Sonographic Determination of Thyroid Gland Volume among Pregnant Women Attending Murtala Muhammad Specialist Hospital Kano, Nigeria

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ABSTRACT

Background: In Kano state, there is a lack of documented thyroid volume data for pregnant women using ultrasound, potentially leading to misdiagnosis of goitre caused by thyroid gland enlargement during pregnancy.**Objectives**: This study aimed to determine the thyroid gland volume of pregnant women at Murtala Muhammad Specialist Hospital (MMSH) using ultrasound.**Materials and Methods**: The study took place at MMSH Kano from January 2021 to January 2023, with 300 pregnant women and 100 controls. Ultrasound scans were performed using a Toshiba TA321 Ultrasound machine. Thyroid lobe volume was calculated with the formula A × B × C × 0.479. Statistical analysis used SPSS version 21.0, employing ANOVA and independent t-tests for comparisons, and Pearson's coefficient correlation for relationships.**Results**: The total thyroid volume for non-gravid and gravid participants in the first, second, and third trimesters was 8.45±1.55 cm3, 7.38±2.37 cm3, 9.01±3.31 cm3, and 9.37±3.57 cm3, respectively. Significant differences were observed in demographic variables and thyroid volumes, except for age and height. There was no significant difference in right thyroid volume (RTV) and total thyroid volume (TTV) between the control and pregnant groups. However, a significant difference was found in left thyroid volume (LTV) between the groups. A moderate positive correlation was observed between TTV and weight, BMI, and BSA, while a weak positive correlation was seen with age and height.**Conclusion**: This study determined the thyroid gland volume in pregnant patients in Kano state, showing a progressive increase with advancing trimesters.

Keywords: Kano; Pregnancy; Thyroid; Trimesters; Ultrasonography.

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INTRODUCTION

During normal pregnancy, the thyroid gland undergoes adaptive physiological hyperplasia due to enhanced production of estrogen and elevated concentration of human gonadotrophin (hCG) hormones.[1] These result in the adjustment of the ratio of bound-free thyronine (T3) and thyroxine (T4) against the throglobulin (TGG) concentration and increase the secretions of T3 and T4 in the first trimester. In the second trimester, there would be a conversion of T4 to reverse T3 (rT3,) by the enzymatic action of type III monodeiodinase. This helps the gland adapt to the increased metabolic demands of gestation.

The changes depend on iodine availability intake. It was established that in iodine-sufficient countries the thyroid gland size increases by about 10% during pregnancy and 20-40% in iodine-deficient countries.[1, 2] Insufficient iodine supply could lead to iodine deficiency disorders (IDD). Iodine deficiency disease is a global burden as it was estimated that 2.2 million people suffer from the disorder.[3] Women of childbearing age and pregnant and lactating women are considered key populations for the diagnosis and treatment of IDD.[4] The disease is associated with both adverse maternal and fetal outcomes. The risks for the fetus or infants include fetal or neonatal prematurity, low birth weight, congenital anomalies, mental retardation, cretinism and fetal death. [1, 5]

During routine screening, 2-3% of pregnant patients will have elevated thyroid stimulating hormone (TSH) levels, among which 0.3-0.5% will have overt hypothyroidism and 2-2.5% will have subclinical hypothyroidism and the prevalence of both conditions increased in iodine-deficient regions. [6] Hyperthyroidism was recorded in 0.1-0.4% of pregnant patients [6]. Overt hypothyroidism in pregnancy increases the risk of, preeclampsia, placental abruption, postpartum haemorrhage, cardiac dysfunction and maternal hypertension. [7]

Other factors that affect thyroid volume are genetics, gender, age, height, weight, parity, smoking and genetic factors.[6, 8, 9]

Enlargement of the thyroid gland during pregnancy can be misdiagnosed as goitre. A recorded thyroid volume in pregnancy is needed so that an increase in thyroid volume during pregnancy can be related to and differentiated from thyroid goitre. Despite the high population in Kano state, no documented thyroid volume can be referred to during pregnancy while using ultrasound. Only guided values are being used especially borrowed from the Caucasians despite the geographical differences. Consequently, it can lead to false positives or negatives during the conclusion of the diagnosis. The study will benefit the radiologist, sonographers and physicians both in the diagnosis and management of the patient as it will serve as a guide for grading and differentiation of gestational goitre from thyroid goitres. Thus the study aimed to sonographically determine the thyroid volume in pregnant women attending Murtala Muhammad Specialist Hospital (MMSH) in Kano Nigeria.

MATERIALS AND METHODS

The study is a comparative one, involving pregnant and non-pregnant women (control) which was conducted in MMSH Kano from January 2022 to April 2023. An Ethical clearance to conduct the study was obtained from the Research and Ethical Committee of the Ministry of Health Kano State. Consent was obtained from the patient by explaining the details of the study and the procedure in the attached consent form. Therefore only patients who accepted to participate were included. One hundred singleton pregnant in each trimester and 100 controls (non-pregnant women) were randomly included in the studies. All pregnant participants with multiple gestations or those with any kind of thyroid disorders clinically, those with palpable, visible neck mass or any form of malignancy and those with sickle cell anaemia were excluded from the study. Participants with abnormal parenchymal echotexture or nodules while scanning were also excluded from the studies. The participants were interviewed face to face and their demographic information such as age, height, and weight was obtained. Their height was measured in meters (m) using a stadiometer, weight was measured in kilogram (Kg) using a bathroom weighing scale. Body mass index (BMI) was calculated in (Kg/m^2) using the following formula;

BMI=

$Weight/Height^2$ [10]

Body surface area (BSA) was calculated using DuBois formulas;

$$BSA= (w^{(0.425)} \text{ X } H^{0.722}) \text{X } 0.007184$$

Where; W= weight and H=Height

Gestational age was determined during the examination of each patient from the last menstrual period as well as by obstetric ultrasound using conventional methods (during the first trimester by crown-rump length, later by biparietal diameter and femur diaphysis (length). If there was a discrepancy, the GA obtained by obstetric ultrasound was used. All scanning was done with an Ultrasound machine, Model; Toshiba, TA321 equipped with a linear probe (7-10MHz). The transducer was placed perpendicularly in the transverse plane above the sternal notch and moved superiorly to view the entire gland from the inferior to the superior aspect. The measurements were done on the image that showed the lobe at its greatest depth and width on both the right and left lobes. Measurements of the maximal width (mediolateral) and depth (anteroposterior) of the transverse section of each lobe, with the depth measurement at a 90^0 angle to the skin surface and the width measurement at 90^0 to the depth measurement were taken. The transducer is placed perpendicularly in the sagittal plane above the sternal notch and moved superiorly to view the entire gland from inferior to superior and medial to lateral aspect until the greatest length (craniocaudal) is visualized then freezes. To obtain the greatest length, because of the inferior convergence of the lobes, the transducer is often oriented with its superior end slightly diverging from the midline. Measurements of the maximal length of the longitudinal section for both lobes were taken. The volume of a thyroid lobe was calculated by the formula A × B × C × 0.479, where A is the length, B is the width, and C is the thickness (depth) of the lobe, while 0.479 (0.524) is the correction factor for the ellipsoidal shape of the lobe. Both descriptive and inferential statistics were applied to the data. The data were subjected to normality tests. However, those who failed the test were subjected to appropriate transformation. Positively skewed data were transformed to normally distributed using the log(10), while negatively skewed data were transformed using the X^2. Means ± standard deviations (SD) and ranges of age, height, weight BMI, BSA, GA, right thyroid volume (RTV), left thyroid volume (LTV) and total thyroid volume (TTV) were presented using descriptive statistics. Furthermore, one-way ANOVA was used to compare the variables between the groups. A pairwise comparison was further used if there was a significant difference between groups. An Independent t-test was employed to compare the right and left thyroid volumes and TVV in the control and study groups. Pearson's coefficient correlation was used to determine the relationship between the anthropometrics and the TTV. All statistical analysis was done with SPSS version 21.0 and statistical significance was set at $p<0.05$.

RESULTS

The demographic variables and thyroid volumes of the included participants were summarized in Table 1. The total thyroid volume for the non-gravid and the gravid participants in the first, second and third trimesters were 8.45±1.55 cm^3, 7.38±2.37 cm^3, 9.01±3.31 cm^3 and 9.37±3.57 cm^3 respectively as demonstrated in Table 1. A statistically significant difference was seen in all the demographic variables and the thyroid volumes except in their age and height as seen in Table 1.

Table 1: Demographic variables and comparison of the thyroid volumes between the non-gravid and the gravid participants.

BMI: Body Mass Index, **BSA**: Body Surface Area, **GA**: Gestational Age, **RTV**: Right Thyroid Volume,
LTV: Left Thyroid Volume, **TTV**: Total Thyroid Volume
* ANOVA

A post-hoc pairwise comparison indicated that the non-gravid,
second and third-trimester participants had statistically larger
thyroid gland volume than the first-trimester participants as indicated in Table 2.
However, no statistically significant difference was seen among the non-gravid,
second and third-trimester participants as seen in

Table 1: Demographic variables and comparison of the thyroid volumes between the non-gravid and the gravid participants.

Variables	Control (N=100)	First Trimester (N=100)	Second Trimester (N=100)	Third Trimester (N=100)	*P-Value (<0.05)
Age (years)	27.23±4.69	27.73±6.08	27.69±5.99	27.65±5.94	0.610
(Range)	(20-37)	(18-39)	(18-40)	(15-45)	
Height (m)	1.65±0.10	1.65±0.70	1.69±0.95	1.65±0.07	0.672
(Range)	(1.47-1.78)	(1.4-1.78)	(1.13-1.90)	(1.5-18)	
Weight (Kg)	62.54±9.23	50.30±8.32	59.48±13.60	62.76±15.93	0.001
(Range)	(47-80)	(35-68)	(40-115)	(41-141)	
BMI (Kg/m^2)	23.17±4.69	18.53±2.69	22.11±5.96	23.06±5.34	0.001
(Range)	(36-14)	(12.46-23.83)	(14.93-46.07)	(14.58-50.14)	
BSA(m^2)	1.69±0.13	1.51±0.14	1.64±0.19	1.68±0.22	0.001
(Range)	(1.44-1.98)	(1.24-1.83)	(1.25-2.29)	(1.34-2.56)	
RTV(cm^3)	4.63±0.78	3.57±1.15	4.59±1.77	4.71±2.05	0.001
(Range)	(3.07-5.78)	(1.66-6.58)	(1.49-10.50)	(1.89-14.06)	
LTV(cm^3)	3.82±0.97	3.78±1.37	4.42±1.73	4.66±1.78	0.001
(Range)	(2.31-5.78)	(1.2-8.57)	(1.21-10.13)	(1.72-14.03	
TTV(cm^3)	8.45±1.55	7.35±2.34	9.01±3.31	9.37±3.57	0.001
(Range)	(6.03-11.26)	(2.85-15.10)	(2.96-20.42)	(4.04-26.90)	

table 2

FT: First trimester, **ST**: Second Trimester, **TT**: Third Trimester

Independent t-test indicated no statistically significant difference in the RTV and TTV between the controls and the pregnant groups (p=0.47) and (p=0.39) respectively, however, there was a statistically significant difference in the LTV between the controls and the pregnant groups (p=0.02) as seen in Table 3.

Table 3. Comparison of the right, and left thyroids lobe volumes between the pregnant and control groups.

Volumes	Groups	Mean	t value	*p-value(<0.05)
RTV	Control	4.63±0.78	0.72	0.47
	Pregnant	4.45±1.84		
LTV	Control	3.82±0.97	-3.70	0.02
	Pregnant	4.40±1.71		
TTV	Control	8.45±1.45		
	Pregnant	8.845±3.34	-850	0.39

RTV: Right thyroid volume: LTV: Left thyroid volume, * Independent t-test

RTV: Right Thyroid Volume, **LTV**: Left Thyroid Volume.

Table 2: Pairwise comparisons of Weight, BMI, BSA and TTV in all the control and study groups

GROUPS		p-value(<0.05)			
		Weight (Kg)	BMI (Kg/m^2)	BSA (m^2)	TTV (cm^3)
Control	FT	0.001	0.001	0.001	0.006
	ST	0.084	0.10	0.09	0.210
	TT	0.710	0.810	0.521	0.611
FT	Control	0.001	0.001	0.001	0.006
	ST	0.001	0.001	0.001	0.000
	TT	0.001	0.001	0.001	0.000
ST	Control	0.084	0.10	0.091	0.210
	FT	0.001	0.001	0.001	0.000
	TT	0.311	0.076	0.532	0.428
TT	Control	0.710	0.810	0.521	0.091
	FT	0.001	0.001	0.001	0.000
	ST	0.311	0.76	0.532	0.428

Table 5 Correlation of thyroid volume and anthropometric variables in pregnancy and control

Volume	Anthropometric Variables									
	Age		Height		Weight		BMI		BSA	
	r	p	r	p	r	p	r	p	R	p
TTV	0.183	0.001	0.177	0.001	0.400	0.001	0.301	0.001	0.404	0.001

Pearson correlation coefficient indicated a weak positive correlation between the total thyroid volume with age and height. However, a moderate positive correlation was seen between the TTV with weight, BMI and BSA as demonstrated in Table 5.

TTV: Total thyroid volume, r: Pearson correlation coefficient, p: Significance level (<0.05)

DISCUSSION

The present study provides trimester-specific reference ranges for thyroid volume during pregnancy and compared with non-pregnant patients. The TTV measurements for the gravid group during different trimesters indicate varying thyroid volumes throughout pregnancy compared to non-pregnant individuals. The mean TTV for the pregnant participants increased progressively from the first trimester to the third trimester. The findings are similar to those reported by Rasool *et al,* [1], Elebrashy *et al,* [6], Fister *et al,* [12] Henrietta *et al,* [13], Brander & Kivisaari [14]. The finding is expected as studies show TSH values in normal pregnancy increase progressively throughout the pregnancy. [6,15,16] In the current study, there was a significant difference in TTV in all the groups according to ANOVA. However, the post-hoc pairwise comparison indicated that control, second and third-trimester groups had statistically significantly higher TTV than the first-trimester groups. However, no statistically significant difference in TTV between the control and second, control and third trimesters, and second and third trimesters. The decrease in the first trimester might be influenced by hormonal changes that occur early in pregnancy. The thyroid gland experiences physiological adaptations during this period, which could lead to a slightly smaller volume. The increase in the second and third trimesters aligns with the expected physiological changes during pregnancy, as the thyroid gland enlarges to meet the demands of the developing fetus. Hormonal alterations and increased blood flow to the thyroid contribute to this growth. It could also be explained by the distribution of the anthropometric parameters, especially the weight, BMI and BAS. The Control, second and third-trimester groups had statistically significantly higher mean weight, BMI and BAS than those in the first trimesters.

The TTV of the pregnant participants was non-significantly higher than that of non-pregnant control subjects in the current study. The findings are in agreement with those reported by Elebrashy *et al,* [6], Brander & Kivisaari [14], Berghout & Wiersinga [17]. The possible reason for the similarity could be related to the fact that all the studies were conducted in iodine-sufficient countries. However, the findings are contrary to those reported by Rasool *et al,* [1] in Pakistan and Glinoer *et al,* [18] in Belgium. Pakistan and Belgium are known to be among iodine-deficient countries. When iodine supply is sufficient during pregnancy, the thyroid gland adjusts its hormonal output and attains the state of equilibrium, thus presumably explaining the failure of ultrasound reports confirming significant changes in thyroidal size associated with pregnancy.[19] However, if the supply is not sufficient the adaptation could vary from physiological to pathological depending on the duration and severity, consequently could lead to gestational goitres, impaired fetal brain development, mental retardation, cretinism and glandular hyperplasia at birth in the newborn. [1] Furthermore, renal clearance of iodine is increased during gestation and remains enhanced until delivery which contributes to thyroid enlargement. [20] The current study revealed that no significant differences exist between the right lobe of the controls and the study group. Yet there is a significant difference between the left lobe of the control and study groups. Furthermore, no significant differences exist between the right and left lobes in the first, second and third trimesters. This difference shows that there is an increase in left thyroid lobe activities during pregnancy, and more thyroid hormones are secreted from the left lobe than the right.

In the current study, a weak significant positive correlation was seen between TTV with age and height, while a moderately significant positive correlation was seen between TTV with weight, BMI and BAS. Elebrashy *et al,* [6] reported a correlation between thyroid volume and BMI alone, Henrietta *et al,* [13], found a moderate relationship between thyroid volume and weight, a poor relationship with BMI and height and no relationship with age whatsoever. Fister *et al,* [18] found that the changes in volume are associated with changes in BMI and TSH in the iodine-sufficient Republic of Slovenia. Agrawal et al, [21] found a positive correlation between age and thyroid volume though it was insignificant. Guo e*t al*, [22] and Tuccilli *et al*, [23] reported no correlation of thyroid volume in pregnant females with age.

The current study had limitations, including the lack of evaluation of thyroid function, iodine status and a small sample size. The cross-sectional design prevented the assessment of dynamic changes in thyroid functions and volume throughout pregnancy. Future research should employ larger sample sizes and longitudinal designs to track these changes over the entire gestational period. Additionally, conducting population-based studies would help establish trimester-specific reference ranges for thyroid hormone levels during pregnancy. This information would improve the interpretation of thyroid function tests and aid in the management of thyroid disorders in pregnant females.

CONCLUSION

The findings indicate that TTV tends to increase during pregnancy, with the highest volume observed in the third trimester. These results align with the known physiological changes in the thyroid gland during gestation. Monitoring thyroid volume and function during prenatal care is crucial to ensure the well-being of both the mother and the developing fetus.

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Author contributions

Abubakar Aminu Abubakar, Amina Abdulwahab and Anas Ya'u conceptualized and designed the study. Umar Mansur and Aliyu Abdullahi Hassan contributed to the implementation of the project and revision of the manuscript. All authors were involved in the writing and revision of the manuscript. The authors read and approved the final manuscript and agr
eed to be accountable for all aspects of the work.

Data availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of interest

None declared.

Ethical approval

The study was approved by the Research and Ethical Committee of the Ministry of Health Kano State.

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