Kanem J Med Sci 2024; 18(2): 94 - 103
Open Access article distribution in the terms of the Creative Commons Attribution License (CC by 4.0)

ISSN 2006-4772
https://doi.org/10.36020/kjms.2024.1802.007

Original Article

Relationship between sonographically determined thyroid gland volume and thyroid function in adult diabetic patients without overt thyroid dysfunction in Gombe.

Amina M. Damji,[1] Suleiman T. Sa'ad,[1] Aminu U. Usman,[1] Ibinaiye Philip,[2] Talatu B. Ali,[1] Sambo S. Abubakar.[1]

[1]Department of Radiology, Federal Teaching Hospital, Gombe, Gombe State, Nigeria [2]Department of Radiology, Ahmadu Bello University Teaching Hospital, Zaria, Kaduna State, Nigeria

Correspondence to: Dr Suleiman T. Sa'ad, Department of Radiology, Federal Teaching Hospital, Gombe, Gombe State, Nigeria.
Email: drstsaad@gmail.com.
Phone: +2348036361239

Abstract

Background: Diabetes mellitus (DM) and thyroid dysfunction (TD) are the most common endocrine disorders encountered in the general population. Patients with DM are at increased risk of developing thyroid dysfunction. Insulin resistance states may increase thyroid gland volume, which can lead to thyroid dysfunction and, consequently, poor glycemic control. Traditionally, thyroid volume has been estimated clinically. However, recent reports indicate thyroid gland ultrasonography is a more precise method of determining the gland volume. Objective: This study aimed to sonographically assess thyroid gland volume and correlate it with thyroid function in adult diabetic patients without overt thyroid dysfunction and compare the same with apparently healthy adults in Gombe, Northeastern Nigeria. **Methodology:** This cross-sectional study was conducted at the Radiology and Chemical Pathology Departments from April 2021 to October 2022. Eighty-five diabetic subjects aged 25 to 78 years and an equal number of age and sex matched apparently healthy controls were consecutively selected for this study using simple random sampling. After documenting the age, sex, weight, height, body mass index (BMI), and body surface area (BSA) of the study subjects, their thyroid volumes were assessed using a Versana Essential ultrasound scan machine equipped with a 7.5MHz linear transducer. Free thyroxine (FT4) and thyroid stimulating hormone (TSH) values were also estimated using analysis kits manufactured by Monobind Inc. of USA. **Results:** The mean thyroid volume was higher in the diabetics (12.9 ± 8.7 cm3) group than in controls (8.76 ± 2.91 cm3), and it was statistically significant (P=0.0001). The levels of TSH and FT4 were not significantly higher in diabetic patients than in controls (p = 0.122; 95% CI = -0.127-1.073) and (p = 0.277; 95% CI = -0.063-0.219), respectively. Sub-clinical hypothyroidism (1.2%) was the common thyroid dysfunction in diabetic patients. There was no statistically significant correlation between total thyroid volume and TSH (r = -0.069, p = 0.531) in the diabetic patients. No significant correlation was found between total thyroid volume and FT4 (r = -0.042, p = 0.704) in the diabetic patients. A significant correlation was found between total thyroid volume and BMI, BSA, and weight (r =0.321, p =0.001; r =0.247, p=0.001; r =0.332, p =0.001). **Conclusions:** The results revealed that patients with diabetes without overt thyroid dysfunction have significantly increased thyroid volume, and some of them with sub-clinical thyroid hormone levels. Furthermore, there is no significant correlation between ultrasonographically determined thyroid volumes with thyroid function. Sub-clinical hyperthyroidism was the most common thyroid disorder and was found to be higher in females.

Key words: *Diabetes Mellitus, Thyroid volume, Thyroid hormones, Ultrasound Scan.*

Introduction

The two most common endocrine disorders diagnosed in clinical practice at different ages and in different populations all the time are diabetes mellitus (DM) and thyroid dysfunction.[1] DM is a group of metabolic disorders characterized by absolute or relative deficiency of insulin or its action, resulting in hyperglycemia and disorders of carbohydrate, protein, and lipid metabolism.[2] Many factors are associated with the disease, such as obesity, sedentary lifestyle, and high blood pressure. The pathogenesis of DM includes autoimmune destruction of pancreatic insulin-secreting cells (β-cells) resulting in insulin deficiency and abnormalities that result in insulin resistance. DM is divided into two major types.

Cite this article as: Amina M. Damji, Suleiman T. Sa'ad, Aminu U. Usman, Ibinaiye Philip, Talatu B. Ali, Sambo S. Abubakar - Relationship between sonographically determined thyroid gland volume and thyroid function in adult diabetic patients without overt thyroid dysfunction in Gombe.. Kanem J Med Sci 2024; 18(2): 94 - 103.

Received: 5th August 2024 **Accepted: 19th October 2024** **Published: 30th December 2024**

- Insulin dependent diabetes or type-1 diabetes (T1DM). In this case, pancreatic beta cells release insufficient amounts of insulin or no insulin.
- Non-insulin-dependent diabetes or type-2 diabetes (T2DM), which is the more common form of DM (90-95% of all diabetic cases). This type results from a combination of resistance to insulin action in body cells and an inadequate insulin secretion from pancreatic beta cells.[3]

In a study carried out in a tertiary health institute in Gombe, North-eastern Nigeria, the prevalence of DM was found to be 5.16%.[4] The prevalence of DM in the six geopolitical zones of Nigeria ranges from 3.0% in the North-west, 5.9% in the North-east, 3.8% in the North-central zone, 5.5% in the South-west, 4.6% in the South-east, and 9.8% in the South-south zone.[5] In Nigeria, based on the 2013 International Diabetes Federation (IDF) global diabetes scorecard, the prevalence of DM, estimated at 4.99%, is rapidly increasing.[6] Globally, the prevalence of DM among adults over 18 years of age has risen from 8.5% (422 million) in 2014 to 9.3% (463 million) in 2019.[7] The prevalence is higher in urban (10.8%) than in rural areas (7.2%), and in high income (10.4%) than in low income countries (4.0%).[7]

Thyroid disorder (TD), which is the second most common endocrinopathy, has been said to be more common in diabetic patients. Both diseases are closely related to each other, and this has important clinical implications in glycemic control. TD includes thyroid enlargement (goiter), hypothyroidism (Hashimoto's thyroiditis), and hyperthyroidism (Graves' disease).[8] Hashimoto's thyroiditis and Graves' disease are induced by an autoimmune process, and they are included in the spectrum of autoimmune thyroid disease.

In the general population, the prevalence of thyroid disorder in Nigeria ranges from 1.6% in the Southwest to 2.4% in the South-east.[9] It is 6.6% in North-east England and 5.9% in the US National Health and Nutrition Examination Survey (NHANES III).[10] Among diabetic patients, the prevalence reported in Nigeria is 46.5% [11] and it varies from 13.4% in Scotland to 12.5% in Jordan and from 15% in Spain to 26% in Saudi Arabia.[12-16]

TD may go undiagnosed in diabetic patients because of the common signs and symptoms of both disorders. For this reason, TD may be overlooked or attributed to other medical disorders.[17] These TDs may manifest in the form of glandular enlargement. Therefore, regular screening of the thyroid gland size in diabetic patients may allow for early detection and treatment of these disorders.
Thyroid volume is usually determined clinically, but recent reports indicated ultrasonography (US) as a more precise method of determining gland volume, and its accuracy is higher than that of clinical examination in establishing the presence of goiter.[18] US is thus effectively superior to clinical palpation. It is also faster, cheaper, does not use ionizing radiation, convenient, and more readily available for estimating thyroid volume and parenchymal abnormality than computerized tomography and magnetic resonance imaging. In addition, CT uses ionizing radiation, and MRI is time-consuming and not readily available in our environment. The World Health Organization (WHO) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) now consider the US the diagnostic method of choice for assessment of goiter.[19]
The aim of this study is to sonographically assess thyroid gland volume and determine thyroid function in adult diabetic patients without overt thyroid dysfunction and compare the same with apparently healthy adults (controls).

Materials and methods

Study design
This prospective cross-sectional study was carried out from April 2021 to October 2022 at the departments of Radiology and Chemical Pathology, Federal Teaching Hospital Gombe. Subjects were recruited consecutively based on the inclusion criteria stated below. The data were recorded on a structured data collection form (appendix I) that contains a patient's age, gender, height, weight, BMI, BSA, ultrasound, and biochemical findings.

Study area
The study was carried out at the Federal Teaching Hospital (FTH) Gombe, the North-eastern part of Nigeria.

Sampling Technique
The subjects were recruited using simple random sampling techniques using the inclusion criteria below.

Inclusion criteria study group
1. Diabetic patients are 18 years and above.
2. Subjects without anterior neck swelling or clinical evidence of thyroid disease
3. Subjects with no history of thyroid surgery, trauma, or radiotherapy to the neck.
4. Consenting subjects who are 18 years and above

Exclusion criteria study group
1. Subjects<18 years of age
2. Subjects with a known history of DM.`
3. Pregnant women are affected by pregnancy-related physiological changes.
4. Subject with a previous history of neck trauma, surgery, or radiotherapy
5. Non-consenting patients

Methodology

This study was carried out on 170 subjects comprising 85 diabetes mellitus patients without overt thyroid dysfunction and 85 control subjects who fulfilled the inclusion criteria. The nature of the research was explained to each subject, and a brief clinical history was obtained. Biodata, which included age and sex, was recorded for each patient. Blood samples of the control subjects were taken for fasting blood sugar (FBS) to rule out DM. Those subjects with normal FBS were recruited for the study. The height (in meters) and weight (in kilograms) of each subject were taken using a meter rule and beam weighing scales, respectively.

Body surface area (BSA) was calculated using the Dubois formula.[20]

BSA = 0.20247 × Height (m) 0.725 × Weight (kg) 0.425

The body mass index was calculated as a ratio of measured weight to the square of the measured height (Kg/m^2).

Sonographic technique of thyroid volume measurement

The ultrasound scan examination of the thyroid gland was performed using a 7.5MHz linear transducer of the Versana Essential ultrasound scan machine. The procedure was explained to all participants, and informed consent (Appendix II) was obtained. Each subject was assessed in a supine position. A pillow was placed under their shoulders to hyperextend the neck.

Ultrasound gel was applied over the anterior neck (thyroid area) and served as a coupling agent. The transducer was placed directly on the skin over the thyroid area. Placing the probe midline over the thyroid cartilage, a transverse plane image was obtained that revealed a panoramic view of two lobes of the thyroid gland joined by the isthmus at their superomedial borders to give an appearance of the butterfly. The probe was then slightly shifted laterally to the right and left in the same plane to visualize the individual right and left lobes, respectively. The maximum anteroposterior (AB) dimension of each thyroid lobe was measured on the transverse scan (Figures 1).

With the probe in the transverse orientation over each thyroid gland lobe, it was rotated to obtain the longitudinal images. The maximum mediolateral (CD) and craniocaudal dimensions (EF) were then measured (Figures 2). All measurements were then taken thrice, and average values were recorded to minimize intra-observer error.

The volume of each thyroid lobe was automatically calculated by the ellipsoid formula on the ultrasound machine[21] thus.

Volume = Anteroposterior (thickness) × Mediolateral (width) × Craniocaudal (length) × 0.479 (conversion factor). The volume of the whole thyroid gland was calculated by an aggregate of the estimated volumes of each lobe (right and left).

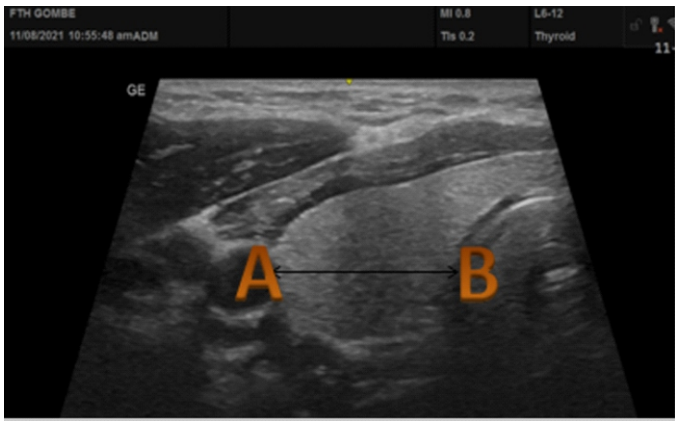

Figure 1: Transverse ultrasound scan image of the thyroid gland acquired in transverse plane at the level of the thyroid cartilage illustrating measurement of the maximum transverse diameter (A-B) of the right thyroid lobe.

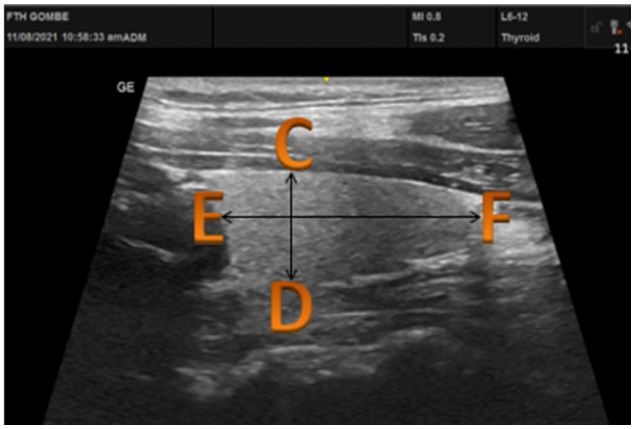

Figure 2: Longitudinal ultrasound scan image of the thyroid gland, showing measurement of the maximum longitudinal (E-F) and anteroposterior (C-D) diameters of the thyroid lobe.

Hormonal analysis

Sample collection, processing, and storage: -

A tourniquet was applied to the upper arm 2cm above the ante-cubital fossa to enhance visualization of the veins. The ante-cubital fossa was cleaned with an alcohol-based solution-soaked swab to disinfect the site. The ideal vein for cannulation was then identified and punctured with a sterile 21G needle attached to a 5ml syringe. Blood sample (5ml) was then collected and the needle gently withdrawn and haemostasis secured by applying pressure with dry cotton wool. The blood collected was transferred to a plain sample bottle and allowed to clot undisturbed for 30 minutes at room temperature. It was then centrifuged at 4000 rpm for 10 minutes. The supernatant serum was then pipetted into another plain sample bottle. Aliquots of the serum samples were taken and analysed for serum glucose. The remaining serum samples were stored frozen at -20^{0}C °C in a freezer until the time of TSH, FT3, and FT4 analysis. Serum glucose was measured using the

glucose oxidase method. Serum TSH, FT3, and FT4 were measured using the ELISA method. The analyses were done in the Chemical Pathology Laboratory of Federal Teaching Hospital, Gombe. Subjects will be selected as controls if they have normal fasting blood sugar; otherwise, they will be excluded from the study immediately, i.e., before ultrasound is done and before samples are sent to the laboratory.

The normal laboratory reference values for the measured biochemical parameters are as follows:

- TSH (0.4-6.0 ulU/ml)
- FT4 (4.8 12.0 ng/ml)
- FPG: 3.0–7.2 mmol/l

Methods of data analysis

The data obtained from the structured data proforma was processed and analysed using IBM Statistics Package for Social Sciences (SPSS) version 23 (IBM Plc, NY, USA)./;

The results were presented in the form of tables, graphs, and charts where applicable. Statistical parameters such as Chi-square and Student's T-test were used for association between different variables. P value of <0.05 was considered statistically significant.

Exploratory data analysis tools like scatter plots, charts, and descriptive statistics (mean, standard deviation, and range) were used to examine the distribution of the thyroid volumes by age, sex, height, weight, BMI, and BSA. The relationship between age and thyroid volume was measured using the Pearson correlation coefficient.

Results

Demographic and anthropometric variables of the studied population

Table 1 shows the comparison of demographic and anthropometric variables of the studied populations. The study population comprised of 56 (65.9%) females and 29(34.1%) males in both the diabetic and the control groups (fig. 3). The mean age difference between the diabetic patients (53.48 ± 13.03) and the apparently healthy controls (53.56 ± 13.35) was not statistically significant (p = 0.972; 95% CI = -4.064 – 3.923). The mean differences between body weight were statistically significant (p = 0.012; 95% CI = 1.186-9.496) while height was not statistically significant (p = 0.938; 95% CI = -0.023-0.025). The BMI showed a significant difference between the cases and controls (p = 0.008; 95% CI = 0.536-3.457) while the BSA showed no significant difference between the cases and controls (p = 0.189).

The thyroid disorder pattern based on gender in the studied population is shown in Table 3. Among the diabetic (cases) patients, the prevalence of thyroid dysfunction was 2.4% (1.2% sub-clinical hypothyroidism and 1.2% sub-clinical hyperthyroidism) as against 6.0% (2.4% sub-clinical hypothyroidism and 3.6% sub-clinical hyperthyroidism) in the apparent healthy non-diabetic controls. Thyroid dysfunction in female patients (85.7%) was higher than male counterparts (14.3%). However, the difference was not statistically significant (p = 0.999).

Table 1: Demographic and anthropometric variables of the studied population

Parameters	Cases (N= 85)	Control (N = 85)	95% CI of Mean Difference	p-value
Sex: n (%)				
Female	56(65.9)	56(65.9)	0.530	0.872
Male	29(34.1)	29(34.1)	1.885	0.886
Age (years)	53.48±13.03	53.56±13.35	-4.064-3.923	0.972
Height (M)	1.66±0.07	1.66±0.08	-0.023-0.025	0.938
Weight (Kg)	73.78±12.98	68.44±14.42	1.186-9.496	0.012
BMI (KG/M ^{2})	26.79±4.61	24.79±5.03	0.536-3.457	0.008
BSA	1.79±0.20	1.75±0.19	-0.020-0.099	0.189

Table 2: Comparison between ultrasound-determined thyroid gland volume in diabetic patients without overt thyroid dysfunction and thyroid gland volume in healthy controls

Parameter	(Mean± SD) **Cases**	(Mean± SD) **Control**	t	95% CI of the difference	P
Right Thyroid Lobe Volume	6.61±3.23	4.90±1.56	4.409	0.948-2.485	< 0.0001
Left Thyroid Lobe Volume	6.41±5.48	3.88±1.42	4.124	1.319-3.744	< 0.0001
Total Thyroid Volume	12.92±8.07	8.76±2.91	4.473	2.326-6.001	< 0.0001
	Female	**Male**			
Right Thyroid Lobe Volume	6.39±3.57	7.04±2.45	-0.876	-2.121-0.824	0.384
Left Thyroid Lobe Volume	6.25±5.83	6.73±4.82	-0.378	-2.983-2.031	0.707
Total Thyroid Volume	12.49±8.75	13.77±6.64	-0.690	-4.963-2.407	0.492

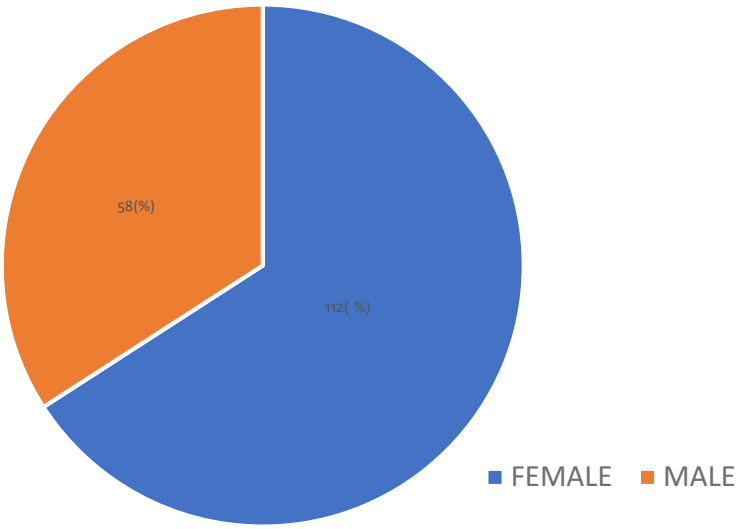

Figure 3 : Pie chart showing sex distribution of the study population.

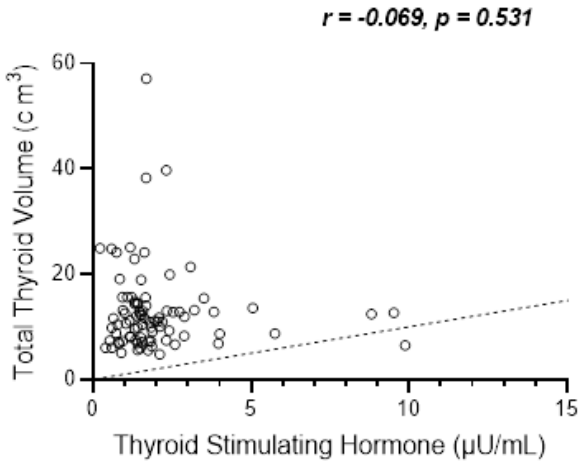

Figure 4: Relationship between total thyroid volume and TSH

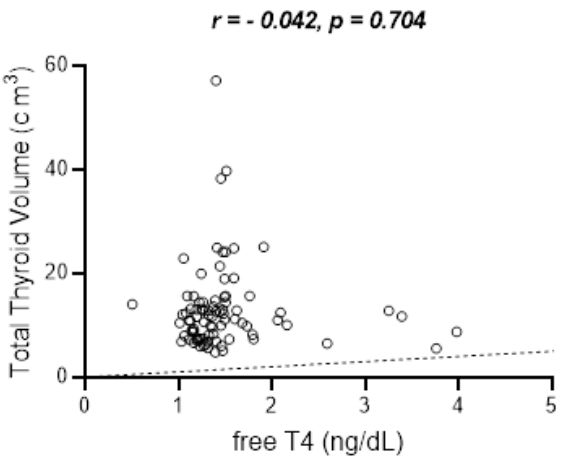

Figure 5: Relationship between Ft4 and total thyroid volume

Table 3: Thyroid disorders in the population studied

Group / Thyroid Disorder	Sex	Cases (n = 85)	Control (n = 85)	Total (n = 170)
Sub- clinical hypothyroidism n (%)	Male	0(0.0)	0(0.0)	0(0.0)
	Female	1(1.2)	2(2.4)	3(1.8)
Primary hypothyroidism n (%)	Male	0(0.0)	0 (0.0)	0(0.0)
	Female	0 (0.0)	0 (0.0)	0(0.0)
Sub- clinical hyperthyroidism n (%)	Male	0(0.0)	1(1.2)	1(0.6)
	Female	1(1.2)	2(2.4)	3(1.8)
Primary hyperthyroidism n (%)	Male	0 (0.0)	0 (0.0)	0(0.0)
	Female	0 (0.0)	0 (0.0)	0(0.0)
Total		2(2.4)	5(6.0)	7(4.2)

Table 4 shows the correlation between anthropometric variables and thyroid volume. There was no statistically significant correlation between total thyroid volume and age (r = 0.077, p = 0.484), height (r = 0.085, p = 0.272). There was a significant positive correlation between total thyroid volume and weight (r = 0.332, p = 0.001), BMI (r = 0.321, p =0.001), and body surface area (r =0.247, p =0.001).

The table also shows the correlation between anthropometric variables and thyroid volume in controls. There was no significant mean correlation between total thyroid volume and age (r = 0.096, p =0.383). There was a significant positive correlation between total thyroid volume and height (r = 0.347, p = 0.001), weight (r = 0.482, p = 0.001), BMI (r = 0.351, p = 0.001), and body surface area (r = 0.510, p = 0.001)

Table 4: Correlation between anthropometric variables and thyroid volume in diabetics

PARAMETERS	Case		Control	
	Correlation	p-value	Correlation	p-value
Age	0.077	0.484	0.096	0.383
Height	0.085	0.272	0.347	0.001*
Weight	0.332	0.001*	0.482	0.001*
BMI	0.321	0.001*	0.351	0.001*
BSA	0.247	0.001*	0.510	0.001*

*= *Significant correlation*

Discussion

This study showed that the mean thyroid volume was significantly higher in diabetic patients 12.9 ± 8.7 cm^3 than in the control group 8.76 ± 2.91 cm^3. Similarly, the mean right thyroid lobe volume and left thyroid lobe volume (p = 0.05; 95% CI =1.319-3.744) were significantly higher in the cases than in the control (p = 0.001; 95% CI = 0.948-2.485). Obasi *et al,* [22] in Calabar South-south Nigeria, also recorded a higher mean thyroid volume in diabetes compared to the controls, 6.8 ± 3.5 cm^3 vs. 6.3 ± 2.9 cm^3, which concurred with the findings in this study. Similarly, Okten *et al*[23] revealed a higher thyroid volume in the diabetic patients when compared with the control group (p = 0.0001). Other workers who documented similar results were Bianchi *et al* [24] who recorded higher mean total thyroid volume in diabetic patients by 46% when compared to their controls, and Duran *et al*[25] who recorded thyroid volume of 6.8 ± 3.5 cm^3 in their diabetic group compared with their corresponding controls 6.3 ± 2.9 cm^3. In addition, Anil *et al*[26] reported higher values of 20.0 ± 8.2 cm^3 in diabetics

compared to 11.4 ± 3.8 cm^3 in the control group. The increased thyroid volume in diabetics compared to the controls might be due to chronic insulin resistance through stimulation of thyroid cell proliferation via the mitogen-activated protein kinase (MAPK) pathway.[27] However, Salam *et al*[28], in Jos, North Central, Nigeria, recorded a higher thyroid volume of 10.68 ± 2.83cm^3 in their control subjects when compared to that of their diabetic subjects. This rather contrasting finding to several similar studies mentioned above may be due to their relatively small sample size.

Alazigha *et al*[29] and Msuega *et al*[30] recorded lower values of thyroid volumes of 6.81 ± 2.18 cm^3 and 6.91 ± 2.41 cm^3 in their healthy adult subjects when compared with the control values 8.76 ± 2.91 cm^3 of this study.

This study also showed that the mean thyroid volume in male diabetics 13.77 ± 6.66cm^3 was higher than the values recorded in female diabetics 12.49 ± 8.75cm^3. This finding was similar to that of Nduka *et al,* [31], which showed a higher mean thyroid volume of 11.5 ± 5.2 cm^3 in male diabetics compared to the female counterpart with a mean thyroid volume of 9.9 ± 6.2 cm^3. A similar finding was also noted in the male and female controls, with values of 7.4 ± 1.9 cm^3 and 7.1 ± 3.4 cm^3 for the males and females, respectively. Similarly, Gomez *et al*[32] also found mean thyroid volumes in male diabetics of 11.5 ± 5.2 cm^3 compared to 9.9 ± 6.2 cm3 in females. They also found higher values of 7.4 ± 1.9 cm^3 in the male controls compared to 7.1 ± 3.4 cm^3 in the females. The increased thyroid volume in males could be due to a difference in body weight[33] or due to the larger size of most anatomical structures in males.[34]

Ahidjo *et al*[35], in North-eastern Nigeria, also recorded higher values of mean thyroid volume in males (9.72cm^3) than in females (7.58cm^3) in their normal healthy subjects.

The index study revealed that in the diabetic patients, average thyroid stimulating hormone (TSH) levels were higher in diabetics (2.01±1.73) than in the control (1.53±2.21). However, the difference was not statistically significant ($p = 0.122$). Anil *et al*[36], in Turkey, also documented similar findings to the index study, which showed that thyroid stimulating hormone (TSH) was higher in the diabetic group (1.9±0.9 mIU/L) than in the control group (1.4 ±0.8 mIU/L) ($p<0.0001$ for both). Singh *et al*[37] in India also observed that the thyroid stimulating hormone (TSH) was higher among the diabetic patients when compared to the control group ($p <0.0001$). Both studies showed statistically significant differences as opposed to the index study where their diabetic TSH levels were higher than the controls, but the difference was not statistically significant.

In addition, the index study found free thyroxine (FT4) was higher in the diabetic cases (1.49±0.56) than in the control subjects (1.41±0.35). However, the difference was not statistically significant. Bianch *et al*[38] noted similar findings of higher FT4 levels in their diabetic study group when compared to the controls. In the same vein, Abdulhamza *et al*[39] revealed that the values of the FT4 in diabetic patients were higher (26.40±5.27pmol/dL) than in the control group (13.81±3.71 pmol/dL).

In contrast to these findings, Annan *et al*[40] in Korle Bu Teaching Hospital, Ghana, established that the levels of TSH (1.53 ± 1.16mIU/ml) were significantly lower in diabetic patients than the controls. The difference was most probably due to the smaller sample size (118) that was used in their study when compared with the index study (170).

Furthermore, Duran *et al* [41] in Italy documented no differences in blood TSH levels between the diabetic and the control groups. However, they conducted a retrospective study rather than a prospective study. Similarly, Obasi *et al* [42] in Nigeria also showed no differences in blood TSH levels between the diabetic and their control groups.

The prevalence of thyroid dysfunction among diabetic patients in this study was 2.4%, while among the controls it was 6.0%. These values are lower than those reported from many studies. Annan *et al,* [39] in Ghana, reported higher thyroid dysfunction of 10.1% in diabetics as against 5.1% in apparently healthy controls. Udong *et al*[11] and Celani *et al* [43] in their studies also reported much higher prevalence of thyroid dysfunction of 31.0% and 46.5%, respectively. Other reports by Perros *et al*[13] and Smithson *et al* [44] estimated the prevalence of thyroid dysfunction among type-2 diabetics to vary between 2.2% to 17%.

Furthermore, the study showed increased prevalence of thyroid dysfunction in female diabetics (85.7%) than in male diabetics (14.3%). Similar reports were recorded by Elmenshawi *et al*[3] who noted increased prevalence of TD in female (37%) than in male (25%) diabetic patients. Annan *et al*[39] in their study also found higher prevalence of Thyroid dysfunction in female patients (66.7%) when compared to their male counterparts (33.3%).[40] and Ghazali *et al* [45] also showed higher values of thyroid dysfunction in females (32.4%) than in males (25.9%).[45] The most common pattern of thyroid dysfunction among subjects in this study was subclinical hypothyroidism (1.2%) and sub-clinical hyperthyroidism (1.2%) in diabetes and subclinical hypothyroidism (2.4%) and sub-clinical hyperthyroidism (3.6%) in apparently healthy controls. Demitrost *et al*[46] showed 16.3% sub-clinical

hypothyroidism, 11.4% hypothyroidism, 2.0% subclinical hyperthyroidism, and 1.5% hyperthyroidism. Whitley *et al*[47] reported that this wide variation in the pattern of thyroid dysfunction in diabetics is influenced by the various medications administered to patients. Some of the oral hypoglycemic agents, such as the phenylthioureas, are known to suppress the levels of FT4 and T4, while raising the levels of TSH. Many investigators reported that the treatment of diabetes with sulfonylurea led to an increased incidence of goiter and hypothyroidism.[48]

This study showed no statistically significant correlation between total thyroid lobe volume (r = -0.069, $p = 0.531$), right thyroid lobe volume (r = -0.069, $p = 0.531$), and left thyroid lobe volume (r = -0.067, $p = 0.542$) with TSH in the diabetic patients. The control group also showed no statistically significant correlation between total thyroid lobe volume (r = 0.016, $p = 0.883$), right thyroid lobe volume (r = 0.024, $p = 0.830$), and left thyroid lobe volume (r = 0.027, $p = 0.810$) with the TSH. This finding concurred with Alazigha *et al*[29] and Bianchi *et al.*[38]

However, this finding differs from what was reported by Mohsen *et al*[49] in their study, who reported a positive correlation between thyroid volume with serum TSH in diabetic patients. The reason for this variance may be due to the difference in methodology. The TSH in their study was assayed by chemoluminescence immune assay using a fully automated analyzer as opposed to the use of ELISA kits, which is a manual method of hormonal assay. Most importantly, they also used a much larger sample size (400) when compared to the current study (170).

Significant positive correlation was found in this study between thyroid volume and body mass index (r = 0.321, $p = 0.001$), body surface area (r = 0.247, $p = 0.001$) and body weight (r = 0.332, $p = 0.001$) indicating that with increasing BMI, BSA and body weight, the thyroid volume also increases in diabetics. The index study further revealed a significant positive correlation between thyroid volume and body mass index (r = 0.321, $p = 0.001$), body surface area (r = 0.247, $p = 0.001$) and body weight (r = 0.332, $p = 0.001$) indicating that with increasing BMI, BSA and body weight, the thyroid volume increases also in the controls. This is in agreement with the finding of Gómez *et al*[32] in their study in Spain showed a positive correlation between thyroid volume and body weight, BMI, and BSA in the diabetic group. In contrast, Nduka *et al*[31] and Obasi *et al*[42] observed no relationship between weight, BMI and thyroid volume among the diabetics.

The study showed no significant correlation between total thyroid volume and age among the diabetics (r = 0.077, $p = 0.484$) and the controls (r = 0.096, $p = 0.383$) which concurred with the findings of Nduka *et al*[31] and Obasi et al[22] who also observed that there was no correlation between age and thyroid volume in the study population.

Conclusion

A significant number of patients with diabetes have ultrasonographically detectable increase in thyroid volume, and a proportion of them present with sub-clinical thyroid hormone levels without clinical evidence of thyroid disease. The value of ultrasound scan in the evaluation of thyroid volume as a tool for early detection of thyroid dysfunction in diabetic patients without overt thyroid disease was investigated.

There was no significant difference between thyroid function (TSH and FT4) in adult diabetic patients without overt thyroid dysfunction with apparently healthy adult controls. There was no significant correlation between ultrasonographically determined thyroid gland volume with thyroid function (TSH and FT4) in diabetic patients.

Limitations of the study

1. Relatively small sample size of the study population may have narrowed down the number of DM patients having thyroid dysfunction.
2. Inability to assay other thyroid hormones such as FT3 and T3 due to financial limitation, this would have ensured a more comprehensive thyroid state evaluation.

Recommendations

1. Ultrasonographically determined thyroid gland volume in diabetic adults without overt thyroid disorder has not been established as a verifiable tool in detecting sub-clinical thyroid dysfunction in such patients.
2. A similar study with a larger sample size that may increase the validity of this study is recommended.
3. A study that will further correlate thyroid volume, thyroid hormones with the duration of diabetes is suggested.

References

1. Jain G, Marwaha TS, Khurana A, Dhoat P. Prevalence of thyroid disorders in patients of Type-2 diabetes mellitus. *Int J Med Dent Sci.* 2013; 2(2):153–161.
2. American Diabetes Association. Classification and diagnosis of diabetes. Diabetes Care 2017; 40:11-24.
3. Elmenshawi IM, Alotaibi SS, Alazmi AS, Alazmi AM, Alruwaili FR, Alazmi NN, *et al.* Prevalence of thyroid dysfunction in diabetic patients. *J Diabetes,*

Metab Disord Control. 2017; 4(2):55-60.
4. Danjin M, Umar NU, Adamu D. Prevalence of diabetes mellitus in a tertiary health institution in Gombe metropolis, Nigeria. *J Med Sci Heal*. 2017; 3(1):1–6.
5. Uloko AE, Musa BM, Ramalan MA, Gezawa ID, Puepet FH, Uloko AT *et al*. Prevalence and risk factors for diabetes mellitus in Nigeria: A systematic review and meta-analysis. *Diabetes Ther.* 2018; 9(3):1307–1316.
6. Beatriz Y, Sheree D, Courtney S, OJ. Global diabetes scorecard tracking progress for action. *IDF*. 2014; 24(1):5–24.
7. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N *et al*. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: In: International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res Clin Pract*; 2019; 157:107843.
8. Witting V, Bergis D, Sadet D BK. Thyroid disease in insulin-treated patients with type-2 diabetes. *Thyroid Res*. 2014; 1(7):2.
9. Okafor EN, Ugonabo MC, Chukwukelu EE, Okonkwo IN, Ezigbo E, Odurukwe O. Prevalence and pattern of thyroid disorders among patients attending University of Nigeria Teaching Hospital, Enugu, Southeastern Nigeria. *Niger Med Journal*. 2019; 60(2):62-67.
10. Hollowell JG, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA *et al*. Serum TSH, T4, and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). *J Clin Endocrinol Metab*. 2007; 1(87):489–499.
11. Udiong CEJ, Udoh AE, Etukudoh. Evaluation of thyroid function in diabetes mellitus in Calabar, Nigeria. *Indian J Clin Biochem*. 2007; 22(2):74–78.
12. Vanderpump M, Tunbridge WMG, French J, Appleton D, Bates D, Clark FL, *et al*. The incidence of thyroid disorders in the community: a twenty-year follow-up of the Whickham Survey. *Clin Endocrinol*. 1995; 43(1):55–68.
13. Perros P, McCrimmon RJ, Shaw G, Frier BM. Frequency of thyroid dysfunction in diabetic patients: value of annual screening. *Diabet Med*. 1995; 12(7):622–627.
14. Radaideh A-RM, Nusier MK, Amari FL, Bateiha AE, El-Khateeb MS, Naser AS, *et al.* Thyroid dysfunction in patients with type-2 diabetes mellitus in Jordan. *Saudi Med J*. 2004; 25(8):1046–1050.
15. Zhao W, Li X, Liu X, Lu L, Gao Z. Thyroid function in patients with type-2 diabetes mellitus and diabetic nephropathy: A single center study. *J Thyroid Res*. 2018; (8):1-7.
16. Akbar DH, Ahmed MM, Al-Mughales J. Thyroid dysfunction and thyroid autoimmunity in Saudi type-2 diabetics. *Acta Diabetol*. 2006; 43(1):14–18.
17. Shen DC, Davidson MB, Kuo SW, Sheu WH. Peripheral and hepatic insulin antagonism in hyperthyroidism. *J Clin Endocrinol Metab* 1988; 66:565–569.
18. Maratou E, Hadjidakis DJ, Peppa M, Alevizaki M, Tsegka K, Lambadiari V, *et al.* Studies of insulin resistance in patients with clinical and subclinical hyperthyroidism. *Eur J Endocrinol.* 2010; 163(4):625–630.
19. O'Meara NM, Blackman JD, Sturis J, Polonsky KS. Alterations in the kinetics of C-peptide and insulin secretion in hyperthyroidism. *J Clin Endocrinol Metab*. 1993; 76(1):79–84.
20. Du Bois D, Du Bois EF. A formula to estimate the approximate surface area if height and weight be known. *Nutrition*. 1989; 5(5):303–311.
21. Brunn J, Block U, Ruf G, Bos I, Kunze WP, Scriba PC. Volumetric analysis of thyroid lobes by real-time ultrasound. *Dtsch Med Wochenschr.* 1981;106(41):1338–1340.
22. Obasi UO, Akintomide AO. Ultrasound thyroid volume in diabetic and apparently healthy adults. *Niger Med J*. 2022;31(1):98-105.
23. Okten A, Akcay S, Cakir M, Girisken I, Kosucu P, Deger O. Iodine status, thyroid function, thyroid volume and thyroid autoimmunity in patients with type 1 diabetes mellitus in an iodine-replete area. *Diabetes Metab*. 2006; 32(4):323–329.
24. Bianchi G, Montanari P, Fabbri A. Thyroid volume in type-1 diabetes patients without overt thyroid disease. *Acta Diabetol*. 1995; 32:49–52.
25. Duran A, Anil C, Gursoy A, Nar A, Inanc M, Bozkurt O, *et al.* Thyroid volume in patients with glucose metabolism disorders. *Arq Bras Endocrinol Metab.* 2014; 58(8): 824–827.
26. Anil C, Akkurt A, Ayturk S, Kut A, Gursoy A. Impaired glucose metabolism is a risk factor for increased thyroid volume and nodule prevalence in a mild-to-moderate iodine deficient area. *Metab Clin Exp*. 2013; 62(7):970–975.
27. Sheng X, Shao A, Yao K, Tu S, Zhang X, Chen T, et al. The role of insulin glargine and human insulin in the regulation of thyroid proliferation through mitogenic signaling. *Frontiers in Endocrinol*. 2019; 10:594.
28. Salaam AJ, Danjem SM, Salaam AA, Angba HA IP.

Determination of relationship between thyroid gland volume and anthropometric indices. *J Adv Med Med Res.* 2019; 31(3):1–12.
29. Alazigha NS, U*gboma EW, Nwankwo NG*, Agi C. Sonographic measurement of the volume of the normal thyroid gland in adults in Brainth Waite Memorial Specialist Hospital, Port Harcourt. *The Nig Health J.* 2016;15(3):133
30. Demitrost L, Ranabir S. Thyroid dysfunction in type-2 diabetes mellitus: A retrospective study. *Indian J Endocrinol Metab* 2012;16: S334-S335.
31. Nduka CC, Adeyekun AA. Ultrasound assessment of thyroid gland volume in diabetic patients without overt thyroid disease. *Ann Afr Med.* 2016; 15(4):157-162.
32. Gómez JM, Maravall FJ, Gumà A, Abós R, Soler J, Fernández-Castañer M. Thyroid volume as measured by ultrasonography in patients with type-1 diabetes mellitus without thyroid dysfunction. *Horm Metab Res*. 2003; 35(8):486–491.
33. Kamran M, Hussan N, Ali M, Ahmed F, Kaza F, Zehra N, et al. Correlation of thyroid gland volume with age and gender in a subset of Karachi population. *Pak J Med Dent* 2014; 3:26-32.
34. Msuega CD, Ugande AA, Iorpagher KP, Obekpa OI, Abdullahi AA. Normative data of thyroid volume - ultrasound evaluation in clinically asymptomatic Nigerian adults at Benue State University Teaching Hospital, Makurdi. *Int J Adv Med* 2021; 8:864-871.
35. Ahidjo A, Tahir A, Tukur M. Ultrasound determination of thyroid gland volume among adult Nigerians. *Internet J Radiol.* 2005; 4(2):2-5
36. Anil C, Akkurt A, Ayturk S, Kut A, Gursoy A. Impaired glucose metabolism is a risk factor for increased thyroid volume and nodule prevalence in a mild-to-moderate iodine deficient area. *Metab Clin Exp*. 2013; 62(7):970–975.
37. Singh, P., Khan, S., Mittal RK. Assessment of thyroid dysfunction in the type 2 diabetic patients. *Int J Diabetes Dev Ctries*. 2014; 34:229.
38. Bianchi G, Montanari P, Fabbri A. Thyroid volume in type-1 diabetes patients without overt thyroid disease. *Acta Diabetol*. 1995; 32:49–52.
39. Abdulhamza RH, Ban Waheed HB, Satar Jabbar RA. Evaluation of thyroid volume and thyroid function in newly diagnosed Type-2 diabetes mellitus patients. *Sys Rev Pharm*. 2020; 11(5):445–450.
40. Annan D, Ababio G. Evaluation of thyroid profile in Ghanaian patients with Type-2 diabetes. *Int J Adv Res.*2014; 2:206-209.
41. Duran A, Anil C, Gursoy A, Nar A, Inanc M, Bozkurt O, *et al.* Thyroid volume in patients with glucose metabolism disorders. *Arq Bras Endocrinol Metab.* 2014; 58(8): 824–827.
42. Obasi UO, Akintomide AO. Ultrasound thyroid volume in diabetic and apparently healthy adults. *Niger Med J*. 2022;31(1):98-105.
43. Celani MF, Bonati ME, Stucci N. Prevalence of abnormal thyrotropin concentrations measured by a sensitive assay in patients with Type-2 diabetes mellitus. *Diabetes Res* 1994;27(1): 15-25.
44. Smithson, M. J. (1998): Screening for thyroid dysfunction in a community population of diabetic patients. *Diabetes Med.*, 15(2); 148-150.
45. Ghazali SM, Abbiyesuku AF. Thyroid dysfunction in type-2 diabetics seen at the University College Hospital, Ibadan, Nigeria. *Nig J Physiol Sci*. 2010; 25: 173–179.
46. Demitrost L, Ranabir S. Thyroid dysfunction in type-2 diabetes mellitus: A retrospective study. *Indian J Endocrinol Metab* 2012;16: S334-S335.
47. Whitley RJ. Thyroid function. In Burtis C, Ashwood AR. editors. Teitz text book of clinical chemistry, 3rd Edition. Philadelphia: Saunders & Company. 1984; 1496-1529.
48. Makandar A, Sonagra AD, Shafi N. Study of thyroid function in type 2 diabetic and non-diabetic population. *Int J Med Sci Public Health* 2015; 4:769-772
49. Manal M, Alyaa AE, Ahmed MB, Emadabd EE, Mahmoud MN. Study of possible relation between thyroid volume, nodule formation and glucose metabolism disorders in Egyptian population. *J Egypt Soc Parasitol.* 2017; 47(3):599 – 606.