Original Research Article

ULTRASONOGRAPHIC EVALUATION OF EFFECTS OF PREGNANCY ON THYROID VOLUME IN A NIGERIAN COHORT.

ABSTRACT

Background: During pregnancy, the thyroid gland experiences physiological changes critical for metabolism regulation. Ultrasonography provides a non-invasive means to assess these changes effectively. Thyroid gland responds physiologically to increased demands for iodine and energy which is the case in pregnant women.

Aim: This study aims to evaluate the physiological and pathological alterations in the thyroid gland of pregnant women across gestational ages (0-40 weeks) at a specialist hospital in Port Harcourt, Nigeria. The study is also aimed at giving normative values of thyroid volume in pregnancy which helps in ascertaining when a pregnant woman develops goiter as well as properly monitor thyroid hormones.

Methods: A prospective study involving 559 healthy pregnant women was conducted from September 2023 to May 2024. Data collected included age, BMI, weight, and height. Thyroid volume was assessed via ultrasound. Statistical analysis was performed using SPSS version 21.0 with a significance level set at $p < 0.05$.

Results: The mean maternal age was 29.95 ± 6.34 years. Significant positive correlations were observed between thyroid volume in the right lobe and variables such as age, BMI, weight, and height. The left lobe volume showed a positive correlation with parity.

Conclusion: The study confirms thyroid volume increases during pregnancy, with significant correlations to specific demographic and anthropometric factors. These findings underscore the importance of routine ultrasonographic evaluation of the thyroid in pregnant women for early detection and management of potential disorders.

Keywords: Ultrasonographic, Thyroid volume, Pregnancy, Parity, Nigeria.

INTRODUCTION

Pregnancy is a natural physiologic change that affects the woman's hormonal and metabolic functions. These changes can trigger both physiological and pathologic conditions. One of these changes is in the endocrine system, specifically the thyroid gland, the second most common gland affected during pregnancy[1]. The thyroid gland is a single midline endocrine organ in the anterior neck responsible for thyroid hormone production[1]. During pregnancy, the thyroid gland enlarges slightly due to increased hormone production and increased iodine demand by the mother and fetus.

According to WHO, it has been observed that thyroid volume is variable in different geographical regions due to varying dietary iodine intake and renal loss in pregnancy. These factors have been suggested to be the probable cause of thyroid enlargement in pregnancyccord

Thyroid disease during pregnancy can cause complications for the mother and fetus. Hence, the need for this study, to promptly detect/diagnose thyroid disease in pregnancy and offer appropriate therapeutic measures in order to reduce maternal and fetal morbidity and mortality. The hypothalamic-pituitary-thyroid axis produces thyroid hormones. The hypothalamus secretes the thyrotropin-releasing hormone (TRH), which, in turn, stimulates the anterior pituitary gland to produce thyroid-stimulating hormone (TSH). TSH stimulates the secretion of triiodothyronine (T3) and thyroxine(T4) by the thyroid gland, and these hormones are seen increasing during pregnancy. Apart from pregnancy, various other factors such as age BMI, gender, iodine status, genetic factors, impact the size/volume of the thyroid gland[2,3]

This study aims to establish normative data for thyroid volume changes throughout pregnancy in a Nigerian cohort, thereby contributing knowledge essential for the management of thyroid disorders in pregnant women.

MATERIALS AND METHOD: This is an eight-month prospective cross-sectional study conducted in the Radiology department of a specialist hospital in Port Harcourt between September 2023 and May 2024. A total number of 559 patients were recruited into the study.

Data Collection: Demographic data, including age, weight, height, and BMI, were obtained. Weight was measured in kilograms (kg), height in meters (m), and BMI was calculated as weight in kg divided by height in m^2.

Technique: Thyroid volume was assessed through ultrasound, which involved taking three-dimensional gland measurements. (Figure 1). An ultrasound scan of the thyroid gland and an obstetric scan were done to determine the thyroid volume and gestational age.

The patientlies supine on a couch, and the neck was extended slightly with a pillow between the shoulders. A water-based gel was placed on the neck to help transmit sound waves. Next, the probe or transducer back and forth on the skin of the neck. The transducer gives off sound waves, which, in turn, appear as images on a monitor. A three-dimensional measurement -height, length and width were taken, giving the gland volume [Figure 1]. Additional manoeuvres, such as swallowing, could be done for a better assessment of retrosternal extension.

Inclusion criteria: Only pregnant women in the clinically euthyroid state who came for a routine ultrasound scan, either obstetric or any other part of the body, were included in the study.

Exclusion criteria: Pregnant women who have had previous thyroid disease, who have been on antithyroid drugs, who have had previous thyroid surgeries and finally patients who refused to give consent were excluded

Ethical approval

The Ethics Committee of the University of Port Harcourt Teaching Hospital approved the protocol. Informed consent was obtained from all study participants and analysed using the SSPS 21.0 version, and statistical significance was set at <0.05.

Statistical Analysis: Data were analysed using SPSS version 21.0. Statistical significance was set at $p < 0.05$.

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Figure 1

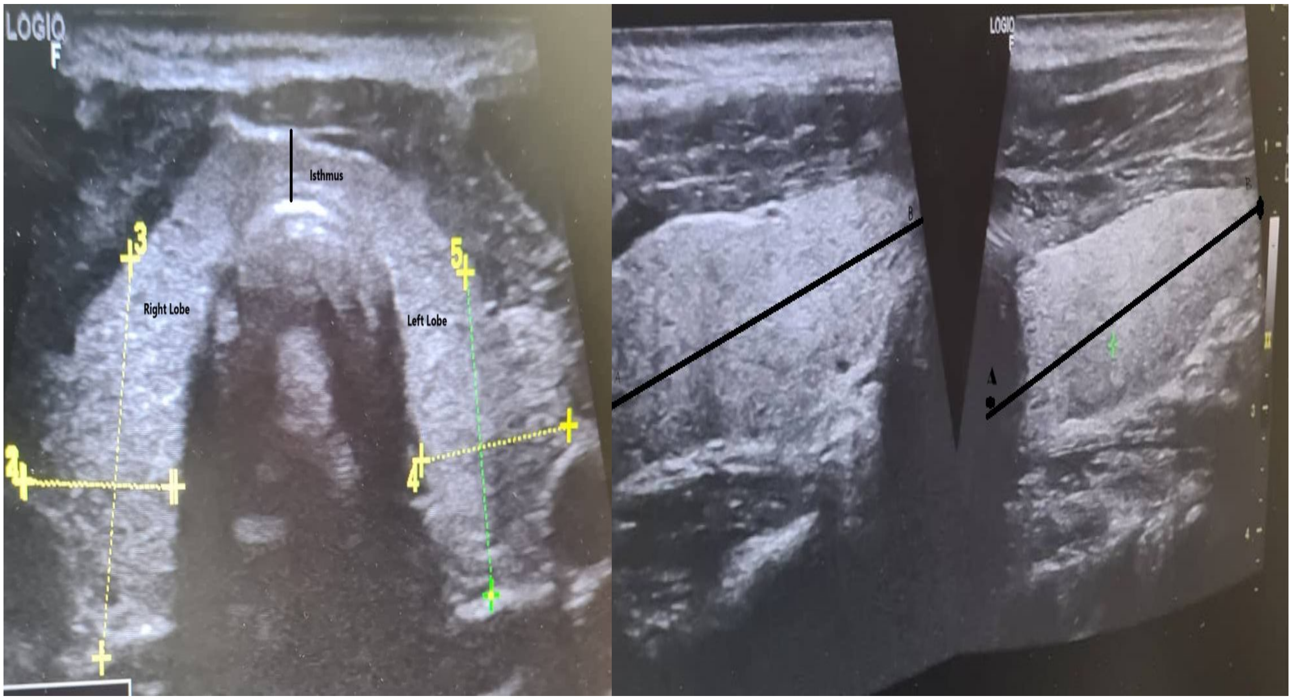

Figure 1: Ultrasound scan of the thyroid showing the lobes and the isthmus.

RESULTS:

Table 1 shows the socio-demographic characteristics of the study's 559 participants revealing that the majority were young, with 89.27% aged between 20 and 39 years. The mean age was 29.95 years (SD = 6.34), ranging from 14 to 54 years. Most participants (76.92%) had completed secondary education, followed by 11.09% with university education, indicating a high educational attainment. A smaller portion had primary education (10.73%) or no formal education (1.25%).

Table 1: Socio-Demographic Characteristics (n=559)

Variables	Frequency	Percent (%)
Age		
10-19	25	4.47
20-29	228	40.79
30-39	271	48.48
40-49	32	5.72
50-59	3	0.54

Mean ± SD	29.95±6.34[∞]	
Range	[14-54]	
Educational Level		
None	7	1.25
Primary	60	10.73
Secondary	430	76.92
University	62	11.09

∞=Mean ± Standard Deviation

Table 2 shows the study's participants had a mean weight of 69.74 kg (SD = 16.40), ranging from 32 to 121 kg. The average height was 157.93 cm (SD = 9.57), with a range of 116 to 190 cm. The mean BMI was 28.29 (SD = 7.94), ranging from 11.89 to 74.32. BMI categorization indicated that 5.37% were underweight, 35.42% fell within the normal range (18.5-24.9), 22% were overweight (25-29.9), and 37.21% were obese (≥30). This distribution highlights a significant prevalence of overweight and obesity among the participants.

Table 2: Anthropometric Parameters (n=559)

Variables	Frequency	Percent (%)
Weight (kg)		
Mean ± SD	69.74±16.40$^{\infty}$	
Range	[32-121]	
Height (cm)		
Mean ± SD	157.93±9.57$^{\infty}$	
Range	[116-190]	
BMI		
Mean ± SD	28.29±7.94$^{\infty}$	
Range	[11.89-74.32]	
BMI Category		
Underweight (<18.5)	30	5.37
18.5 and 24.9	198	35.42
Overweight 25 and 29.9	123	22.00
Obesity ≥ 30	208	37.21

∞=Mean ± Standard Deviation

Table 3 shows the maternal characteristics of the study's 559 participants reveal a median parity of 1 with an interquartile range (IQR) of 0.5 to 2. Within this, 33.27% were nulliparous, 64.22% had 1 to 3 previous births, and 2.50% had four or more. The mean gestational age was 14.09 weeks (SD = 4.80), ranging from 6 to 37 weeks. Nearly all participants (99.64%) were less than 37 weeks pregnant, indicating that most were in early to mid-pregnancy. Only 0.36% had reached or exceeded 37 weeks, highlighting the study's focus on women earlier in their pregnancy.

Table 3: Maternal Characteristics (n=559)

Variables	**Frequency**	**Percent (%)**
Parity		
Median	1^{α}	
IQR	[0.5-2]	
Parity		
0	186	33.27
1-3	359	64.22
≥4	14	2.50
Gestational Age		
Mean ± SD	$14.09 \pm 4.80^{\infty}$	
Range	[6-37]	
Gestational Age		
<37	557	99.64
≥37	2	0.36

∞=Mean ± Standard Deviation, α=Median, Inter-quartile Range

Table 4: shows the thyroid volume measurements of the 559 participants showing distinct differences between the right and left lobes. For the right thyroid lobe, the mean width was 1.41 cm (SD = 0.32), with a range from 0.55 to 2.53 cm. The mean height was 1.22 cm (SD = 0.23), ranging from 0.70 to 1.8 cm, and the mean length was 3.57 cm (SD = 0.65), with a range of 1.23 to 4.90 cm. The total mean volume of the right lobe was 3.77 cm^3 (SD = 1.60), with values spanning from 0.80 to 10.19 cm^3.

For the left thyroid lobe, the mean width was slightly larger at 1.53 cm (SD = 0.52), and ranged from 0.96 to 4.3 cm. The mean height was 1.23 cm (SD = 0.39), with a range of 0.73 to 3.28 cm, while the mean length was 3.45 cm (SD = 0.59), ranging from 2.0 to 4.9 cm. The total mean volume of the left lobe was 4.05 cm^3 (SD = 2.24), with a range from 1.17 to 5.04 cm^3.

These measurements indicate that the left thyroid lobe tends to be larger than the right lobe in terms of both volume and width. The values highlight the variability in thyroid size among the study population, with significant differences in volume and dimensions between individuals. This variability underscores the importance of individualized assessment in clinical settings. The broader range and higher standard deviations for the left lobe’s measurements suggest more pronounced anatomical variations in this part of the thyroid gland among the pregnant women studied.

Table 4:Thyroid Volume (n=559)

Variables	Mean ± SD
Thyroid Volume Right	
Width	
Mean ± SD	1.41±0.32
Range	[0.55-2.53]
Height	
Mean ± SD	1.22±0.23
Range	[0.70-1.8]
Length	
Mean ± SD	3.57±0.65
Range	[1.23-4.90]
Total Volume	
Mean ± SD	3.77±1.60
Range	[0.80-10.19]
Thyroid Volume Left	
Width	
Mean ± SD	1.53±0.52
Range	[0.96-4.3]
Height	
Mean ± SD	1.23±0.39
Range	[0.73-3.28]
Length	
Mean ± SD	3.45±0.59
Range	[2.0-4.9]
Total Volume	
Mean ± SD	4.05±2.24
Range	[1.17-5.04]

Table 5 shows Pearson correlation analysis showing significant positive correlations between age and the right thyroid's width (r = 0.324, p = 0.023), height (r = 0.193, p = 0.050), and length (r = 0.260, p = 0.018). This indicates that as age increases, these dimensions of the right thyroid lobe also increase. Conversely, the isthmus displays a significant negative correlation with age (r = -0.167, p = 0.001), suggesting it decreases in thickness with age. No significant correlations were found between age and the left thyroid lobe dimensions or total volumes, highlighting that age-related changes primarily affect the right thyroid lobe.

Table 5: To assess how Age is associated with selected parameters using the *Pearson correlational coefficient analysis*

Variables	**AGE**			
	The Pearson correlation coefficient, r	**95.0% Confidence Interval for r**		***p-value***
		Lower Bound	**Upper Bound**	
Thyroid Right – Width	0.324	0.885	11.841	**0.023***
Thyroid Right – Height	0.193	-0.003	10.625	**0.050***
Thyroid Right – Length	0.260	0.447	4.660	**0.018***
Thyroid Right – Total	-0.379	-3.218	0.214	0.086
Thyroid Left – Width	0.062	-3.387	4.905	0.719
Thyroid Left – Height	0.047	-4.404	5.912	0.774
Thyroid Left – Length	-0.030	-2.328	1.685	0.753
Thyroid Left – Total	-0.038	-1.731	1.514	0.896
Isthmus	-0.167	-20.951	-5.883	**0.001***

Statistically significant (p<0.05)

Table 6 shows Pearson correlation analysis indicating significant associations between parity and several thyroid parameters. Parity shows a negative correlation with the right thyroid width (r = -0.346, p = 0.003), suggesting that higher parity is associated with smaller right thyroid width. The left thyroid width (r = -0.787, p = 0.0001), height (r = -0.524, p = 0.0001), and length (r = -0.289, p = 0.0001) all have strong negative correlations with parity, showing smaller dimensions with increased parity. However, the left thyroid total volume (r = 1.141, p = 0.0001) and isthmus (r = 0.131, p = 0.001) show strong positive correlations, increasing with higher parity. The right thyroid height and length, and the right thyroid total volume, were not significantly correlated with parity.

Table 6: To assess how Parity is associated with selected parameters using the *Pearson correlational coefficient analysis.*

Variables	**PARITY**			
	The Pearson correlation coefficient, r	**95.0% Confidence Interval for r**		***p-value***
		Lower Bound	**Upper Bound**	
Thyroid Right – Width	-0.346	-1.924	-0.391	**0.003***
Thyroid Right – Height	0.154	-0.019	1.468	0.056
Thyroid Right – Length	0.147	-0.048	0.542	0.100
Thyroid Right – Total	-0.133	-0.330	0.150	0.461
Thyroid Left – Width	-0.787	-2.230	-1.070	**0.0001***
Thyroid Left – Height	-0.524	-2.150	-0.706	**0.0001***
Thyroid Left – Length	-0.289	-0.806	-0.244	**0.0001***
Thyroid Left – Total	1.141	0.325	0.779	**0.0001***
Isthmus	0.131	2.854	0.746	**0.001***

Statistically significant (p<0.05)

The Pearson correlation analysis (Table 7) examines the association between weight and thyroid parameters. Significant positive correlations were found for the right thyroid width (r = 0.206, p = 0.0001), height (r = 0.076, p = 0.002), and length (r = 0.097, p = 0.0001), suggesting that higher weight is associated with larger dimensions in these areas. Conversely, the right thyroid total volume has a significant negative correlation with weight (r = -0.251, p = 0.0001).
For the left thyroid, only the length showed a significant negative correlation with weight (r = -0.059, p = 0.014), while other left thyroid parameters (width, height, total volume) and the isthmus did not show significant correlations. This indicates that weight primarily influences the dimensions of the right thyroid lobe.

Table 7: To assess how Weight is associated with selected parameters using the *Pearson correlational coefficient analysis*

Variables	**WEIGHT**			
	The Pearson correlation coefficient, r	**95.0% Confidence Interval for r**		***p-value***
		Lower Bound	**Upper Bound**	
Thyroid Right – Width	0.206	6.890	13.962	**0.0001***
Thyroid Right – Height	0.076	1.986	8.846	**0.002***
Thyroid Right – Length	0.097	1.097	3.817	**0.0001***
Thyroid Right – Total	-0.251	-3.681	-1.466	**0.0001***
Thyroid Left – Width	-0.034	-3.761	1.592	0.426
Thyroid Left – Height	-0.077	-6.513	0.146	0.061
Thyroid Left – Length	-0.059	-2.920	-0.330	**0.014***
Thyroid Left – Total	0.094	-0.361	1.734	0.198
Isthmus	0.011	-2.484	7.242	0.337

****Statistically significant (p<0.05)***

The Pearson correlation analysis (Table 8) assesses the relationship between height and thyroid parameters. Significant negative correlations were seen for the right thyroid width (r = -0.748, p = 0.0001), height (r = -0.310, p = 0.0001), and length (r = -0.390, p = 0.0001), indicating that taller individuals tend to have smaller dimensions in these areas. However, the right thyroid total volume shows a strong positive correlation with height (r = 0.942, p = 0.0001).

For the left thyroid, significant positive correlations were found for height (r = 0.326, p = 0.031) and length (r = 0.241, p = 0.006), but not for width or total volume. The isthmus did not show a significant correlation with height (r = -0.036, p = 0.411). This suggests that height has a complex relationship with various thyroid dimensions, differing between the right and left lobes.

Table 8: To assess how Height is associated with selected parameters using the *Pearson correlational coefficient analysis* .

Variables	**HEIGHT**			
	The Pearson correlation coefficient, r	**95.0% Confidence Interval for r**		***p-value***
		Lower Bound	**Upper Bound**	
Thyroid Right – Width	-0.748	-29.695	-14.565	**0.0001***
Thyroid Right – Height	-0.310	-20.227	-5.551	**0.0001***
Thyroid Right – Length	-0.390	-8.684	-2.865	**0.0001***
Thyroid Right – Total	0.942	3.263	8.002	**0.0001***
Thyroid Left – Width	0.161	-2.738	8.714	0.306
Thyroid Left – Height	0.326	0.717	14.963	**0.031***
Thyroid Left – Length	0.241	1.092	6.634	**0.006***
Thyroid Left – Total	-0.398	-3.943	0.538	0.136
Isthmus	-0.036	-14.761	6.047	0.411

Statistically significant (p<0.05)

The Pearson correlation analysis (Table 9) evaluates the relationship between BMI and thyroid parameters. Significant positive correlations were observed for the right thyroid width (r = 0.686, p = 0.0001), height (r = 0.221, p = 0.003), and length (r = 0.297, p = 0.0001), indicating that higher BMI is associated with larger dimensions in these areas. Conversely, the total volume of the right thyroid shows a significant negative correlation with BMI (r = -0.799, p = 0.0001).
For the left thyroid, none of the parameters (width, height, length, and total volume) showed significant correlations with BMI, with p-values above the 0.05 threshold. The isthmus also did not significantly correlate with BMI (r = 0.051, p = 0.158). This shows that BMI primarily influences the dimensions of the right thyroid lobe, while the dimensions and isthmus of the left thyroid lobe are not significantly affected by BMI.

Table 9: To assess how BMI is associated with selected parameters using the *Pearson correlational coefficient analysis*

Variables	**BMI**			
	The Pearson correlation coefficient, r	**95.0% Confidence Interval for r**		***p-value***
		Lower Bound	**Upper Bound**	
Thyroid Right – Width	0.686	11.699	21.984	**0.0001***
Thyroid Right – Height	0.221	2.651	12.628	**0.003***
Thyroid Right – Length	0.297	1.670	5.626	**0.0001***
Thyroid Right – Total	-0.799	-5.576	-2.355	**0.0001***
Thyroid Left – Width	0.111	-2.189	5.595	0.390
Thyroid Left – Height	-0.056	-5.966	3.718	0.649
Thyroid Left – Length	-0.139	-3.731	.037	0.055
Thyroid Left – Total	0.009	-1.489	1.557	0.965
Isthmus	0.051	-1.985	12.160	0.158

Statistically significant (p<0.05)

DISCUSSION:

This study aimed to investigate the physiological adaptations of the thyroid gland during pregnancy and correlate the findings with various maternal factors. Various research has shown that the thyroid gland enlarges during pregnancy in accordance with the increased metabolic demands of the mother and growing foetus.

The enlargement of the thyroid gland is one of the significant physiological adaptations that pregnancy induces to accommodate the heightened metabolic demands of both the mother and the developing foetus. The cohort of women aged 10 to 59 was the focus of this study, which determined that the 30-39 age group had the highest representation (48.48%). This demographic distribution starkly contrasts the results of Mehran et al. (2013), in which 69.5% of participants were younger, with an average age of 25.3 years. The importance of contextual comprehension when comparing thyroid volume changes across diverse populations is underscored by these demographic differences, emphasising the potential impact of age disparities on observed outcomes. These demographics suggest the study's predominance of young, educated women, potentially influencing the overall health awareness and outcomes observed.

The mean total thyroid volume (TTV) increased significantly in the left lobe (4.05±2.24 cm^3) compared to the right lobe (3.77±1.60 cm^3) in this study. This discovery is consistent with previous research conducted by Fister et al. (2009), which indicates inherent lateral variations in the development of the thyroid gland during pregnancy. Variations in the left lobe's vascular supply, glandular composition, or distinctive adaptive physiological responses could account for differential enlargement. These results underscore the potential necessity for additional research on the lateral differences in thyroid gland activity across various physiological conditions and populations and the intricacy of thyroid adaptation during pregnancy.

The demographic patterns of the study indicated that 64.22% of participants were within the primigravida and gravida three groups, an observation that is consistent with the findings of Fister et al. (2009), who reported that 67.7% of participants in their study were multiparous. This starkly contrasts the study conducted by Alkal et al. (2023), which revealed a significantly higher prevalence of primigravida (47.5%). Sociodemographic factors, regional reproductive health policies, and access to maternal healthcare services influence reproductive patterns, which may account for the disparity. The cumulative effect of successive pregnancies on thyroid gland enlargement may be suggested by this study's observed increased thyroid volume in multiparous women. This is consistent with the notion that multiple pregnancies can cumulatively influence the thyroid gland's morphology because of the repeated physiological demands imposed on it.

The correlation between the mean volume of the right thyroid lobe and advancing age, BMI, and parity was major research finding. These findings are consistent with those of Sahin et al. (2014) and Mariana et al. (2023), further supporting the idea that these anthropometric parameters are essential for thyroid adaptation during pregnancy. The strong positive correlation between thyroid volume and age, weight, height, and BMI, particularly in the right lobe, implies that these variables are essential for regulating metabolism and hormones. This starkly contrasts the findings of Abubakar et al. (2023), who reported weakened correlations, emphasising the potential genetic, environmental, and nutritional differences that may affect thyroid health. A better approach to examining thyroid volume changes during pregnancy is required, considering these discrepancies' regional and demographic contexts.

These results differ from those of Agrawal et al. (2023), Guo et al. (2020), and Tuccilli et al. (2018), who reported no correlation between age and thyroid volume in expectant females. These discrepancies may result from regional variations in iodine ingestion, genetic predispositions, or study design and sample size variations. Similarly, Elebrashy et al. (2021) discovered that thyroid volume correlated with BMI alone, whereas Henrietta et al. (2023) reported moderate correlations with weight but negligible correlations with BMI and height. The multifactorial nature of thyroid volume changes is underscored by these conflicting results, which emphasise the necessity of comprehensive studies that consider a diverse range of influencing factors,such as geographic, dietary and genetic variables. According to Ogbole G I (2009), there is a weak correlation between the thyroid volume and parity. no correlation between thyroid volume and maternal age. This is in contrast to the case study which shows a significant positive correlation between parity and thyroid volume.

The significance of routine thyroid volume assessments in prenatal care is emphasised by the significant correlations observed in this study. The early detection and management of thyroid anomalies are essential for the prevention of adverse maternal and foetal outcomes, including preeclampsia, preterm birth, and developmental issues in the foetus. Regular ultrasonography monitoring is a viable and effective method for continuous thyroid assessment and intervention during pregnancy, as it is non-invasive. These results suggest that integrating thyroid evaluations into standard prenatal visits can be beneficial in preventing potential thyroid dysfunctions and improving the health outcomes of both the mother and the fetus/child. Our investigation was severely restricted by the absence of thyroid function tests and iodine status evaluations, indispensable for a thorough comprehension of thyroid health. The absence of postpartum follow-up limits our ability to evaluate pregnancy's long-term effects on thyroid volume. Future research should incorporate these parameters and extend these parameters into the postpartum period to assess for persistent thyroid pathologies. Furthermore, incorporating a more diverse and extensive sample size could offer a more comprehensive understanding of the impact of socioeconomic status, diet, and ethnicity on thyroid alterations during pregnancy. Understanding these factors will facilitate the development of customised interventions and guidelines to effectively manage thyroid health in diverse populations.

The integration of these findings with the existing literature demonstrates that the thyroid volume during pregnancy is influenced by various factors, such as age, BMI, parity, and potentially genetic and environmental variables. The observed asymmetry in thyroid volume increase, particularly the more significant enlargement of the left lobe, adds a layer of complexity that requires further investigation. This could entail investigating the anatomical and physiological mechanisms that underlie these lateral differences and their correlation with clinical outcomes. This level of detail will improve the capacity to predict and manage thyroid-related complications in pregnancy more effectively.

Conclusion: this research substantiates the critical role of demographic and anthropometric factors and the substantial influence of pregnancy on thyroid volume. The multifactorial influences on thyroid health during pregnancy are underscored by the significant correlations identified between thyroid volume and age, weight, height, and BMI. Despite its limitations, the study's results emphasise the importance of routine ultrasonographic evaluation of the thyroid in prenatal care to facilitate the early detection and management of prospective thyroid disorders. To completely understand the intricate interplay of factors that affect thyroid health during and after pregnancy, future research should strive to incorporate comprehensive thyroid function assessments and involve more extensive, more diverse cohorts. By integrating these considerations, healthcare providers can enhance the health outcomes of both mothers and their children by more effectively anticipating and mitigating thyroid-related risks.

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1. option 1

2.

3

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