

CARDIAC MANIFESTATIONS OF HYPOTHYROIDISM AND HYPERTHYROIDISM: A STUDY ON ECHOCARDIOGRAPHIC FINDINGS

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Abstract

Background: Thyroid disorders, such as hypothyroidism and hyperthyroidism, substantially impact heart anatomy and function. This study examines the clinical and echocardiographic manifestations of thyroid dysfunction in a population from North-East India. **Materials and Methods:** A cross-sectional study was conducted from September 2022 to March 2024 at the Regional Institute of Medical Sciences, Imphal, India. A total of 180 patients with hypo- or hyperthyroidism aged 18–75 years were enrolled, with 146 completing the study after applying inclusion and exclusion criteria. Clinical parameters, thyroid function tests, ECG, and 2D-ECHO findings were analyzed. Statistical analysis was conducted using IBM SPSS version 21, with significance set at $P < 0.05$. **Result:** The study population (mean age: 45.63 ± 13.72 years) consisted of 89 hypothyroid and 57 hyperthyroid patients, primarily females (85.6%). Significant differences were observed between thyroid groups for TSH, T3, T4, heart rate, and systolic BP ($p < 0.001$), but not for BMI ($p = 0.681$) or diastolic BP ($p = 0.056$). Hypothyroidism correlated with bradycardia (41.6%) and left ventricular diastolic dysfunction (71.9%), whereas hyperthyroidism was linked to pulmonary hypertension (89.5%) and sinus tachycardia (56.1%). Patients with hyperthyroidism demonstrated a higher prevalence of echocardiographic abnormalities (94.7%) than those with hypothyroidism (75.3%) ($P = 0.003$). Medication reduced the prevalence of cardiac abnormalities in hypothyroid patients ($P < 0.001$). **Conclusion:** Thyroid dysfunction correlates with specific cardiovascular profiles, with hyperthyroidism presenting an elevated risk of cardiac problems. Regular ECG and echocardiographic surveillance are crucial, especially in hyperthyroid individuals, to facilitate early identification and management. The research highlights the importance of medication compliance in reducing cardiac abnormalities among hypothyroid patients.

INTRODUCTION

Thyroid dysfunction, encompassing hypothyroidism and hyperthyroidism, is among the most prevalent endocrine disorders worldwide, significantly influencing multiple physiological systems, including the cardiovascular system.^[1] The thyroid gland plays a pivotal role in regulating metabolic rate, cardiovascular function, and energy homeostasis through its hormonal influence on various tissues. Consequently, abnormalities in thyroid hormone levels can result in profound cardiovascular

manifestations.^[2] In hypothyroidism, reduced thyroid hormone levels result in a metabolic deceleration, affecting heart structure and function. Typical manifestations encompass bradycardia, decreased cardiac output, diastolic dysfunction, and pericardial effusion. Conversely, hyperthyroidism is marked by a hypermetabolic condition, frequently exhibiting sinus tachycardia, atrial fibrillation, and elevated cardiac output.^[3] Prolonged untreated thyroid dysfunction can result in structural alterations, such as left ventricular hypertrophy and pulmonary

hypertension, significantly affecting patient morbidity and mortality.^[4]

Despite the established link between thyroid dysfunction and cardiovascular disease, the patterns and prevalence of specific cardiac manifestations vary across populations due to genetic, environmental, and healthcare access differences. The North-East Indian population, with its unique ethnic and demographic characteristics, remains underrepresented in such studies.^[5]

Exploring the specific cardiac manifestations of thyroid dysfunction in this demographic can provide valuable insights into regional variations and inform targeted clinical strategies.^[6]

Echocardiography, a non-invasive imaging modality, plays a pivotal role in evaluating cardiac structure and function. It provides comprehensive insights into the cardiovascular changes associated with thyroid dysfunction, including chamber size, ventricular function, pericardial abnormalities, and pulmonary pressures.^[7]

Despite its utility, there is a paucity of data on echocardiographic findings in thyroid disorders in the North-East Indian population. This study aims to evaluate the cardiac manifestations of hypothyroidism and hyperthyroidism using echocardiographic findings in a cohort from this region.^[8]

By identifying the specific cardiovascular changes associated with thyroid dysfunction, this research seeks to enhance the understanding of thyroid-related cardiac complications, emphasize the importance of timely diagnosis and treatment, and contribute to the optimization of clinical management strategies.^[9]

Furthermore, this study highlights the critical role of timely diagnosis and treatment in mitigating cardiovascular risks associated with thyroid disorders. The findings of this study are expected to enhance the understanding of thyroid dysfunction's effects on cardiac health, especially within a specific demographic. This research seeks to assist doctors in optimizing the care of thyroid illnesses by detecting distinct echocardiographic patterns and their clinical connections, hence improving patient outcomes.

Aim

This study aims to evaluate the echocardiographic associations with clinical characteristics in patients with hypo and hyperthyroidism.

MATERIALS AND METHODS

Ethical Statement

The cross-sectional study was carried out in accordance of the Declaration of Helsinki 1964 and its later amendments. Written consent was taken from all participants. All study procedure was approved by the Research Ethics Board of the hospital.

Study design and populations

The study is a cross-sectional study carried out in the Department of Medicine, Regional Institute of Medical Sciences, Imphal, Manipur, India from 1st September 2022 to 31st March 2024. A total of 180

patients were enrolled during the study period. A total of 20 patients were excluded because they were confirmed with terminal illness, chronic diseases such as chronic renal failure, chronic liver failure, pregnant or nursing, hypertension, coronary artery disease, valvular disease and diabetes mellitus. Nine patients were lost during the follow-up and not-reachable whereas another 5 patients voluntarily choose to discontinue their participation. Therefore, out of the total 180 patients 146 patients completed the study protocol. The study population belongs to urban and sub-urban populations with mixed socio-economic class and the majority of population belongs to 41-50 years old.

Inclusion Criteria

The inclusion criteria include the following:

- (i) Patients with age 18-75 years,
- (ii) Patients with hypo or hyperthyroidism
- (iii) North-East Indian population or North-East Indian ethnicity

Exclusion Criteria

The exclusion criteria include the following:

- (i) Patients with terminal illness such as cancer.
- (ii) Patients with chronic diseases such as chronic renal failure, chronic liver failure
- (iii) Pregnant or nursing
- (iv) Patients with hypertension, coronary artery disease, valvular disease and diabetes mellitus

Measurements

The clinical characteristics of the patients such as age, sex, height, weight, BMI, thyroid medication, thyroid function test was measured and considered as the independent variables. On the other hand, laboratory measurements such as ECG findings, 2D-ECHO findings, chamber size, LV functions, pericardial findings and PAH were measured and considered as the outcome variable.

Statistical Analysis

The IBM SPSS version 21 statistical software package (SPSS, Inc., Chicago, IL, USA) was used to conduct statistical analyses. Descriptive statistics were used for the analysis of age, sex, thyroid profile. Continuous variables are presented as Means \pm Standard deviation. Chi-square test and Fisher's exact test were employed to test the association between age group and echocardiographic findings. Student t-test was employed to test the association of mean age with hyper and hypothyroidism. $P < 0.05$ was considered the statistically significant value.

RESULTS

In the present study, a total of 146 patients were included in the study with 89 cases of hypothyroid and 57 cases with hyperthyroid patient. Female patients account for 85.6% (125) compared to 14.4% (21) of male patients. A majority of the patient belong to the 41 – 50 years (30.8%) age group followed by 31-40 years (21.9%). The age group above 60 years has 13.7% of the patients [Figure 1]. The mean age of the patients was 45.63 ± 13.72 years [Figure 1].

The age group 41 - 50 years (35.1%) has the maximum number of hyperthyroid patients followed by 51 - 60 years' age group with 22.8% [Figure 2]. A total of 44 (30.1%) patients were having anti-thyroid medications for more than 6 months whereas 102 (69.9%) patients were newly diagnosed or having medications for less than 6 months [Figure 3].

[Table 1] highlights significant differences in thyroid hormones viz. TSH, T3, T4 ($p < 0.001$), heart rate ($p < 0.001$), and systolic BP ($p < 0.001$) between hypothyroid and hyperthyroid individuals. These findings are consistent with the expected physiological changes associated with thyroid dysfunction. However, BMI ($p < 0.681$) and diastolic BP ($p < 0.056$) differences were not significant, indicating variability in how these parameters are affected by thyroid status.

[Table 2] highlights the distribution of the hyperthyroid patients by ECG findings (N=57) which indicates the predominance of sinus tachycardia (56.1%) and the presence of atrial fibrillation (12.3%) highlight the impact of hyperthyroidism on cardiac rhythm. Left ventricular hypertrophy (22.8%) suggests structural cardiac adaptations, while normal sinus rhythm (40.4%) in a notable subset of patients indicates variability in cardiac responses to hyperthyroidism. The findings underscore the need for routine ECG monitoring in hyperthyroid patients to identify and manage potential cardiac complications early. Whereas the distribution of the hypothyroid patients by ECG findings (N=89) is presented in [Figure 4]. Maximum of the hypothyroid patients had bradycardia (41.6%) in their ECG followed by low voltage complexes (14.6%).

[Table 3] present the most common signs and symptoms in hypothyroid patients include easy fatigue (70, 78.7%), weight gain (67, 75.3%), and dry skin (42, 47.2%). These findings reflect the metabolic slowdown and skin/hair changes associated with hypothyroidism. Prominent symptoms in hyperthyroid patients include pulmonary hypertension (51, 89.5%), fast heartbeat (33, 57.9%), weight loss (31, 54.4%), and tremors (27, 47.4%). These symptoms reflect the hypermetabolic state and sympathetic overactivity in hyperthyroidism

[Table 2]. The most common echocardiographic finding in the Hypothyroid Patients was left ventricular diastolic dysfunction grade I (64, 71.9%), followed by pericardial effusion (51, 57.3%). Therefore, the findings suggest cardiovascular effects of hypothyroidism, including fluid retention and reduced ventricular compliance. On the other hand, most common abnormality was pulmonary hypertension (51, 89.5%), followed by mild mitral regurgitation (44, 77.2%) and hypercontractile heart (17, 29.8%) was seen among the Hyperthyroid Patients [Table 3]. These results indicate the impact of hyperthyroidism on heart structure and function, with increased pulmonary pressures and hyperdynamic circulation. Maximum of the hyperthyroid patients had sinus tachycardia (56.1%) in their ECG followed by normal sinus rhythm

(40.4%) and left ventricular hypertrophy (22.8%). Atrial fibrillation was seen in 12.3% of the hyperthyroid patients.

[Table 4] observed that hypothyroidism was more prevalent among females, affecting 69 out of 89 patients (77.5%), while nearly all hyperthyroid cases were female (56 out of 57 patients, 98.2%). The difference in gender distribution is statistically significant ($P < 0.001$), highlighting a strong association between female gender and thyroid disorders, especially hyperthyroidism. The males accounted for a smaller proportion of thyroid disorders, with 20 patients (22.5%) in the hypothyroid group and only 1 patient (1.8%) in the hyperthyroid group. The mean age of hypothyroid patients was 44.89 years (± 14.52), while hyperthyroid patients had a slightly higher mean age of 46.79 years (± 12.42). The age difference between the two groups was not statistically significant ($P = 0.416$), indicating that age is not a significant differentiating factor between hypothyroidism and hyperthyroidism [Table 4]. [Table 5] highlights the association between thyroid disorder and Echo findings. Patients with hypothyroidism had fewer echocardiographic abnormalities, with 24.7% showing no significant abnormality, compared to 5.3% in hyperthyroidism ($P = 0.003$). Abnormalities were more common in both groups, observed in 75.3% of hypothyroid and 94.7% of hyperthyroid patients ($P = 0.003$). Thus, indicating a stronger association of echocardiographic abnormalities with hyperthyroidism. On the other hand, among the hypothyroid patients, those on medication were significantly more likely to have no significant abnormalities (55.2%) compared to non-medicated patients (10.0%, $P < 0.001$). Moreover, the prevalence of abnormalities was significantly higher in non-medicated patients (90.0%) than in those on medication (44.8%, $P < 0.001$) which highlights the critical role of medication in reducing cardiac abnormalities in hypothyroid patients.

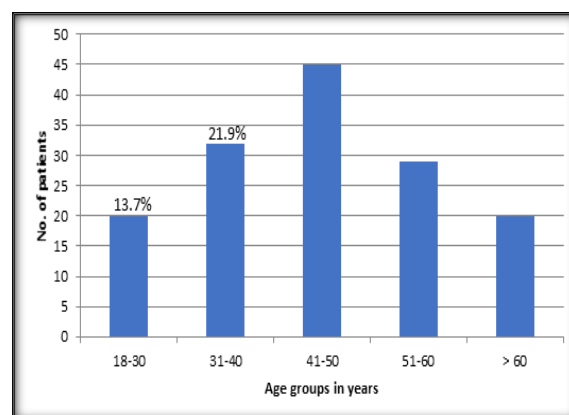


Figure 1: Distribution of the patients by age (N=146)

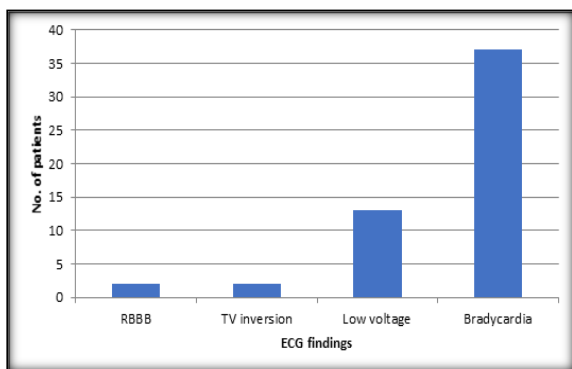


Figure 2: Distribution of the hypothyroid patients by ECG findings (N=89)

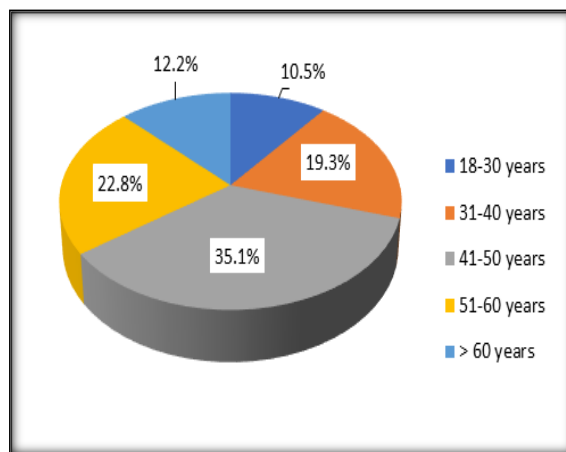


Figure 4: Distribution of the hyperthyroid patients by age (N=57)

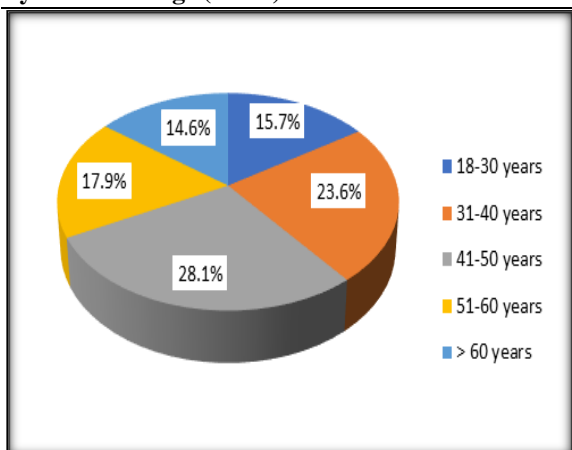


Figure 3: Distribution of the hypothyroid patients by age (N=89)

Table 1: Distribution of the patients by BMI, thyroid profile and vitals (N=146).

SN	Characteristics	Hypothyroid (Mean ± SD)	Hyperthyroid (Mean ± SD)	P-value
1.	BMI kg/m ²	25.9 ± 2.62	25.7 ± 2.67	0.681
2.	TSH	9.0 ± 4.74	2.1 ± 4.04	< 0.001
3.	T3	1.6 ± 0.41	3.9 ± 1.39	< 0.001
4.	T4	12.4 ± 18.43	135.7 ± 77.74	< 0.001
5.	Heart rate	68.3 ± 10.55	107.3 ± 10.56	< 0.001
6.	Systolic BP	124.8 ± 7.95	132.8 ± 6.87	< 0.001
7.	Diastolic BP	84.83 ± 9.30	97.7 ± 8.02	0.056

Table 2: Distribution of the hyperthyroid patients by ECG findings (N=57).

Sl.no.	ECG findings	No. of patients	Percentages (%)
1.	Left ventricular hypertrophy	13	22.8
2.	Atrial fibrillation	7	12.3
3.	Sinus tachycardia	32	56.1
4.	Normal sinus rhythm	23	40.4

Table 3: Signs and symptoms and Echo findings of hypothyroid patients and Hyperthyroid).

SN	Hypothyroid (N=89) [n (%)]	Hyperthyroid (N=57) [n (%)]
	Signs and symptoms	Signs and symptoms
1	Weight gain 67 (75.3 %)	Heat intolerance 17 (29.8 %)
2	Easy fatigue 70 (78.7 %)	Anxiety 24 (42.1 %)
3	Shortness of breath 25 (28.1 %)	Weight loss 31 (54.4%)
4	Hair loss 30 (33.7 %)	Fast heart beat 33 (57.9 %)
5	Dry skin 42 (47.2 %)	Increased sweating 14 (24.6 %)
6	-	Hair loss 11 (19.3 %)
7	-	Brittle hair 29 (50.9 %)
8	-	Restlessness 17 (29.8 %)
9	-	Tremor 27 (47.4 %)
	Echo Findings	Echo Findings
10	Concentric ventricular hypertrophy 18 (20.2 %)	Concentric left ventricular hypertrophy 7 (12.3 %)
11	Mild Mitral regurgitation 5 (5.6 %)	Hyper contractile heart 17 (29.8 %)
12	Left ventricular diastolic dysfunction with mild pericardial effusion 4 (4.5 %)	Mild mitral regurgitation 44 (77.2 %)

13	Left ventricular diastolic dysfunction grade II	3 (3.4 %)	Pulmonary hypertension	51 (89.5 %)
14	Left ventricular diastolic dysfunction grade I	64 (71.9 %)	No significant abnormalities	3 (5.3 %)
15	Pericardial effusion	51 (57.3 %)	-	-
16	No significant abnormality	22 (24.7 %)	-	-

Table 4: Clinical associations based on age and sex.

Sl.no.	Gender	Thyroid disorder, n (% / ±SD)		P value
		Hypothyroid	Hyperthyroid	
1	Female	69 (77.5 %)	56 (98.2 %)	< 0.001
2	Male	20 (22.5 %)	1 (1.8 %)	
3	Age	44.89 (±14.52)	46.79 (±12.42)	0.416

Table 5: Clinical associations based on thyroid disorder and medicine intake in Hypothyroid).

SN	Echo Finding	Thyroid Disorder (n, %) N=146		Medicine Intake among Hypothyroid (n, %) N=89			
		Hypothyroid	Hyperthyroid	P-value	Yes	No	P-value
1	No significant abnormality	22 (24.7 %)	3 (5.3 %)	0.003	16 (55.2 %)	6 (10.0 %)	< 0.001
2	Abnormality	67 (75.3 %)	54 (94.7 %)		13 (44.8 %)	54 (90.0 %)	

DISCUSSION

The present study highlights the significant cardiac manifestations of hypothyroidism and hyperthyroidism using clinical and echocardiographic findings in 146 patients, revealing distinct physiological, structural, and functional cardiac effects associated with thyroid dysfunction. The predominance of females in both hypothyroid (77.5%) and hyperthyroid (98.2%) groups emphasizes the strong association between thyroid disorders and female gender, particularly hyperthyroidism. This finding aligns with existing literature, which attributes hormonal and autoimmune factors to the gender disparity.^[10,11] The majority of patients in the current study are in the age bracket of 41–50 years (30.8%), followed by those aged 31–40 years (21.9%). Patients aged over 60 years constitute 13.7% of the total. The average age of the patients was 45.63 ± 13.72 years. In the two groups of thyroid disorders, the age range of 41 to 50 years comprises the highest percentage of hypothyroid patients at 28.1%, followed by the 31 to 40 years age group at 23.6%. However, the lack of significant age differences between groups suggests that age is not a critical factor in differentiating these conditions, though the clustering of cases in the 41–50 years age group warrants further investigation into age-related thyroid dysfunction trends.^[12] The contrasting clinical presentations of hypothyroidism and hyperthyroidism were evident. Hypothyroid patients exhibited classical symptoms of metabolic slowing, including fatigue (78.7%), weight gain (75.3%), and dry skin (47.2%). Conversely, hyperthyroid patients experienced hypermetabolic symptoms such as pulmonary hypertension (89.5%), fast heartbeat (57.9%), and tremors (47.4%). These findings reinforce the physiological consequences of thyroid dysfunction, emphasizing the need for clinicians to recognize these hallmark symptoms for timely diagnosis.^[13] Similar reports observed that hypothyroid patients most commonly had weight gain (76.6%), dry skin (63.3%), cold intolerance

(50%) and menstrual symptoms in 59% of women, lethargy, bradycardia (30%), delayed ankle jerk in 66.6%, and hoarseness of voice (Shah SK et al.^[22]) Similarly, Bal BS et al,^[21] found that hypothyroid individuals had lower heart rates than euthyroid controls. In another hypothyroid study, it was reported that tiredness/weakness (67.6%) was the most prevalent symptom, followed by dyspnea (42.6%) and hair loss (41.2%).^[14] The ECG findings demonstrated significant variations between hypothyroidism and hyperthyroidism. Bradycardia (41.6%) and low-voltage complexes (14.6%) were predominant in hypothyroid patients, consistent with reduced cardiac output and slowed metabolism. In contrast, sinus tachycardia (56.1%) and atrial fibrillation (12.3%) in hyperthyroid patients reflect hyperdynamic circulation and sympathetic overactivity. The increased prevalence of left ventricular hypertrophy (22.8%) in hyperthyroidism further suggests structural cardiac adaptations due to chronic hemodynamic stress. A similar study found that electrocardiogram alterations in hypothyroid patients were prevalent, with bradycardia occurring in 44%, low-voltage complexes in 32%, T-wave variations in 19.3%, and ST segment changes in 36.0%.^[15] Other findings included QT prolongation, diminished P wave amplitude, low-voltage complexes, atrioventricular and interventricular block, incomplete right bundle branch block, and atrial fibrillation.^[16]

Echocardiographic analysis provided critical insights into the structural and functional cardiac impacts of thyroid disorders. Among hypothyroid patients, left ventricular diastolic dysfunction grade I (71.9%) and pericardial effusion (57.3%) were prevalent, highlighting reduced ventricular compliance and fluid retention. In hyperthyroid patients, pulmonary hypertension (89.5%) and mild mitral regurgitation (77.2%) were common, reflecting increased pulmonary pressures and a hypercontractile state. Notably, echocardiographic abnormalities were more prevalent in hyperthyroid patients (94.7%) than hypothyroid patients (75.3%, P = 0.003), emphasizing the greater cardiovascular burden

associated with hyperthyroidism. A similar study by Bal et al,^[17] found concentric left ventricular hypertrophy in 23.3% of hypothyroid patients, while Shah SK et al,^[18] found normal findings in 30%, pericardial effusion in 26.7%, and diastolic dysfunction in 26.6%. Sawartha et al. found grade I diastolic dysfunction in 30.8%, and Tandia et al,^[19] The protective effect of medication was evident among hypothyroid patients, with a significantly lower prevalence of echocardiographic abnormalities in medicated patients (44.8%) compared to non-medicated ones (90.0%, $P < 0.001$). This underscores the importance of early and sustained medical management in mitigating cardiac complications in thyroid disorders. The findings of this study highlight the necessity for routine cardiovascular assessment, including ECG and echocardiography, in patients with thyroid dysfunction to identify and manage potential complications early. The significant differences in cardiac manifestations between hypothyroidism and hyperthyroidism underscore the need for tailored therapeutic strategies. Furthermore, the study underscores the role of anti-thyroid and thyroid hormone replacement therapies in mitigating cardiac abnormalities and improving clinical outcomes.

CONCLUSION

In conclusion, hypothyroidism was more common than hyperthyroidism among thyroid disorders, with both diagnoses primarily affecting females. Thyroid disorders substantially affected middle-aged individuals. Typical manifestations of hypothyroidism encompass lethargy, weight gain, dyspnea, alopecia, and xerosis, while hyperthyroidism is characterized by tachycardia, weight loss, anxiety, brittle hair, tremors, restlessness, and profuse sweating. Electrocardiographic data indicated that bradycardia and low voltage complexes were prevalent in hypothyroid individuals, whereas hyperthyroid patients commonly displayed sinus tachycardia and left ventricular hypertrophy. Echocardiography revealed that hypothyroid patients frequently had grade I left ventricular diastolic dysfunction, pericardial effusion, and concentric ventricular hypertrophy. Conversely, hyperthyroid individuals exhibited pulmonary hypertension, mild mitral regurgitation, and a hypercontractile myocardium. These findings underscore the significance of early identification and therapy of cardiovascular symptoms to mitigate morbidity and death linked to thyroid diseases.

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