Anthropometric Parameters and Thyroid Morphology in a Sample of Overweight and Obese Syrian Women

Authors: *Dareen Alnasser Allah,[1] Lilianne Haj Hassan,[1] Zaynab Alourfi[2]

1. Endocrinology Department, Al-Mouwasat University Hospital, Damascus University, Damascus, Syria
2. Department of Internal Medicine, Faculty of Medicine, Damascus University, Damascus, Syria
   *Correspondence to d.d.d882011@gmail.com

Abstract

Objective: Obesity and thyroid nodules are very common. Many studies have reported that weight gain is a new risk factor for goiters and thyroid nodules. In this study, the authors aimed to evaluate thyroid morphology in obese women and tried to link thyroid morphology with anthropometric parameters.

Design: A cross-sectional study was conducted between January 2017 and January 2018. Overweight and obese Syrian females, aged >35 years, without past or recent thyroid complaints, and living in the southern region of Syria were included in the study. Weight, height, and hip and waist circumference were measured to calculate anthropometric parameters. Thyroid volume and prevalence of thyroid nodules were compared among BMI groups as defined by World Health Organization classifications. Body Surface Area (BSA), waist circumference (WC), waist:hip ratio, and waist-to-height ratio (WtHR) were compared between nodule groups.

Results: A total of 140 overweight and obese females, with a mean age of aged 53±7 years were studied. Mean thyroid volume was 12.4±7.4 mL, with the highest volume identified in the Obesity Class III group (14.9±10.9 mL). Significant positive correlations were found between thyroid volume and weight, BMI, WC, BSA, and WtHR ($p < 0.05$). Thyroid nodule prevalence was 84.3%, and 22.0% of the nodules were fine needle aspiration indicated. Weight and BSA were positively correlated with thyroid nodules ($p < 0.05$), while BMI was not.

Conclusion: Thyroid volume was positively correlated with increased weight, BMI, WC, BSA, and WtHR in Syrian females. Positive correlations were found between weight, BSA, and thyroid nodules after age and thyroid stimulating hormone were excluded.

INTRODUCTION

A goiter is a nodular or diffuse enlargement of the thyroid gland. It is defined as an adaptive response of the thyroid follicular cells to any factor that impairs thyroid hormone synthesis.[1,2] Genetics, iodine deficiency, and thyroid stimulating hormone (TSH) are the most important factors that contribute to elevated thyroid volume and nodules formation,[2-4] with women and the elderly more likely to have thyroid nodules.[5-7] Some studies have suggested other risk factors, such as smoking, obesity, and insulin resistance, contribute to nodule formation.[3,8-10] Recently, the association between metabolic obesity and thyroid morphology has received attention. While some studies demonstrated a significant positive correlation between obesity and altered thyroid morphology,[6,11-13] others did not.[14-16] BMI, body surface area (BSA), waist circumference (WC), waist:hip ratio (WHR), and waist-to-height ratio (WtHR) are clinical parameters of body fat and visceral obesity.[17,18]

In this study, the authors evaluate thyroid gland morphology, via ultrasonography, in a sample of overweight and obese females, and examine its relation to BMI and other anthropometric parameters in a mild iodine deficiency area.[19]

METHODS

Population Features

A cross-sectional study was conducted between January 2017 and January 2018. Participants were females aged >35 years and had lived in southern Syria (an area of mild iodine deficiency)[20] for the last 10 years. The participants were selected from outpatient clinics, patients in the hospital wards, and their relatives at Al-Mouwasat University Hospital, Damascus, Syria. Subjects with previous or recent thyroid complaints were excluded. All individuals who gave informed consent were interviewed using a questionnaire that collected information regarding patient age, demographic characteristics, medical history, family history of thyroid disease, smoking, and dietary iodised salt.

Anthropometric Parameters

Weight (with light clothes) and barefoot height were measured using the Seca Scale Model 713 device (Boian Surgical, Padstow, Australia). Waist circumference (the midpoint between the top of the iliac crest and the lower margin of the last palpable rib) and hip circumference (around the widest portion of the buttocks)[17] were measured by the same physician with a flexible tape. BMI, BSA, WHR, and WtHR were calculated as follows:

> BMI = weight (kg)/height (m)^2.
> BSA (Dubois formula) = 0.007184×(height [m]$^{0.725}$)×(weight [kg]$^{0.425}$).[21]
> WHR = waist circumference (cm)/hip circumference (cm).[17]
> WtHR = waist circumference (cm)/height (cm).[18]

Depending on BMI, participants were classified into four groups (overweight [BMI: 25.0–29.9 kg/m^2], Obesity Class I [BMI: 30.0–34.9 kg/m^2], Obesity Class II [BMI: 35.0–39.9 kg/m^2], and Obesity Class III [BMI: ≥40 kg/m^2]) according to the World Health Organization classification.[22] All subjects with BMI <25 kg/m^2 were excluded.

Thyroid Morphology

Thyroid ultrasound, using a L14-6N (6-14 Mhz) Mindray (Providian Medical Equipment, Highland Heights, Ohio, USA) ultrasound device, was performed with the patients in the supine position. Total thyroid volume was determined by the addition of the volumes of both lobes. The lobe volume was calculated using the formula: (length x width x thickness x π/6).[23] Isthmus volume was ignored unless it had nodules, whereupon their volumes were calculated and added to the total volume. A goiter was defined as thyroid volume ≥18 mL in females.[24,25] Each detected nodule (≥2 mm) in the gland was evaluated for fine needle aspiration (FNA) indications according to the American Thyroid Association (ATA) criteria.[26]

Serum TSH was measured in the central laboratory of the hospital, using either Icroma™ (Boditech Med Inc., Chungcheon-si, South Korea), IMMULITE® (Siemens Healthineers, Erlangen, Germany), or Liaison® XL (DiaSorin, Saluggia, Italy) kits, with a 0.3–5.0 μIU/mL reference range.

STATISTICAL ANALYSES

Data analysis was performed using the SPSS software version 23.0 (IBM, Armonk, New York, USA), where p values <0.05 were considered statistically significant. Competitive data were compared among different groups based on variable distribution using the Kolmogorov–Smirnov test. T test and analysis of variance (ANOVA) were used for normal distribution, while Mann–Whitney and Kruskal–Wallis analyses were used as nonparametric tests. The chi square test was used for nominal data and Spearman's rho for correlation.

RESULTS

General Characteristics

A total of 140 overweight or obese females were studied. Their mean age was 53±7 years (Table 1). Mean BMI was 34.2±5.1 kg/m^2 (24.2% overweight, 32.9% Obesity Class I, 27.9% Obesity Class II, and 15.0% Obesity Class III). In total, 87.9% of subjects had a WC of >88 cm and 85.9% had a WHR of ≥0.85.

Thyroid Volume and Anthropometric Parameters

Goiter (thyroid volume >18 mL) prevalence was 10.7%. Significant differences were found in thyroid volume among BMI groups (p<0.05). The Obesity Class III group had the highest thyroid volume (14.9±10.9 mL) (Table 2). Spearman's rho showed a statistically significant positive correlation between thyroid volume and BMI before and after excluding age and TSH as confounding factors in partial correlation (r=0.24; p=0.004 and r=0.23; p=0.008, respectively). Thyroid volume was also positively correlated with weight, WC, BSA, and WtHR (p<0.05) (Table 3).

Thyroid Nodules and Anthropometric Parameters

Thyroid nodules were detected in 84.6% of the participants, 22% of which had FNA indication. The patients were divided into three groups: no nodules (15.7%), nodules without FNA indication (65.7%), and nodules with FNA indication (18.6%) (Table 4). Weight, WC, and BSA were higher in nodule groups with significant difference (p<0.05). There were significant positive correlations between weight, BSA, and thyroid nodules after age and TSH were excluded (r=0.17, p=0.049).

Table 1: Characteristics of the 140 female patients included in the study.

Parameters	Mean±standard deviation
Age (years)	53±7
Weight (kg)	80±12
BMI (kg/m^2)	34.2±5.1
BSA (m^2)	1.75±0.13
Waist circumference (cm)	101±10
WHR	0.92±0.08
WtHR	0.66±0.07
TV (mL)	12.4±7.4
TSH (μu/mL)	1.7±1.1
Thyroid ultrasound	**Percentage**
Nodular thyroid	84.3%
Nodules with FNA indication	18.6%
Goiter (TV>18 mL)	10.7%

BSA: body surface area; TSH: thyroid stimulating hormone; TV: thyroid volume; WHR: waist:hip ratio; WtHR: waist-to-height ratio.

Table 2: Comparison of thyroid volume and thyroid stimulating hormone among BMI groups.

	Percentage	TV (mL)*	p value	TSH (μu/mL)*	p	Age (years)*	p
Overweight	24.2%	9.9±4.4		1.5±0.9		54±7	
Obesity I	32.9%	12.2±6.3	0.02†	1.7±1.1	0.2	53±6	0.5
Obesity II	27.9%	13.3±8.0		1.9±1.1		53±7	
Obesity III	15.0%	14.9±10.9		1.8±1.2		52±6	

*Mean±standard deviation

†Statistically significant

TSH: thyroid stimulating hormone; TV: thyroid volume.

Table 3: Correlations between thyroid volume and anthropometric parameters.

	Spearman's rho		Partial correlation after excluding age and TSH	
Correlation between thyroid volume and:	r	p value	r	p value
Weight	0.26	0.001*	0.26	0.003*
BMI	0.24	0.004*	0.23	0.008*
BSA	0.28	0.001*	0.24	0.005*
WC	0.22	0.009*	0.22	0.010*
WHR	0.06	0.440	0.12	0.170
WtHR	0.18	0.020*	0.20	0.020*

*Statistically significant

BSA: body surface area; TSH: thyroid stimulating hormone; TV: thyroid volume; WC: waist circumference; WHR: waist:hip ratio; WtHR: waist-to-height ratio.

DISCUSSION

Obesity is a complex, multifactorial, chronic disease. Its prevalence has been increasing dramatically worldwide, almost tripling between 1975 and 2016.[27] Obesity is considered a major risk factor for diabetes, hypertension, and cardiovascular diseases. Recently, many studies have tried to find other comorbidities associated with obesity. Thyroid disorders are the most common endocrine diseases. High prevalence of goiter and incidental thyroid nodules has led researchers to investigate their relationship with obesity.

In this study, the authors evaluated thyroid gland morphology in a sample of middle-aged, obese females with no thyroid complaints. The Obesity Class III group had the highest goiter prevalence and the largest thyroid volume. Positive correlations were found between thyroid volume and other anthropometric parameters (weight, BSA, WtHR, and WC), but not WHR.

These results were aligned with those of many other studies.[28-32] Dauksiene et al.[29] showed that BMI was an independent predictor of goiter development. Eray et al.[32] showed that thyroid volume was positively correlated with BMI, with an important reduction in weight loss after 6 months. Turcios et al.[28] found that BMI and BSA were positively linked to thyroid volume but WHR was not. WtHR, as a metabolic parameter, has not been studied with thyroid volume before. The positive results presented here indicate its importance as an independent predictor for thyroid volume.

Table 4: Comparison of anthropometric parameters among nodule groups.

	NO nodules*	Nodules without FNA indication*	Nodules with FNA indication*	p value
Age (years)	53±7	53±6	54±8	0.710
Weight (kg)	76±10	79±12	85±12	0.02[†]
BMI (kg/m²)	33.0±5.3	34.0±5.1	35.8±4.9	0.140
BSA (m²)	1.71±0.10	1.75±0.13	1.83±0.13	0.005[†]
WC (cm)	98±10	101±10	106±10	0.040[†]
WHR	0.90±0.07	0.92±0.08	0.95±0.10	0.170
WtHR	0.65±0.08	0.66±0.07	0.68±0.06	0.230

*Mean±standard deviation

[†]Statistically significant

BSA: body surface area; FNA: fine needle aspiration; TSH: thyroid stimulating hormone; TV: thyroid volume; WC: waist circumference; WHR: waist:hip ratio; WtHR: waist-to-height ratio.

Regarding thyroid nodules, a high prevalence of thyroid nodules (84.6%) was documented in the mildly iodine deficient southern region of Syria; this was higher than the mean prevalence in other studies, including 44.9%, 34.2%, and 35.4% in Yemen,[33] South Korea[6] and China,[11] respectively. It is hypothesised that the high prevalence maybe due to the age group and female sex. Values of weight, BSA, and WC were the highest in the FNA-indicated nodules group in a statically significant pattern, while BMI and WHR were insignificant. Panagiotou et al.[16] reported that WC was the only anthropometric parametric value that was significantly higher in the nodules groups compared to the no nodules group. Song et al.[13] found a positive significant correlation between thyroid nodules and BMI and BSA, which became insignificant with BMI after being modulated by age and TSH as confounding factors. In a Korean survey, on apparently healthy people, Moon et al.[6] documented that WC and BMI were highest in the thyroid nodules group.

The mechanism of the association between obesity and thyroid morphology is not entirely understood. Obesity is characterised by many complicated mechanisms, of which insulin resistance is the most important.[34] Hyperinsulinaemia, in the case of insulin resistance, can up-regulate hepatic growth hormone receptors and suppress insulin-like growth factors binding proteins, leading to increased bioactive insulin-like growth factor 1 (IGF1) levels.[35] Insulin and IGF1 act via their highly homologous receptors,[36,37] which are expressed in thyrocytes by TSH.[38] They synergise with TSH, enhancing proliferation and differentiation of thyroid cells,[38] and having anti-apoptotic effects (Igf1).[39] This hypothesis is supported by the findings of Anil et al.,[40] who demonstrated that metformin (an insulin sensitiser agent) therapy significantly decreased thyroid volume in subjects with insulin resistance. Insulin resistance may explain the goitrogenic effects of obesity, but more studies are still needed.

LIMITATIONS

In this study, the authors faced many limitations. The focus was placed on thyroid dimensions to calculate the volume, but this did not evaluate thyroid echogenicity. The study did not include grey-scale analysis[41] and could not detect the possible accumulation of lipids in the thyroid in cases of high BMI. In addition, there was a lack of description of autoimmune thyroiditis echographic features which may be present in patients with obesis.[41]

CONCLUSION

This study indicates an association between obesity and thyroid morphology in middle-aged

Syrian females. High prevalence of goiter and thyroid nodules in obese females should highlight the importance of evaluating the thyroid gland using thyroid ultrasound as a screening test. Early detection of thyroid nodules will result in a better prognosis.

References

1. Schlumberger M et al., "Nontoxic diffuse goiter, nodular thyroid disorders, and thyroid malignancies," Melmed S et al. (eds.), Williams textbook of endocrinology (2016), 13th edition, London: Elsevier, Inc., pp. 449-89.

2. Graf H, "Multinodular goiter: Pathogenesis and management," Braverman LE, Cooper DS (eds.), Werner & Ingbar's the thyroid a fundamental and clinical text (2013), 10th edition, Philadelphia: Lippincott Williams & Wilkins, pp. 635-49.

3. Knobel M. Etiopathology, clinical features, and treatment of diffuse and multinodular nontoxic goiters. J Endocrinol Invest. 2016;39(4):357-73.

4. Zimmermann MB, Boelaert K. Iodine deficiency and thyroid disorders. Lancet Diabetes Endocrinol. 2015;3(4):286-95.

5. Polyzos SA et al. Thyroid nodules – Stepwise diagnosis and management. Hormones (Athens). 2007;6(2):101-19.

6. Moon JH et al. Prevalence of thyroid nodules and their associated clinical parameters: A large-scale, multicenter-based health checkup study. Korean J Intern Med. 2018;33(4):753-62.

7. Kwong N et al. The influence of patient age on thyroid nodule formation, multinodularity, and thyroid cancer risk. J Clin Endocrinol Metab. 2015;100(12):4434-40.

8. Jiang H et al. The prevalence of thyroid nodules and an analysis of related lifestyle factors in Beijing communities. Int J Environ Res Public Health. 2016;13(4):442.

9. Rezzonico J et al. Introducing the thyroid gland as another victim of the insulin resistance syndrome. Thyroid. 2008;18(4):461-4.

10. Heidari Z et al. Insulin resistance in patients with benign thyroid nodules. Arch Iran Med. 2015;18(9):572-6.

11. Liu Y et al. The prevalence of thyroid nodules in northwest China and its correlation with metabolic parameters and uric acid. Oncotarget. 2017;8(25):41555-62.

12. Buscemi S et al. Association of obesity and diabetes with thyroid nodules. Endocrine. 2018;60(2):339-47.

13. Song B et al. Association of thyroid nodules with adiposity: A community-based cross-sectional study in China. BMC Endocr Disord. 2018;18(1):3.

14. Guo H et al. The prevalence of thyroid nodules and its relationship with metabolic parameters in a Chinese community-based population aged over 40 years. Endocrine. 2014;45(2):230-5.

15. Sharen G et al. Retrospective epidemiological study of thyroid nodules by ultrasound in asymptomatic subjects. Chin Med J (Engl). 2014;127(9):1661-5.

16. Panagiotou G et al. Association between lifestyle and anthropometric parameters and thyroid nodule features. Endocrine. 2017;56(3):560-7.

17. World Health Organization. Waist circumference and waist-hip ratio: Report of a WHO expert consultation. 2008. Available at: https://www.who.int/nutrition/publications/obesity/WHO_report_waistcircumference_and_waisthip_ratio/en/. Last accessed; 21 February 2019.

18. Alves Junior CA et al. Anthropometric indicators as body fat discriminators in children and adolescents: A systematic review and meta-analysis. Adv Nutr. 2017;8(5):718-27.

19. Mohammadi M et al. Iodine deficiency status in the WHO Eastern Mediterranean region: A systematic review. Environ Geochem Health. 2017;40(1):87-97.

20. UNICEF. [Iodine deficiency of primary school students in Syria]. Available at: https://www.unicef.org/arabic/education/files/IDD_new_29-4-2008.8 March 2019. (In Arabic).

21. Dubois D, Dubois EF. A formula to estimate the approximate surface area if height and weight be known. Arch Intern Med (Chic). 1916;17(6_2):863-71.

22. World Health Organization. Global Database on Body Mass Index. 2004. Available at: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html/BMI classification. Last accessed: 21 February 2019.

23. Baskin HJ, "Anatomy and anomalies," Baskin HJ et al. (eds.), Thyroid ultrasound and ultrasound-guided FNA (2008), 2nd edition, Berlin: Springer, pp. 45-61.

24. Kocak M et al. Current prevalence of goiter determined by ultrasonography and associated risk factors in a formerly iodine-deficient area of Turkey. Endocrine 2014;47(1):290-8.

25. Halenka M, Fryšák Z (eds.), Atlas of thyroid ultrasonography (2017), Berlin: Springer, pp. 11-16.

26. Haugen BR et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: The American Thyroid Association Guidelines task force on thyroid nodules and differentiated thyroid cancer. Thyroid. 2016;26(1):1-133.

27. World Health Organization. Obesity and Overweight. 2018. Available at: http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Last accessed: 21 February 2019.

28. Turcios S et al. Thyroid volume and its relation to anthropometric measures in a healthy cuban population. Eur Thyroid J. 2015;4(1):55-61.

29. Dauksiene D et al. Factors associated with the prevalence of thyroid nodules and goiter in middle-aged euthyroid subjects. Int J Endocrinol. 2017:840151.

30. Kocak M et al. Current prevalence of goiter determined by ultrasonography and associated risk factors in a formerly iodine-deficient area of Turkey. Endocrine. 2014;47(1):290-8.

31. Zheng L et al. An epidemiological study of risk factors of thyroid nodule and goiter in Chinese women. Int J Environ Res Public Health. 2015;12(9):11608-20.

32. Eray E et al. Relationship between thyroid volume and iodine, leptin, and adiponectin in obese women before and after weight loss. Med Princ Pract. 2011;20:43-6.

33. Shahrani A et al. The epidemiology of thyroid diseases in the Arab world: A systematic review. J Public Health Epidemiol. 2016;8(2):17-26.

34. Fontenelle LC et al. Thyroid function in human obesity: Underlying mechanisms. Horm Metab Res. 2016;48(12):787-94.

35. Godsland IF. Insulin resistance and hyperinsulinaemia in the development and progression of cancer. Clin Sci (Lond). 2009;118(5):315-32.

36. Mantzoros C et al. Insulin resistance: Definition and clinical spectrum. 2013. Available at: https://www.uptodate.com/contents/insulin-resistance-definition-and-clinical-spectrum. Last accessed: 21 February 2019.

37. Djiogue S et al. Insulin resistance and cancer: the role of insulin and IGFs.

Endocr Relat Cancer. 2013;20(1):R1-R17.

38. Kimura T et al. Regulation of thyroid cell proliferation by TSH and other factors: A critical evaluation of in vitro models. Endocr Rev. 2001;22(5):631-56.

39. Ren M et al. Phosphatidylinositol 3-kinase/nuclear factor-kB signaling pathway is involved in the regulation of IGF-I on Fas-associated death domain-like interleukin-1-converting enzyme-inhibitory protein expression in cultured FRTL thyroid cells. J Mol Endocrinol. 2007;38:619-25.

40. Anil C et al. Metformin Decreases Thyroid Volume and nodule size in subjects with insulin resistance: A preliminary study. Med Princ Pract. 2016;25:233-6.

41. Kyrou I et al. Improved thyroid hypoechogenicity following bariatric-induced weight loss in euthyroidadults with severe obesity - A pilot study. Front Endocrinol (Lausanne). 2018;9:488.

FOR REPRINT QUERIES PLEASE CONTACT: +44 (0) 1245 334450