less than 1% of all pregnancies, but it has important consequences for both the mother and fetus. Overactivity of the thyroid gland, nearly due to Graves' disease, develops during pregnancy. The diagnosis is not always easy because some of the symptoms of thyroid overactivity, such as an increased heart rate and palpitations, increased perspiration, increased temperature, nervousness and tiredness, may also occur in pregnant women with a normal thyroid gland (11).

Although many women with hyperthyroidism acknowledge changes in their menstrual cycle, such as irregular periods and absence of ovulation, these changes have not transformed into infertility problems in a woman with only mild hyperthyroidism. Nevertheless, once a woman with hyperthyroidism becomes pregnant, there is a greater risk of miscarriage, spontaneous abortion, fetal growth retardation, premature labor and delivery, congenital malformations and probably pre-eclampsia (7, 12).

Fetal death may occur as a result of chromosomal abnormalities such as Down's syndrome. These risks are decreased in women where the hyperthyroidism is recognized early and treated appropriately (7, 12).

Because many of the symptoms of normal pregnancy such as weight gain, fatigue and swelling correspond with the symptoms of hypothyroidism, it may be difficult to assume this diagnosis during pregnancy. Standard thyroid function blood tests could confirm this diagnosis, leading to effective treatment (7, 12).

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The diagnosis and timely treatment of thyroid hormones deficiency (before or during the first weeks of gestation) can considerably reduce some of the related adverse effects. However, there is no consensus on the reference levels of thyroid hormones during pregnancy to establish the diagnosis and there is no consensus on universal screening of women during first trimester of pregnancy to detect thyroid dysfunction, to provide treatment and to reduce adverse perinatal events, so it is necessary to carry out specific studies for each population that provide information about it (10).

Abnormalities of thyroid function are considerably common after delivery, and can occur about three months after the baby is born. During this postpartum stage mild hyperthyroidism, hypothyroidism, or thyroid over activity followed by under activity may occur. Recent studies indicate that as many as about 15 per cent of women, specifically those who have certain thyroid antibodies present in their blood when they are pregnant, could develop some disorder of thyroid function during the first 3 – 6 months after delivery (11).

Thyroiditis is the most common cause of postpartum thyroid disease. It is usually due to an autoimmune process. Thyroiditis occurs when the body produces antibodies against its own thyroid cells, either causing an increase in thyroid hormones to be released into the bloodstream (hyperthyroidism) or destroying so much thyroid tissue that reduces the amount of thyroid hormone (hypothyroidism). Within the first one to four months after delivery, the hyperthyroid or overactive thyroid is most common. A minor enlargement of the thyroid gland and increased anxiety, restlessness, insomnia, weight loss, and difficulty concentrating can be observed (12).

Hypothyroidism occurs mostly in women during menopause, which typically occurs in their late 40s and early 50s. However, women with hyperthyroidism or hypothyroidism may have an earlier onset, or premature, menopause (occurring before age 40) with rare or absent periods. Often symptoms of hyperthyroidism, such as irregular or absent menses, heat intolerance, "hot flashes," insomnia, and mood swings may be confused with symptoms of menopause. Once the hyperthyroidism is controlled these symptoms may resolve, with the recommencement of normal menstrual cycles and normal onset of menopause. This restoration of the menses results in a normal level of female hormones (estrogen) that is important for maintaining the body's bone

mass and decreasing the risk of osteoporosis (12).

Thyroid disorders in neonates and children

Thyroid hormones play a crucial role as a regulator of growth, nervous system myelination, metabolism, and organ functions. Disorders of the thyroid gland represent the most common endocrinopathies in childhood. The etiology and clinical presentation of thyroid disorders in children and adolescents significantly differs from that in adults. Thus, pediatric medical care requires an appreciation of distinct characteristics of thyroid function and dysfunction in childhood and adolescence. Early diagnosis and treatment are essential to prevent irreversible and permanent nervous system damage and developmental delay, especially in infants as they are extremely vulnerable to thyroid dysfunction (13).

Thyroid hormones have been shown to be absolutely necessary for early brain development. During pregnancy, both maternal and fetal thyroid hormones contribute to fetal brain development and maternal supply explains why most of the athyreotic newborns usually do not show any signs of hypothyroidism at birth. Fetal and/or neonatal hypothyroidism is a rare disorder. Its incidence, as indicated by neonatal screening, is about 1:4000. Abnormal thyroid development (i.e. agenesia, ectopic gland, and hypoplasia) or inborn errors in thyroid hormone biosynthesis are the most common causes of permanent congenital hypothyroidism (13, 14).

At birth clinical picture may be not always so obvious and typical signs appear only after several weeks but a delayed diagnosis could have severe consequences consisting of delayed physical and mental development. Even if substitutive therapy is promptly started some learning difficulties might still arise suggesting that intrauterine adequate levels of thyroid hormones are absolutely necessary for a normal neurological development. Placental transfer of maternal antithyroid antibodies inhibiting fetal thyroid function can cause transient hypothyroidism at birth. If the mother with thyroid autoimmune disease is also hypothyroid during pregnancy and she doesn't receive substitutive therapy, a worse neurological outcome may be expected for her fetus (14, 15).

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Fetal and/or neonatal hyperthyroidism is a very rare condition. The most common causes are maternal thyroid autoimmune disorders, such as Graves' disease and Hashimoto's thyroiditis. Rarer non autoimmune causes recently identified are represented by TSH receptor mutations leading to constitutively activated TSH receptor. Infants born to mothers with Graves' history may develop neonatal thyrotoxicosis. It's extremely important recognizing and treating Graves' disease in mothers as soon as possible, because a thyrotoxic state may have adverse effects on the outcome of pregnancy and both on the fetus and newborn (11).

Neonatal Graves' disease tends to resolve spontaneously within 3 – 12 weeks as maternal thyroid stimulating immunoglobulins are cleared from the circulation but subsequent development may be impaired by perceptual motor difficulties (14).

Thyroid diseases in the elderly

In the elderly, thyroid dysfunction usually develops insidiously and is dominated by non-specific symptoms and clinical findings, typically related to normal aging or to age-associated disease. Case finding, in combination with a low threshold for biochemical control, is recommended. In Denmark, as reported by Mikkelsen, Andersen-Ranberg and Hegedüs in 2001, hyperthyroidism is more frequent than hypothyroidism. Subclinical hyperthyroidism is generally temporary. In subclinical hypothyroidism the annual progression rate to manifest hypothyroidism is 2-3%, but higher (5-10%) in the presence of thyroid autoantibodies (16).

Treatment recommendation is related to the serum level of thyroid stimulating hormone and the presence of thyroid peroxidase autoantibodies. Hypothyroidism should be treated with lower doses of thyroxine, and the titration phase is longer. An antithyroid drug is the initial treatment in hyperthyroidism, often followed by radioiodine therapy (16, 17).

It is not necessary to modify the thyroid exploration according to the age; nevertheless, due to the increase of morphological and functional heterogeneity of the thyroid, elderly people would be more sensitive to thyroid disease; even if the thyroid function doesn't change in good health, we must be careful about the interpretation of the results, taking into account the possible associated diseases and especially medical treatments that are very frequent in this population (17, 18).

The objectives of this study is to:

1. Study the prevalence of hyperthyroidism and hypothyroidism
2. Investigate the significance of sex on thyroid functions.
3. Investigate the significance of age on thyroid functions.

Serum T4, T3 and TSH test results were used for the evaluation of the thyroid functions. These results along with the age and sex of each subject were organized statistically to achieve this aim.

Materials and Methods

Sample collection

The present study has been designed and conducted to investigate the prevalence of thyroid diseases, and the significance of two factors; sex and age on thyroid functions.

Thyroid function test results were taken from the records of the Radio Immunoassay Laboratory at the Nuclear Medicine Department of the Sudan Atomic Energy Commission. The tests were carried out during the period from February to November 2001. The total number of respondents was 550. Male respondents were 61 and female respondents were 489.

The results taken consisted of individuals with hyperthyroidism or hypothyroidism or euthyroid. Subjects affected with hyperthyroidism were 67, of which the majority was females (58 females and 9 males). Subjects affected with hypothyroidism were 21; 19 females and 2 males.

The data constructed contained the sex and age of each subject along with his/her results for the three thyroid function tests; no one single test is 100% accurate in diagnosing all types of thyroid disease; a combination of two or more tests is necessary. This combination can usually detect even the slightest abnormality of thyroid function.

Measurement of thyroid hormones

The assay used in this study was modified and developed by the Department of Isotope of the Chinese Institute of Atomic Energy. This is the method now used in the Radio Immunoassay Laboratory at the Nuclear Medicine Department of the Sudan Atomic Energy Commission, from which the samples used in this study have been taken.

- **Determination of Total Thyroxine (T4)**

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Thyroxine was measured by RIA, which is an assay used for the direct quantitative determination of total thyroxine (T4) in human serum to aid in the differential diagnosis of thyroid disease. The measurement range is 0- 240ng/ml (0-310nmol/l).

Reference range for thyroxine (T4), used in RIA laboratory of Sudan Atomic Energy Commission:

Hyperthyroid more than 150 (nmol/l)
Euthyroid 50 – 150 (nmol/l)
Hypothyroid less than 50 (nmol/l)

- **Determination of Total Triiodothyronine (T3)**

T3 was measured by RIA, which is an assay used for the quantitative measurement of T3 in human serum or plasma. The measurement range is 0.5-0.8ng/ml.

Reference range for triiodothyronine (T3) used at the RIA laboratory of the Sudan Atomic Energy Commission:

Hyperthyroid more than 3.0 (nmol/l)
Euthyroid 0.8 – 3.0 (nmol/l)
Hypothyroid less than 0.8 (nmol/l)

- **Determination of TSH**

This assay is used for the quantitative determination of human TSH in serum with magnetic separation reagent.

Reference range for TSH used in the RIA laboratory of the Sudan Atomic Energy Commission:

Hyperthyroid less than 0.4 mIU/L
Euthyroid 0.4 – 5.0 mIU/L
Hypothyroid more than 5.0 mIU/L

Statistical Methods

- **Correlation coefficient**

The data was analyzed using Pearson's Coefficient of linear correlation for investigating the strength of the correlation between age and each of the thyroid function tests. (Bland *et al.* 1986 and Brown *et al.* 1993 and Armitage *et al.* 1994)

- **T-Test**

T-Test for Independent samples: This test is essentially used to investigate the variation between the results of each of the thyroid function tests with male/female sex. (Bland *et al.* 1986 and Brown *et al.* 1993 and Armitage *et al.* 1994)

- **Frequency Distribution**

Frequency distribution or frequency table is the way in which statistical data is organized and summarized. This data is then presented in the form of graphs. (Barry *et al.* 1994) In this study the results are presented in the form of columns.

These statistical methods were achieved using SPSS (Statistical Package for Social Sciences) program.

Results

1. Levels of thyroid hormones and TSH

The data collected in this study was obtained from the records of the Radio Immunoassay Laboratory at the Nuclear Medicine Department of the Sudan Atomic Energy Commission. The data consisted of the results of the thyroid function tests T4, T3 and TSH of all individuals (550 respondents) who were subjected to these tests during the period from February to November 2001.

- **Level of T4**

Results given in table (1) indicated that there was a great difference in the concentration of T4 in blood serum of the respondents (range 3.2 – 494 nmol/l). Distribution of the respondents according to their levels of T4 suggested that 3.82 % of the respondents were affected with hypothyroidism, 12.18 % were affected with hyperthyroidism and 84 % were euthyroid (Table 2). The level of T4 in blood serum of male (123 nmol/l) and female (122.73 nmol/l) were of insignificant difference, compared to the overall mean (122.87 nmol/l) (Fig. 1).

Table 1: Levels of T4 (nmol/l) in serum of respondents

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Sex	Age Year	No. of cases	Mean of T_4	Range (Min.-Max.)
			(nmol/l)	
Male	< 10	2	110	83 – 137.70
	11 – 20	4	166.50	95 – 240
	21 – 30	15	123.20	86 – 258
	31 – 40	19	126.21	75 – 313
	41 – 50	10	117.80	82 – 172
	51 – 60	6	94.33	8 – 176
	> 60	5	123	8 – 270
	Mean		**123**	
Female	< 10	8	137.25	77 – 245
	11 – 20	73	113.56	3.2 – 305
	21 – 30	187	131.98	15 – 388
	31 – 40	125	128.07	7.5 – 494
	41 – 50	62	115.10	10 – 287
	51 – 60	24	112.29	66 – 294
	> 60	10	120.86	19.60 – 255
	Mean		**122.73**	
Overall Mean			**122.87**	

Table 2: Frequency of distribution according to level of T4

Level of T_4 (nmol/l)	No of cases	Percentage
(< 50)	21	3.82 %
(50 – 150)	462	84.00 %
(> 150)	67	12.18 %
Total	550	100 %

- **Level of T3**

Results given in table (3) showed a great variation in the concentration of T3 in blood serum of respondents (range 0.01 – 11.50 nmol/l). The distribution of the respondents according to their levels of T3 suggested that 3.45 % of the respondents were affected with hypothyroidism, 9.64% were affected with hyperthyroidism and 86.91 % were euthyroid (Table 4). The level of T3 in blood serum of male (2.15 nmol/l) and female (1.88 nmol/l) were of insignificant difference, compared to the overall mean (2.02 nmol/l) (Fig. 2).

Table 3: Level of T3 (nmol/l) in serum of respondents

Sex	Age Year	No. of cases	Mean of T_3	Range (Min.-Max.)
			(nmol/l)	
Male	< 10	2	1.95	1.20 – 2.70
	11 – 20	4	4.63	1.50 – 9.40
	21 – 30	15	1.91	0.90 – 5.50
	31 – 40	19	1.80	0.90 – 3.90
	41 – 50	10	1.73	0.40 – 3.00
	51 – 60	6	1.67	0.01 – 3.80
	> 60	5	1.34	0.50 – 2.40
	Mean		**2.15**	
Female	< 10	8	2.20	1.30 – 3.30
	11 – 20	73	1.74	0.03 – 5.40
	21 – 30	187	2.25	0.20 – 11.50
	31 – 40	125	1.94	0.20 – 11.20
	41 – 50	62	1.78	0.01 – 7.60
	51 – 60	24	1.57	1.00 – 4.20
	> 60	10	1.66	0.01 – 4.90
	Mean		**1.88**	
Overall Mean			**2.02**	

Table 4: Frequency of distribution according to level of T3

Level of T_3 (nmol/l)	No. of cases	Percentage
(< 0.8)	19	3.45 %
(0.8-3.0)	478	86.91 %
(> 3.0)	53	9.64 %
Total	550	100%

- **Level of TSH**

The results from table (5) indicate a great variation in the concentration of TSH in blood serum (0.00 – 75 mIU/L). The distribution of the respondents according to their levels of TSH suggested that 3.82 % of the respondents were affected with hypothyroidism, 5.09 % were affected with hyperthyroidism and 91.09 % were euthyroid (Table 6). The level of TSH in blood serum

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of male (5.23 mIU/L) and female (4.12 mIU/L) were of insignificant difference, compared to the overall mean (4.68 mIU/L) (Fig. 3).

Table 5: Level of TSH (mIU/L) in serum of respondents

Sex	Age Year	No. of cases	Mean of TSH	Range (Min.-Max.)
			(mIU/L)	
Male	< 10	2	0.95	0.90 – 1.00
	11 – 20	4	1.66	0.70 – 2.60
	21 – 30	15	1.28	0.20 – 2.90
	31 – 40	19	1.26	0.10 – 3.40
	41 – 50	10	1.30	0.20 – 2.70
	51 – 60	6	14.18	0.50 – 75
	> 60	5	15.98	0.40 – 75
	Mean		**5.23**	
Female	< 10	8	2.14	0.50 – 4.20
	11 – 20	73	5.55	0.20 - 75
	21 – 30	187	2.11	0.00 – 75
	31 – 40	125	2.06	0.10 – 75
	41 – 50	62	6.36	0.10 – 75
	51 – 60	24	1.63	0.50 – 5.00
	> 60	10	8.99	0.50 – 75
	Mean		**4.12**	
Overall Mean			**4.68**	

Table 6: Frequency of distribution according to level of TSH

Level of TSH (mIU/L)	No. of cases	Percentage
(< 0.4)	28	5.09 %
(0.4 - 5.0)	501	91.09 %
(> 5.0)	21	3.82 %
Total	550	100%

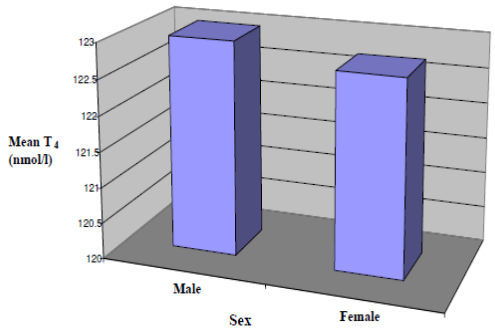

Fig. (1) Level of T4 vs Sex (male and female) in all respondents

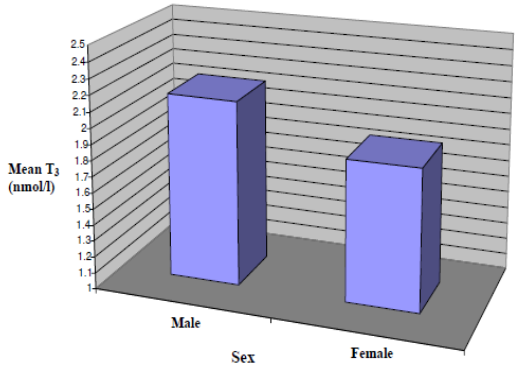

Fig. (2) Level of T3 vs Sex (male and female) in all respondents

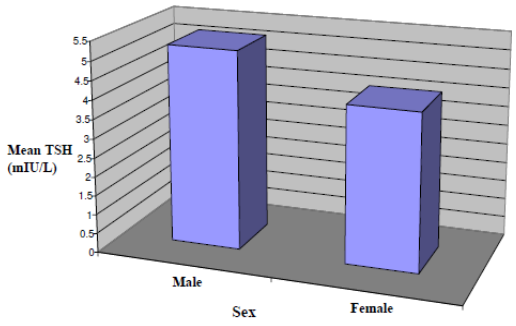

Fig. (3) Level of TSH vs Sex (male and female) in all respondents

2. Distribution of respondents according to results

According to the results presented in tables (1, 3, and 5) and figures (1, 2 and 3), it is observed that the majority of the respondents were euthyroid and the minority of cases were hypothyroidism and hyperthyroidism.

2.1. Hypothyroidism

The total number of respondents with hypothyroidism was 21 (2 males and 19 females), which is 3.82 % of the total number of respondents. In cases of hypothyroidism the reference level of T4 was (< 50 nmol/l); according to the reference range (50 – 150 nmol/l) used at the RIA laboratory. The level of T4 in blood serum of female respondents (24.83 nmol/l) with hypothyroidism was significantly higher than that of male respondents (8 nmol/l), compared to the overall mean (16.42 nmol/l) (Table 7) (Fig. 4). Female respondents with hypothyroidism were found in almost all age ranges except below 11 years and the age range from 51 to 60, while male respondents were only found in older ages (> 50 years).

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The reference level of T3 in cases of hypothyroidism was (<0.8 nmol/l). The level of T3 in blood serum of female respondents (0.63 nmol/l) with hypothyroidism was significantly higher than that of male respondents (0.25 nmol/l), compared to the overall mean (0.44 nmol/l) (Table 8) (Fig. 5).

The reference level of TSH in cases of hypothyroidism was (>5 mIU/L). The level of TSH in blood serum of male respondents (75 mIU/L) with hypothyroidism was significantly higher than that of female respondents (52.36 mIU/L), compared to the overall mean (63.68 mIU/L) (Table 9) (Fig. 6).

Table 7: Levels of T4 (nmol/l) in serum of respondents with hypothyroidism

Sex	Age Year	No. of cases	Mean of T_4 (nmol/l)	Range (Min.-Max.) (nmol/l)
Male	51 – 60	1	8	–
	> 60	1	8	–
	Mean		**8**	
Female	11 – 20	6	22.7	3.20 – 45
	21 – 30	4	33.75	15 – 43
	31 – 40	2	23.75	7.5 – 40
	41 – 50	6	24.33	10 – 38
	> 60	1	19.60	–
	Mean		**24.83**	
Overall Mean			**16.42**	

Table 8: Levels of T3 (nmol/l) in serum of respondents with Hypothyroidism

Sex	Age Year	No. of cases	Mean of T_3	Range (Min.-Max.)
			(nmol/l)	
Male	51 – 60	1	0.01	–
	> 60	1	0.50	–
	Mean		0.25	
Female	11 – 20	6	0.97	0.03 – 2.70
	21 – 30	4	1.1	0.20 – 1.90
	31 – 40	2	0.55	0.20 – 0.90
	41 – 50	6	0.50	0.01 – 1.60
	> 60	1	0.01	–
	Mean		0.63	
Overall Mean			0.44	

Table 9: Levels of TSH (mIU/L) in serum of respondents with hypothyroidism

Sex	Age Year	No. of cases	Mean of TSH	Range (Min.-Max.)
			(mIU/L)	
Male	51 – 60	1	75	–
	> 60	1	75	–
	Mean		75	
Female	11 – 20	6	48.12	8 – 75
	21 – 30	4	41.22	9.60 – 75
	31 – 40	2	42.65	10.30 – 75
	41 – 50	6	54.82	12 – 75
	> 60	1	75	–
	Mean		52.36	
Overall Mean			63.68	

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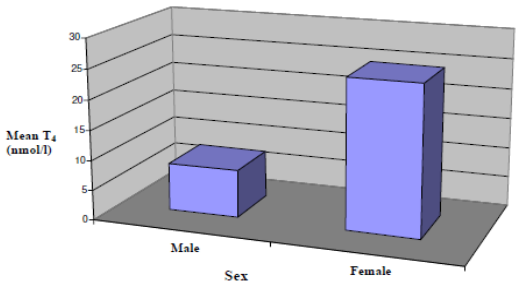

Fig. (4) Level of T4 vs Sex (male and female) in respondents with hypothyroidism

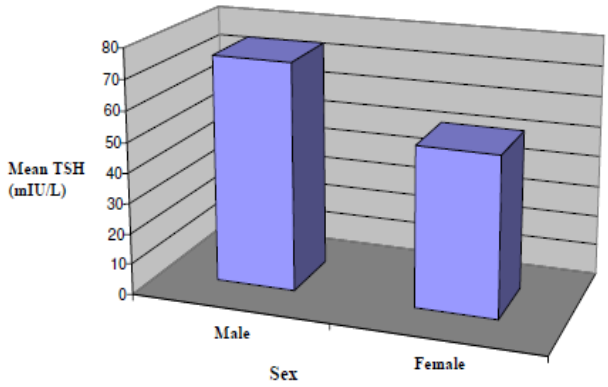

Fig. (6) Level of TSH Vs Sex (male and female) in respondents with hypothyroidism

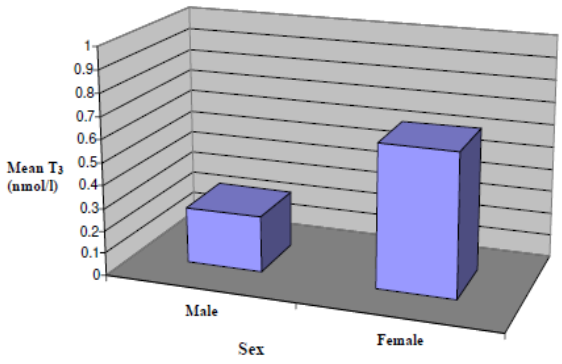

Fig. (5) Level of T3 Vs Sex (male and female) in respondents with hypothyroidism

2.2. Hyperthyroidism

The total number of respondents with hypothyroidism was 67 (9 males and 58 females), which is 12.18 % of the total number of respondents. In cases of hyperthyroidism the reference level of T4 was (> 150 nmol/l); according to the reference range (50 – 150 nmol/l) used at the RIA laboratory. There was no statistical difference between the level of T4 in blood serum of female respondents (220.10 nmol/l) with hyperthyroidism and that of male respondents (245.94 nmol/l), compared to the overall mean (233.02 nmol/l) (Table 10) (Fig. 7). Both female and male respondents with hyperthyroidism were found in almost all age ranges.

The reference level of T3 in cases of hyperthyroidism was (> 3 nmol/l). The level of T3 in blood serum of female respondents (4.63 nmol/l) with hyperthyroidism was slightly higher than that of male respondents (3.67 nmol/l), compared to the overall mean (4.15 nmol/l) (Table 11) (Fig. 8).

The reference level of TSH in cases of hyperthyroidism was (< 0.4 mIU/L). The level of TSH in blood serum of male respondents (0.39 mIU/L) with hyperthyroidism was slightly lower than that of female respondents (0.56 mIU/L), compared to the overall mean (0.48 mIU/L) (Table 12) (Fig. 9).

Table 10: Levels of T4 (nmol/l) in serum of respondents with Hyperthyroidism

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Sex	Age Year	No. of cases	Mean of T_4	Range (Min.-Max.)
			(nmol/l)	
Male	11 – 20	2	231.50	223 – 240
	21 – 30	2	211	164 – 258
	31 – 40	2	260	207 – 313
	41 – 50	1	172	–
	51 – 60	1	176	–
	> 60	1	270	–
	Mean		**220.10**	
Female	< 10	1	245	
	11 – 20	3	228.33	155 – 305
	21 – 30	29	244.59	155 – 388
	31 – 40	17	239.90	151 – 494
	41 – 50	6	214.80	151 – 287
	51 – 60	1	294	–
	> 60	1	255	–
	Mean		**245.94**	
Overall Mean			**233.02**	

Table 11: Levels of T3 (nmol/l) in serum of respondents with Hyperthyroidism

Sex	Age Year	No. of cases	Mean of T_3	Range (Min.-Max.)
			(nmol/l)	
Male	11 – 20	2	7.40	5.40 – 9.40
	21 – 30	2	3.55	1.60 – 5.50
	31 – 40	2	2.55	1.20 – 3.90
	41 – 50	1	2.30	–
	51 – 60	1	3.80	–
	> 60	1	2.40	–
	Mean		**3.67**	
Female	< 10	1	3.30	
	11 – 20	3	3.93	2.20 – 5.40
	21 – 30	29	6.19	1.50 – 11.50
	31 – 40	17	5.25	1.30 – 11.20
	41 – 50	6	4.65	1.70 – 7.60
	51 – 60	1	4.20	–
	> 60	1	4.90	–
	Mean		**4.63**	
Overall Mean			**4.15**	

Table 12: Levels of TSH (mIU/L) in serum of respondents with Hyperthyroidism

Sex	Age Year	No. of cases	Mean of TSH	Range (Min.-Max.)
			(mIU/L)	
Male	11 – 20	2	0.80	0.70 – 0.90
	21 – 30	2	0.20	0.20
	31 – 40	2	0.25	0.10 – 0.40
	41 – 50	1	0.20	–
	51 – 60	1	0.50	–
	> 60	1	0.40	–
	Mean		**0.39**	
Female	< 10	1	0.50	
	11 – 20	3	0.90	0.20 – 1.6
	21 – 30	29	0.43	0.00 – 1.20
	31 – 40	17	0.49	0.10 – 0.90
	41 – 50	6	0.42	0.10 – 0.90
	51 – 60	1	0.60	–
	> 60	1	0.60	–
	Mean		**0.56**	
Overall Mean			**0.48**	

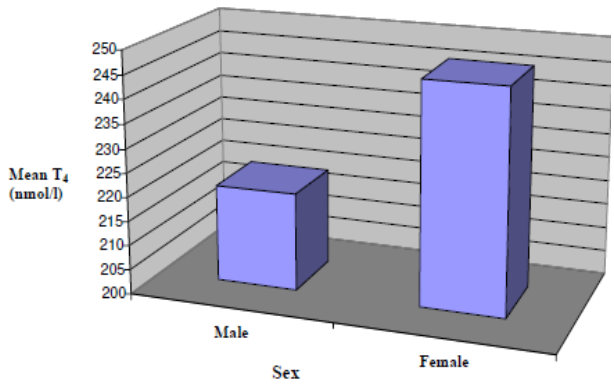

Fig. (7) Level of T4 vs Sex (male and female) in respondents with hyperthyroidism

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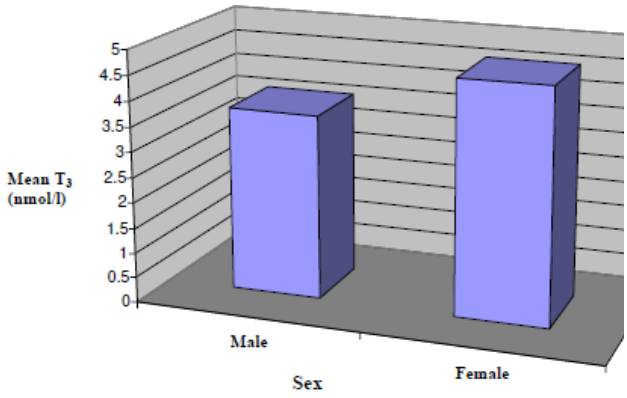

Fig. (8) Level of T3 vs Sex (male and female) in respondents with hyperthyroidism

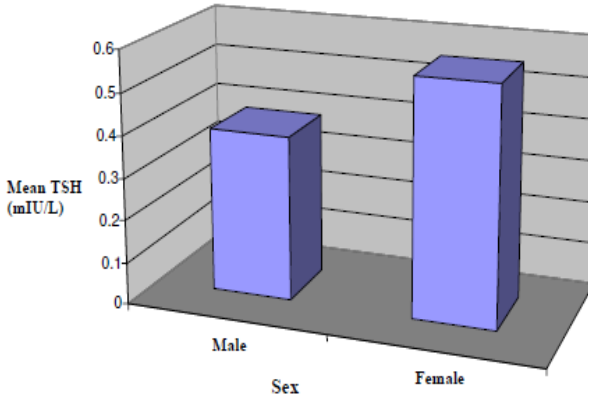

Fig. (9) Level of TSH vs Sex (male and female) in respondents with hyperthyroidism

Discussion

The total number of respondents in this study was 550. This is the number of individuals who visited the RIA laboratory within the year 2001. This number reflects the incidence of 3 cases per day. It is considered a high incidence since the RIA laboratory of the Sudan Atomic Energy Commission receives about 1⁄10 of the total samples received by all RIA laboratories in the area.

According to the distribution of the respondents by their results of levels of serum T4, T3 and TSH tests and according to the profile of each respondent, a percentage of 3.82 % was found to be of patients suffering from hypothyroidism and 12.18 % suffering from hyperthyroidism. It is also noticed that 84 % of the respondents were euthyroid. This may be due to suspicion of thyroid disorders by the physician, therefore these respondents were sent to check the normality of their thyroid functions.

The results revealed that the number of patients with hyperthyroidism was more than three times higher than that of patients with hypothyroidism. This might be due to the symptoms that appear on patients with hyperthyroidism, which include increased activity, intolerance to heat, excessive perspiration, rapid pulse and increased appetite along with decreased weight, that are easily recognized on a patient, compared to symptoms of hypothyroidism, which include

decreased activity, intolerance to cold temperature, slower perspiration, slower pulse and weight gain. In developing countries, where illiteracy is as high as 80 % and nutrition awareness is hardly known, weight gain is considered as a sign for good health (1).

Another reason might be the slow appearance of symptoms of hypothyroidism on an affected person. The symptoms are often present for years before the diagnosis is made and because of their non-specific and vague nature are often attributed to non-organ causes. The patient usually has no complaints and the diagnosis is made almost accidentally (19).

The variation in the number of respondents with hypothyroidism, hyperthyroidism or euthyroid, according to their levels of T4, T3 and TSH is due to many reasons (Tables 9, 11 and 13). Measurement of the level of all three hormones is necessary for the proper understanding of the functional state of an individual, as no one single test is 100 % accurate in diagnosing all types of thyroid disease.

In thyrotoxicosis the MIT/DIT ratio within the thyroid is increased; the ratio of T3/T4 formed is therefore increased. In iodine deficiency DIT is less abundant than MIT and relatively less T4 is formed than T3, presumably because of the greater chance of coupling of an MIT and a DIT molecule than two DITs (19).

This variation is also due to the response to drugs taken by patients suffering from hypothyroidism or hyperthyroidism. The levels of T4, T3 and TSH in blood serum of those patients changes due to the treatment. It is noticed that in some patients suffering from hyperthyroidism and that have received treatment, blood serum levels of T4 were slightly decreased while the concentration of TSH in blood serum was still low. Due to the unavailability of clear clinical manifestation of the cases, it is not possible to thoroughly explain these odd results.

In both cases of hypothyroidism and hyperthyroidism, it was noticed that these diseases predominantly affect women. They occur at a slightly younger age group and mostly peaking in the third or fourth decades,

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but no age is immune. 90.5% of patients with hypothyroidism were females, whereas only 9.5 % of them were males. In hyperthyroidism, 86.6 % of the patients were females and 13.4 % of them were males. From the total number of respondents, female respondents represented 88.91 % whereas male respondents represented 11.09 %.

Thyroid disorders are more common in females; this may be due to several factors. The first is that some of the thyroid diseases are of the autoimmune type, in which auto antibodies to hormone receptors may actually mimic the function of the normal hormone concerned and produce disease. Another factor is the effect of sexual steroids; estrogens and progestogens in the immunological system. These female steroid hormones may modulate the lymphocyte differentiation and can induce autoimmune response. In the case of hyperthyroidism, it was found that most cases are due to Graves' disease, which results from the production of thyroid-stimulating IgG (TSI) that activates the TSH receptor. This may result in a diffuse enlargement of the thyroid and excessive uncontrolled production of T3 and T4, since the production of TSI is not under feedback control. In the case of hypothyroidism it is most frequently due to auto-immune chronic thyroiditis and it may appear at any stage of childhood or adolescence (19-21).

From the results of the T-test, it was proven that there was no statistical difference or variation between the Test Variables (T4, T3 and TSH tests) and the Group Variables (male and female). Proven to be insignificant, this statistical analysis contradicts the scientific fact that thyroid diseases are more frequent in females than males. This data comes in accordance to a study in 2020 that analyzed a pediatric population with onset of ATD to assess the gender differences as regard onset age, disease subtype, pubertal status and autoimmunity (22).

The results also revealed that the majority of respondents from both sexes lie between the ages of 20 and 40. During this age a person is totally responsible of oneself and is capable of seeking medical advice on his/her own. People at older or younger ages need a companion or someone to decide for them especially in matters concerning health. It is also an active and mature stage in life. It is noticed that at this age in particular there are more females than males. Females are more concerned in their appearance and look at this age than males, the look that can be affected by the enlargement of the thyroid gland.

Although thyroid dysfunction increases with age, the minority of respondents was found above the age of 50 in both sexes. It is not necessary to modify the thyroid exploration according to the age, but it is important to notify that due to the increase of the morphological and functional heterogeneity of the thyroid, elderly people would be more sensitive to thyroid disease (23). This result comes in accordance with a study by Panayota which stated that serum T4 concentration is normal in healthy elderly subjects, while serum T3 shows an age-dependent decline (24).

The correlation values between age and thyroid function tests in both cases of hypothyroidism and hyperthyroidism were of insignificant difference. This is rational when applied to the scientific data that confirms the correlation but also specifies each age to their own circumstances.

Conclusion

In terms of prevelance, the rate is 3 times higher in hyperthyroidism than in hypothyroidism.

In terms of sex; women are generally at higher risk of most types of thyroid disease than men. They develop thyroid disorders early in life and about 10% of women will have thyroid dysfunction following pregnancy.

It has also been noticed that the severity of thyroid diseases manifests clearly in male respondents rather than females.

In terms of age; the risk of thyroid dysfunction increases with age and it is more prevalent in elderly males.

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