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Association of Anthropometric and Body Adiposity Measures with Thyroid Dysfunction in Clinical Settings of Manipur, Northeast India

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Abstract

Objective This study aimed to understand the association of anthropometric and body adiposity measures with thyroid dysfunction in clinical settings of Manipur, Northeast India.

Materials and Methods The study included 160 Meitei and 152 Thadou-Kuki thyroid dysfunction patients undergoing treatment under medical specialists. Anthropometric data and related adiposity measures were collected along with the medical data.

Results Hypothyroid represents 70.83% and hyperthyroid 29.17% of the total samples included in the study. The incidence of hypothyroid and hyperthyroid, irrespective of ethnic groups, is higher among females (87.49%) than males (12.49%). Hypothyroid individuals are significantly heavier and have higher adiposity measures than hyperthyroid, which is more significantly observed among the Thadou Kuki. Significantly higher waist circumference and weight to height ratio among the hypothyroid patients put the notion of adiposity deposition, apart from just water retention. Ethnic variation in the association reflects socioeconomic intervention in the management of thyroid problems.

Conclusion In conclusion, proper dietary intake or supplements in the course of thyroid dysfunction treatment are important as they can complicate thyroid dysfunction patients with other associated comorbidities.

Keywords
- hypothyroidism
- hyperthyroidism
- body adiposity
- Meitei
- Thadou Kuki

Introduction

Thyroid hormone dysfunction is one of the critical health issues, with over 1.6 billion people worldwide are at risk.[1] Of these, hypothyroidism and hyperthyroidism are the primary dysfunctions that affect overall health. Thyroid hormones are essential regulators of basal and total energy consumption and influence body composition.[2] Indeed, thyroid dysfunction has profound effects on body composition as hyperthyroidism is associated with weight loss, and hypothyroidism appears to cause a modest increase in weight.[3,4] Various studies suggest positive associations between TSH serum

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levels and body mass index (BMI),[5–8] thereby suggesting body composition could be one of the important parameters associated with thyroid dysfunction. This is further affirmed by increased TSH and free triiodothyronine (T3) in obesity,[9,10] suggesting thyroid dysfunction is allied with fluctuations in body weight and composition.[11]

In India, too, thyroid dysfunction affects an estimated population of ~42 million people.[12] However, there is still a lack of information on the association of obesity with thyroid dysfunction, as studies from Asian Indians are significantly less, though the incidence of obesity is quite alarming. It is assumed that India could have the maximum burden of metabolic syndrome-associated disorders in the next few decades. Body adiposity changes due to thyroid dysfunction could be problematic as they can complicate the morbid and may be prone to other complications. Considering this research gap, the present study attempts to understand the association of anthropometric and body adiposity measures with thyroid dysfunction in two ethnic groups of Manipur, Northeast India, under clinical settings.

Materials and Methods

The present study was performed among the Meitei and Thadou-Kuki adults of Manipur, Northeast India, who had attended the Thyroid Clinic of Shija Hospitals, Imphal and Zion Clinic, Tuibong, Churachandpur, from April 2019 to February 2021. The study included 312 samples altogether —160 Meitei and 152 Thadou-Kuki patients undergoing hypothyroid and hyperthyroid treatment under medical specialists. The sample size was determined using EpiInfo software, assuming at a 5% acceptable margin of error with 50% expected frequency of thyroid dysfunction in two clusters of the population at 90% confidence interval, accounting for 135 in each cluster and totaling 270 samples.[13] The patients were selected on convenient sampling, though those who had other forms of thyroid disorders like thyroid carcinoma, papillary thyroid carcinoma, goiter, and recently undergoing thyroid surgery in the past were excluded from the study.

Both population groups are native inhabitants of Manipur belonging to Asian ethnicity. These two communities were selected based on the notion of Meitei representing the plain people and the Thadou Kuki as hilly people, as previous studies have highlighted the differential prevalence in the plain and hilly regions.[14] The lifestyle of these two groups differs based on their ecological niche. Accessibility to healthcare and other basic amenities also varies, as better infrastructural development are concentrated in the valley areas.

Detailed biosocial information, including medical history and test records, was collected to assign the thyroid dysfunction status. Anthropometric measurements such as height, weight, and waist circumference (WC) were also collected to the nearest 0.5 unit, following standard protocol. Measurements were taken twice to obtain the average value for further data analysis. Different body adiposity measures were extracted from the anthropometric data through relevant indices. Body mass index (BMI) was calculated as weight in kg per height in meters square. Body adiposity through BMI was identified through World Health Organization Asian cutoff.[15] WC with cutoff >90 cm (for male) and >80 cm (for female) was used to define abdominal obesity.[15] Waist to height ratio (WHtR) of 0.5 cutoff value was also used to assess the proportion of central fat by height.[16] Waist hip ratio was also used to assess body adiposity with cutoff >0.95 and >0.80 for males and females, respectively.[17]

Descriptive statistics were employed to describe the data. *t*-test was conducted to find the mean differences of the compared anthropometric and body adiposity variables, and a chi-squared test was conducted to find the association of these variables with thyroid dysfunction. Biserial correlation was used to correlate the quantitative variables of anthropometric and body adiposity measures with dual categorical variables of hypo and hyperthyroidism. All the statistical analyses were done through SPSS 26, and the significance tests were done at 0.05. The participants were informed before the data collection, and consent was taken after explaining the study's objectives. The study was ethically approved by Institutional Human Ethics Committee, Manipur University under MU/IHEC/2020/017.

Results

The present study includes 312 patients with thyroid hormone dysfunction belonging to two different ethnicities—Meitei and Thadou Kuki of Manipur. Hypothyroid represents 70.83% and hyperthyroid 29.17% of the total samples included in the study. Of the total patients assessed for thyroid dysfunction, 87.49% were females, and 12.51% were males (►**Table 1**). Ethnic wise, 81.57% of Thadou Kuki patients and 93.1% of Meitei patients were females, indicating that the females are outnumbering in the clinical consultation with the specialists.

The distribution of anthropometric and body adiposity measures among the hypothyroid and hyperthyroid is presented in ►**Table 2**. Overall, hypothyroid patients have higher anthropometric and body adiposity measures than hyperthyroid. Among the Meiteis patient, hypothyroid patients have more significantly larger WC (80.00 ± 10.34 cm) than hyperthyroid (76.02 ± 8.87 cm). In case of Thadou Kuki, hypothyroid patients are significantly heavier (59.71 ± 10.05 kg), have significantly higher hip circumference (HC) (95.30 ± 13.19 cm), WC ($88.6\ 5 \pm 11.33$ cm), BMI (24.73 ± 4.20 kg/m^2), and WHtR (0.57 ± 0.07) (►**Tables 2** and **3**).

The correlation of anthropometric and body adiposity measures with hypothyroid and hyperthyroid patients reveals that WC is significantly correlated with thyroid status among the Meiteis. Among the Thadou Kuki, a significant correlation is observed in weight, HC, WC, BMI, and WHtR (►**Table 3**). Among the Meiteis, abdominal obesity is found to be associated with thyroid dysfunction as hypothyroids have significant WC ($\chi^2 = 6.83$, $p < 0.05$) and WHtR ($\chi^2 = 6.45$, $p < 0.05$) higher than cutoff, as compared with hyperthyroid (►**Table 4**). In case of Thadou Kuki, significant association is

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Table 1 Age and sex distribution of the hypothyroid and hyperthyroid Meitei and Thadou Kuki patients of Manipur

Thyroid status	Meitei			Thadou Kuki			Total		
	Male	Female	Mean age (y)	Male	Female	Mean age (y)	Male	Female	Mean age (y)
Hypothyroid	7 (4.37)	120 (75)	38.05 ± 11.39	16 (10.52)	78 (51.31)	48.68 ± 14.35	23 (7.37)	198 (63.46)	42.57 ± 13.75
Hyperthyroid	4 (2.5)	29 (18.1)	41.45 ± 12.41	12 (7.89)	46 (30.26)	49.84 ± 18.23	16 (5.12)	75 (24.03)	46.80 ± 16.78
χ^2	1.787		1.50[a]	0.321		0.41[a]	3.03		2.12[a,b]

[a]*t*-test analysis to see significant differences between mean ages of hypothyroid and hyperthyroid patients.
[b]Significant at 0.05.
Number in the parenthesis indicates the percentage.

Table 2 Distribution of anthropometric variables and associated body adiposity measures among hypothyroid and hyperthyroid Meitei and Thadou Kuki patients of Manipur

Para meters	Meitei			Thadou Kuki			Total		
	Hypo	Hyper	*t*-test	Hypo	Hyper	*t*-test	Hypo	Hyper	*t*-test
Height (cm)	157.14 ± 7.37	156.46 ± 6.13	0.48	155.58 ± 7.30	155.71 ± 6.81	0.12	156.47 ± 7.37	155.98 ± 6.54	0.55
Weight (kg)	61.09 ± 10.94	57.67 ± 7.94	1.68	59.71 ± 10.05	53.98 ± 10.13	3.40[a]	60.51 ± 10.57	55.32 ± 9.52	4.05[a]
HC (cm)	93.68 ± 8.66	90.87 ± 8.33	1.67	95.30 ± 13.19	86.57 ± 10.13	4.31[a]	94.37 ± 10.83	88.13 ± 9.69	4.76[a]
WC (cm)	80.00 ± 10.34	76.02 ± 8.87	2.02[a]	88.65 ± 11.33	80.08 ± 10.31	4.69[a]	83.68 ± 11.57	78.61 ± 9.96	3.66[a]
BMI (kg/m^2)	24.75 ± 4.17	23.61 ± 3.40	1.45	24.73 ± 4.20	22.16 ± 3.21	3.99[a]	24.74 ± 4.17	22.69 ± 3.33	4.17[a]
WHtR	0.51 ± 0.06	0.49 ± 0.06	1.86	0.57 ± 0.07	0.51 ± 0.06	4.75[a]	0.53 ± 0.07	0.50 ± 0.06	3.48[a]
WHR	0.85 ± 0.08	0.83 ± 0.05	1.21	0.93 ± 0.07	0.92 ± 0.06	0.70	0.89 ± 0.08	0.89 ± 0.07	0.53

Abbreviations: BMI, body mass index; HC, hip circumference; WC, waist circumference; WHR, waist hip ratio; WHtR, weight to height ratio.
[a]Significant at 0.05.

Table 3 Biserial correlation of anthropometric variables and associated body adiposity measures with thyroid status among hypothyroid and hyperthyroid Meitei and Thadou Kuki patients of Manipur

Parameters	Meitei	Thadou Kuki	Total
	r	*r*	*r*
Height	−0.04	0.01	−0.03
Weight	−0.13	−0.27[a]	−0.22[a]
HC	−0.13	−0.33[a]	−0.26[a]
WC	−0.16[a]	−0.36[a]	−0.20[a]
BMI	−0.11	−0.31[a]	−0.23[a]
WHtR	−0.15	−0.36[a]	−0.19[a]
WHR	−0.10	−0.06	0.03

Abbreviations: BMI, body mass index; HC, hip circumference; WC, waist circumference; WHR, waist hip ratio; WHtR, weight to height ratio.
[a]Significant at 0.05.

observed in BMI ($\chi^2 = 14.69$, $p < 0.05$), WC ($\chi^2 = 15.95$, $p < 0.05$), and WHtR ($\chi^2 = 14.73$, $p < 0.05$).

Discussion

Thyroid dysfunction affects body weight and composition.[18,19] The present study also reveals that hypothyroid patients, irrespective of ethnic groups, have higher body adiposity measures than hyperthyroid one. Such body adiposity measures are more significantly expressed among the Thadou Kuki tribesmen than the Meiteis. Studies report that hypothyroidism induces water retention and makes overweight, which is not due to an increase in fat mass.[20,21]

According to American Thyroid Association, the basal metabolic rate among the hypothyroid is decreased. Consequently, an underactive thyroid results in weight gain, which is prominent in severe cases. Such weight gain results from excess accumulation of salt and water.[22] On the other hand, hyperthyroidism has traditionally been associated with weight loss and underweight. The hyperthyroid patients have adrenergic hyperstimulation with increased basal metabolism and thermogenesis and greater overall energy expenditure resulting in greater energy expenditure tendency toward weight loss.[23] However, hyperthyroid patients may also gain weight depending on calorie intake.[22]

The present finding provides new insight into this discourse, as hypothyroid patients have significantly higher central adiposity as measured by WC and WHtR than the hyperthyroid patients in the studied ethnic population. WC and WHtR are considered better indicators of body adiposity than BMI, as WC measures the overall body fat, while WHtR assesses the proportion of central fat by height.[24] This finding is also supported by the correlation analysis with hypothyroid patients having higher anthropometric and body adiposity measures. The association of thyroid dysfunction with body adiposity is a matter of discussion as it can complicate the health condition of the patients related to body adiposity related disorder. However, there are fewer studies on this matter.

The incidence of thyroid dysfunction in the studied ethnic groups is not significant. However, the association of body

Table 4 Association of body adiposity measures with hypothyroid and hyperthyroid Meitei and Thadou Kuki patients of Manipur

	Meitei			Thadou Kuki			Total		
	Hypo	Hyper	χ^2	Hypo	Hyper	χ^2	Hypo	Hyper	χ^2
BMI Underweight (<18.5) Normal (18.5–23) Overweight (23–27.5) Obese (≥ 27.5)	4 (2.5) 49 (30.62) 45 (28.12) 29 (18.12)	1 (0.62) 15 (9.37) 13 (8.12) 4 (2.5)	1.88	4 (2.63) 28 (18.42) 39 (25.65) 23 (15.13)	5 (3.28) 32 (21.05) 17 (11.18) 4 (2.63)	14.69[b]	8 (2.56) 77 (24.67) 84 (26.92) 52 (16.66)	6 (1.92) 47 (15.06) 30 (9.61) 8 (2.56)	13.58[b]
Abdominal obesity (WC) <90/<80[a] ≥90/<80[a]	64 (40) 63 (39.37)	25 (15.62) 8 (5)	6.83[b]	26 (17.10) 68 (44.73)	35 (23.02) 23 (15.13)	15.95[b]	90 (28.84) 131 (41.98)	60 (19.23) 31 (9.93)	16.41[b]
WHR <0.95/<0.80[a] ≥0.95/ ≥0.80[a]	39 (24.37) 88 (55)	11 (6.87) 22 (13.75)	0.08	13 (8.55) 81 (53.28)	12 (7.89) 46 (30.26)	1.23	52 (16.66) 169 (54.16)	23 (7.37) 68 (21.79)	0.11
WHtR <0.5 ≥0.5	 57 (35.62) 70 (43.75)	23 (14.37) 10 (6.25)	6.45[b]	19 (12.5) 75 (49.34)	29 (19.07) 29 (19.07)	14.73[b]	76 (24.35) 145 (46.47)	 52 (16.66) 39 (12.5)	13.79[b]

Abbreviations: BMI, body mass index; WC, waist circumference; WHR, waist hip ratio; WHtR, weight to height ratio.
[a]Represents cutoff of male and females, respectively.
[b]Significant at 0.05.
Number in the parenthesis indicates the percentage.

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adiposity with thyroid dysfunction differs in these ethnic groups with more pronounced among the Thadou Kuki, as reflected by the correlation and mean anthropometric and adiposity measures. Here, proper nutritional intake may effectively control body weight, and adiposity measures as more intake can reduce weight loss among hyperthyroid patients.[25] The Meitei being plain dwellers have better socioeconomic facilities that could enable them to access better nutrition and healthcare than Thadou Kuki, who mainly live in the hilly terrains where proper healthcare facilities and better nutrition are minimal.

The higher incidence of thyroid dysfunction among the females in the present study is concordant with the findings of other studies.[26–28] It is reported that women are ten times more likely to develop thyroid dysfunction. The reason for such gender disparity in thyroid problems is unclear, yet it is believed to be related to female sex hormones.[29] The high occurrence of hypothyroidism and hyperthyroidism among females in the present study is of utmost concern as it can complicate their reproductive health.

Strength and Limitation

The study was designed to assess anthropometric and body adiposity variations among hypothyroid and hyperthyroid patients. Probable sampling error could not be determined due to convenient sampling; however, all the consultations with the specialists during the study were included in the sample. Furthermore, it could not evaluate the body adiposity risk to thyroid dysfunction as the study does not include the control group. However, the study highlights one of the important possible associations of body fat with hypothyroid, not just water retention.

Conclusion

The study highlights one of the important concerns of thyroid dysfunction management related to nutritional health. Hypothyroid patients have higher chances to develop cardiometabolic complications because of higher adiposity deposition. Meanwhile, proper dietary intake or supplements in the course of thyroid dysfunction treatment are important as they can complicate the thyroid dysfunction patients with other associated comorbidities. More in-depth case controls studies may be necessary to affirm the conclusion. However, diet management and socioeconomic intervention could effectively promote thyroid health problems in general and in Manipur.

Ethical Approval and Informed Consent

This study was ethically approved by Institutional Human Ethical Clearance Committee, Manipur University (Ref. No. MU/IHEC/2020/017).

Financial Disclosure

The authors do not have any financial relationships relevant to this article to disclose.

Authors' Contribution

KhD-B conceptualized and designed the study, collected the data, critically reviewed, and drafted the manuscript; SYM coordinated and supervised paper drafting and revised for important intellectual content and participated in the analytical framework for the study. JB and AL worked in identifying the thyroid patients. All authors read and approve the final version of the manuscript to be published.

Conflict of Interest

None declared.

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References

1 Khan A, Khan MMA, Akhtar S. Thyroid disorders, etiology and prevalence. J Med Sci 2002;2(02):89–94
2 Corbetta S, Englaro P, Giambona S, Persani L, Blum WF, Beck-Peccoz P. Lack of effects of circulating thyroid hormone levels on serum leptin concentrations. Eur J Endocrinol 1997;137(06): 659–663
3 Hoogwerf BJ, Nuttall FQ. Long-term weight regulation in treated hyperthyroid and hypothyroid subjects. Am J Med 1984;76(06): 963–970
4 Kyriacou A, Kyriacou A, Makris KC, Syed AA, Perros P. Weight gain following treatment of hyperthyroidism—a forgotten tale. Clin Obes 2019;9(05):e12328
5 Åsvold BO, Bjøro T, Vatten LJ. Association of serum TSH with high body mass differs between smokers and never-smokers. J Clin Endocrinol Metab 2009;94(12):5023–5027
6 Fox CS, Pencina MJ, D'Agostino RB, et al. Relations of thyroid function to body weight: cross-sectional and longitudinal observations in a community-based sample. Arch Intern Med 2008;168 (06):587–592
7 Knudsen N, Laurberg P, Rasmussen LB, et al. Small differences in thyroid function may be important for body mass index and the occurrence of obesity in the population. J Clin Endocrinol Metab 2005;90(07):4019–4024
8 Nyrnes A, Jorde R, Sundsfjord J. Serum TSH is positively associated with BMI. Int J Obes 2006;30(01):100–105
9 Ekinci F, Merder-Coşkun D, Tuncel B, Atila D, Yildiz H, Uzuner A. Relationship between obesity and thyroid function in adults. Marmara Med J. 2018;31(02):76–80
10 Svare A, Nilsen TIL, Bjøro T, Åsvold BO, Langhammer A. Serum TSH related to measures of body mass: longitudinal data from the HUNT Study, Norway. Clin Endocrinol (Oxf) 2011;74(06): 769–775
11 Raatikainen K, Heiskanen N, Heinonen S. Transition from overweight to obesity worsens pregnancy outcome in a BMI-dependent manner. Obesity (Silver Spring) 2006;14(01):165–171
12 Unnikrishnan AG, Menon UV. Thyroid disorders in India: an epidemiological perspective. Indian J Endocrinol Metab 2011; 15(6, Suppl 2):S78–S81
13 Dean A, Arner T, Sunki G, et al. Epi Info™, a database and statistics program for public health professionals. 2011https://www.cdc.gov/epiinfo/index.html
14 Das A, Shaini L, Sangeeta N, et al. Prevalence of thyroid hormone dysfunction among female patients, attending a multispeciality hospital in Manipur. IOSR J Dent Med Sci 2013;10(02):7–11

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15 Nishida C, Barba C, Cavalli-Sforza T, et al; WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363(9403):157–163
16 Ashwell M, Gibson S. A proposal for a primary screening tool: 'Keep your waist circumference to less than half your height'. BMC Med 2014;12(01):207. Doi: 10.1186/s12916-014-0207-1
17 World Health Organization. Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation. 2011. Geneva: World Health Organization
18 Biondi B. Thyroid and obesity: an intriguing relationship. J Clin Endocrinol Metab 2010;95(08):3614–3617
19 Song RH, Wang B, Yao QM, Li Q, Jia X, Zhang JA. The impact of obesity on thyroid autoimmunity and dysfunction: a systematic review and meta-analysis. Front Immunol 2019;10:2349. Doi: 10.3389/fimmu.2019.02349
20 Karmisholt J, Andersen S, Laurberg P. Weight loss after therapy of hypothyroidism is mainly caused by excretion of excess body water associated with myxoedema. J Clin Endocrinol Metab 2011; 96(01):E99–E103
21 O'Malley B, Hickey J, Nevens E. Thyroid dysfunction - weight problems and the psyche: The patient's perspective. J Hum Nutr Diet 2000;13(04):243–248
22 American Thyroid Association. Thyroid and weight. https://www.thyroid.org/thyroid-and-weight/ Accessed February 22, 2022
23 Amouzegar A, Kazemian E, Abdi H, et al. Association between thyroid function and development of different obesity phenotypes in euthyroid adults: a nine-year follow-up. Thyroid 2018;28 (04):458–464
24 Ahmad N, Adam SIM, Nawi AM, Hassan MR, Ghazi HF. Abdominal obesity indicators: waist circumference or waist-to-hip ratio in Malaysian adults population. Int J Prev Med 2016;7(June):82. Doi: 10.4103/2008-7802.183654
25 Abid M, Billington CJ, Nuttall FQ. Thyroid function and energy intake during weight gain following treatment of hyperthyroidism. J Am Coll Nutr 1999;18(02):189–193
26 Hollowell JG, Staehling NW, Flanders WD, 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 2002;87(02):489–499
27 Meng Z, Liu M, Zhang Q, et al. Gender and age impact on the association between thyroid-stimulating hormone and serum lipids. Medicine (Baltimore) 2015;94(49):e2186
28 Vanderpump MP, Tunbridge WM, French JM, et al. The incidence of thyroid disorders in the community: a twenty-year follow-up of the Whickham Survey. Clin Endocrinol (Oxf) 1995;43(01):55–68
29 Grunewald J. Why Do Thyroid Disorders Affect Women More Often Than Men? https://experiencelife.lifetime.life/article/why-do-thyroid-disorders-affect-women-more-often-than-men/ Published 2017. Accessed February 22, 2022

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