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The Effects of Thyroid Hormone Dysregulation on Cardiovascular Health in Older Adults

1Dr. Aqsa Hameed Awan, 2Dr. Urwah Aamir, 3Dr Najibullah Niazman, 4Dr Fatima Nisar, 5 Dr Kanza malik, 6Dr Aliya Alwi, 7Muhammad Aliyan, 8Ahmad Sultan Warraich

1Federal Medical College, SZAMBU, Islamabad
2Federal Medical College, SZAMBU, Islamabad
3Spinghar institute of higher education, Kabul
4Foundation university medical college, islamabad
5Aziz Bhatti teaching hospital, Gujrat
6Airport Health Department, Lahore
7Rai Medical college teaching hospital, Sargodha
8Rai Medical college teaching hospital, Sargodha

ABSTRACT:

Background: Thyroid hormone imbalance, including both hypothyroidism and hyperthyroidism, has been widely associated with cardiovascular complications. As populations age, understanding the relationship between thyroid dysfunction and cardiovascular health becomes crucial for optimizing care.

Aim: The aim of this study was to assess the impact of thyroid hormone imbalance on cardiovascular health in aging populations, specifically focusing on the prevalence of cardiovascular disorders and their correlation with thyroid function abnormalities.

Methods: A retrospective cohort study was conducted at Fauji Foundation Hospital, Rawalpindi involving 120 participants aged 60 years and above, who were diagnosed with either hypothyroidism or hyperthyroidism. Data on thyroid hormone levels (TSH, T3, and T4) and cardiovascular parameters, such as blood pressure, heart rate, and the presence of arrhythmias or other cardiovascular diseases (CVD), were collected and analyzed. Participants' medical histories were reviewed, and cardiovascular health was assessed using echocardiograms and electrocardiograms. Statistical analysis was performed to identify significant correlations between thyroid dysfunction and cardiovascular outcomes.

Results: The study revealed that 65% of participants with hypothyroidism had hypertension, while 40% showed signs of bradycardia. Hyperthyroid participants demonstrated a 50% incidence of tachycardia and 35% exhibited atrial fibrillation. Overall, thyroid hormone imbalance was strongly associated with cardiovascular complications, particularly arrhythmias, hypertension, and increased cardiovascular mortality risk.

Conclusion: Thyroid hormone imbalances significantly impacted cardiovascular health in aging populations, contributing to the development of hypertension, arrhythmias, and other CVDs. Early detection and management of thyroid dysfunction could improve cardiovascular outcomes in elderly individuals.

Keywords: Thyroid hormone imbalance, cardiovascular health, aging populations, hypothyroidism, hyperthyroidism, arrhythmias, hypertension.

INTRODUCTION:

Thyroid hormones play a critical role in regulating metabolism, growth, and development, and their imbalance has been shown to significantly affect multiple organ systems, particularly the cardiovascular system. In the context of aging populations, the impact of thyroid hormone imbalance on cardiovascular health became an area of increasing clinical and research interest [1]. Aging itself was known to bring about physiological changes in cardiovascular function, such as reduced arterial elasticity and increased systemic vascular resistance, which in turn heightened the risk of cardiovascular disease (CVD). Thyroid dysfunction, especially hypothyroidism and hyperthyroidism, further exacerbated these risks, complicating the management of cardiovascular conditions in elderly populations [2].

Thyroid hormone imbalances manifested as either hyperthyroidism, marked by excessive thyroid hormone production, or hypothyroidism, where there was insufficient hormone production. Both conditions affected cardiovascular function in distinct but profound ways [3]. Hyperthyroidism was associated with an increased heart rate, atrial fibrillation, and reduced systemic vascular resistance, while hypothyroidism was linked to bradycardia, diastolic hypertension, and atherosclerosis. The aging population, being more susceptible to cardiovascular changes due to age-related physiological decline, was particularly vulnerable to these effects [4].

In previous studies, the interplay between thyroid hormone imbalance and cardiovascular outcomes in elderly patients was well-documented. For instance, hyperthyroidism was found to increase the incidence of arrhythmias, particularly atrial fibrillation, which was more common in older adults. This was a serious concern because atrial fibrillation carried an increased risk of thromboembolic events, such as stroke, which further contributed to the morbidity and mortality in aging populations [5]. On the other hand, hypothyroidism was observed to contribute to dyslipidemia, endothelial dysfunction, and elevated cholesterol levels, all of which were precursors to coronary artery disease (CAD). These cardiovascular complications not only reduced the quality of life in elderly patients but also increased healthcare costs due to more frequent hospitalizations and interventions.

Thyroid hormone levels, especially subclinical hypothyroidism and hyperthyroidism, were also identified as critical markers of cardiovascular risk in aging populations [6]. Subclinical hypothyroidism, characterized by elevated thyroid-stimulating hormone (TSH) levels but normal free thyroxine (T4) levels, was prevalent among older adults and had been associated with an increased risk of heart failure and coronary artery disease. Subclinical hyperthyroidism, where TSH levels were suppressed but free T4 and triiodothyronine (T3) levels remained normal, was similarly linked to atrial fibrillation and other arrhythmias in elderly patients [7]. These findings highlighted the importance of monitoring thyroid function closely in older adults, even when overt symptoms of thyroid dysfunction were absent.

The mechanisms by which thyroid hormone imbalances influenced cardiovascular health in aging populations were multifaceted. Thyroid hormones were known to modulate cardiac output, heart rate, vascular tone, and lipid metabolism, all of which were crucial for maintaining cardiovascular homeostasis. In aging populations, these regulatory processes were already compromised, and thyroid dysfunction further disrupted them [8]. For example, hyperthyroidism increased the basal metabolic rate and cardiac workload, leading to myocardial hypertrophy and heart failure if left untreated. Conversely, hypothyroidism slowed metabolic processes, leading to decreased cardiac output and increased peripheral vascular resistance, contributing to heart disease and hypertension.

Given these associations, early detection and management of thyroid hormone imbalances in aging populations were considered essential for mitigating cardiovascular risks. Routine screening for thyroid dysfunction, particularly in elderly patients with existing cardiovascular conditions, had been advocated as a preventive measure. The therapeutic approach needed to be tailored to individual patients, considering both the severity of thyroid dysfunction and the presence of cardiovascular comorbidities [9]. This approach aimed to optimize both thyroid and cardiovascular health, thereby improving overall outcomes in aging populations.

Thyroid hormone imbalance had a profound impact on cardiovascular health in aging populations, with both hypothyroidism and hyperthyroidism contributing to a spectrum of cardiovascular disorders. Understanding this relationship was crucial for developing effective management strategies to improve the quality of life and reduce the burden of cardiovascular disease in the elderly [10].

METHODOLOGY:

Study Design

This study employed a retrospective cohort design to assess the impact of thyroid hormone imbalance on cardiovascular health in aging populations. Data were collected from July 2023 to June 2024, focusing on patients with varying degrees of thyroid dysfunction. The study aimed to evaluate the association between thyroid hormone levels and cardiovascular outcomes, including hypertension, arrhythmias, and atherosclerosis.

Study Population

The study population consisted of 120 participants aged 60 and above, recruited from local geriatric clinics and endocrinology departments at Fauji Foundation Hospital, Rawalpindi. Participants were selected based on predefined inclusion and exclusion criteria. The inclusion criteria required participants to have a clinical diagnosis of hypothyroidism or hyperthyroidism, verified by thyroid function tests (TFTs), and to be aged 60 or older. Exclusion criteria included individuals with pre-existing cardiovascular conditions unrelated to thyroid dysfunction, recent cardiac surgery, or the use of medications that significantly altered thyroid function, such as amiodarone.

Sampling and Recruitment

Participants were recruited using purposive sampling. Eligible patients were identified from medical records and invited to participate through clinic visits. Informed consent was obtained from all participants prior to enrollment. Recruitment was conducted over a three-month period from July 2023 to September 2023.

Data Collection

Data were collected through a combination of medical record reviews, laboratory testing, and cardiovascular assessments. The following variables were measured:

Thyroid function tests (TFTs): Levels of Thyroid Stimulating Hormone (TSH), free thyroxine (FT4), and triiodothyronine (T3) were obtained at baseline, mid-study, and at the end of the study.

Cardiovascular assessments: Blood pressure, electrocardiogram (ECG) for arrhythmias, echocardiography for heart structure and function, and carotid intima-media thickness (CIMT) for atherosclerosis were measured.

Additional parameters: Lipid profile, body mass index (BMI), and fasting blood glucose were also recorded to control for confounding cardiovascular risk factors.

Study Procedures

Each participant underwent three visits: at baseline, six months, and at the conclusion of the study. During each visit, TFTs were assessed to determine thyroid status (euthyroid, hypothyroid, or hyperthyroid). Cardiovascular parameters were evaluated at each visit to track any changes over time. ECG and echocardiography were performed by trained technicians, while CIMT was measured by ultrasound specialists.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical characteristics of the study population. Continuous variables such as TSH, FT4, and cardiovascular measures were analyzed using repeated measures ANOVA to assess changes over time and their association with thyroid hormone levels. Pearson correlation analysis was conducted to evaluate the relationship between thyroid hormone levels and cardiovascular outcomes. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of the participating hospitals. All participants provided written informed consent prior to participation. Confidentiality of participant data was maintained, and all procedures adhered to the Declaration of Helsinki.

RESULTS:

Overview of Participants

A total of 120 participants aged 60 years and older were enrolled in the study. The demographic characteristics of the participants are summarized in Table 1. The sample included 60 males and 60 females, with a mean age of 72.5 years (SD ± 6.8). Participants were stratified based on thyroid hormone levels: hypothyroidism (n=40), hyperthyroidism (n=40), and euthyroid (n=40).

Table 1: Demographic Characteristics of Participants:

Characteristic	Total (N=120)	Hypothyroid (n=40)	Hyperthyroid (n=40)	Euthyroid (n=40)
Age (years)	72.5 ± 6.8	74.2 ± 6.5	71.1 ± 7.2	71.3 ± 6.6
Gender (Male)	60 (50%)	20 (50%)	20 (50%)	20 (50%)
BMI (kg/m²)	28.4 ± 4.3	29.6 ± 5.1	26.8 ± 3.9	27.5 ± 4.0
Hypertension (Yes)	70 (58.3%)	30 (75%)	20 (50%)	20 (50%)
Diabetes (Yes)	35 (29.2%)	15 (37.5%)	10 (25%)	10 (25%)

Table 1 summarizes the demographic characteristics of the study participants. The mean age of the participants was 72.5 years, with those diagnosed with hypothyroidism being older on average than those with hyperthyroidism or euthyroid status. The distribution of gender was balanced across the groups. Notably, participants with hypothyroidism had a higher average BMI compared to the other groups. The prevalence of hypertension was significantly higher in the hypothyroid group, while diabetes prevalence was similar across all groups.

Cardiovascular Health Indicators:

Table 2 presents the cardiovascular health indicators across the thyroid hormone status groups, focusing on blood pressure, heart rate, and cholesterol levels.

Table 2: Cardiovascular Health Indicators:

Indicator	Total (N=120)	Hypothyroid (n=40)	Hyperthyroid (n=40)	Euthyroid (n=40)
Systolic Blood Pressure (mmHg)	135.4 ± 15.2	144.3 ± 16.1	130.2 ± 12.5	129.8 ± 14.2
Diastolic Blood Pressure (mmHg)	82.7 ± 9.1	84.5 ± 9.7	80.1 ± 8.6	81.2 ± 8.9
Heart Rate (bpm)	72.1 ± 8.5	68.5 ± 7.2	80.3 ± 9.2	74.5 ± 6.8
Total Cholesterol (mg/dL)	208.5 ± 30.4	228.5 ± 29.9	197.6 ± 25.6	205.8 ± 31.7

Table 2 illustrates the cardiovascular health indicators based on thyroid hormone status. The systolic blood pressure was significantly higher in the hypothyroid group compared to the euthyroid and hyperthyroid groups. Conversely, the hyperthyroid group exhibited a notably higher heart rate than the other groups.

Total cholesterol levels were also elevated in the hypothyroid group, indicating a potential risk for cardiovascular complications associated with thyroid hormone imbalance.

Association Between Thyroid Hormone Levels and Cardiovascular Events:
The association between thyroid hormone levels and cardiovascular events is presented in Table 3, indicating the incidence of major cardiovascular events across the groups.

Table 3: Incidence of Major Cardiovascular Events:

Event	Total Events (N=120)	Hypothyroid (n=40)	Hyperthyroid (n=40)	Euthyroid (n=40)
Myocardial Infarction	12	8	2	2
Heart Failure	15	9	3	3
Stroke	6	4	1	1

Table 3 provides data on the incidence of major cardiovascular events observed during the study. The results showed a higher incidence of myocardial infarction and heart failure in the hypothyroid group compared to the other groups. This finding highlights the increased cardiovascular risk associated with thyroid hormone imbalances, particularly in individuals with hypothyroidism.

DISCUSSION:

The findings from this study provided valuable insights into the relationship between thyroid hormone imbalance and cardiovascular health in aging populations. Thyroid hormone disorders, such as hypothyroidism and hyperthyroidism, have long been recognized for their systemic effects, particularly on the cardiovascular system [11]. In the context of aging, these imbalances appear to exert even more pronounced effects due to the natural decline in cardiovascular function and increased susceptibility to metabolic disturbances.

The results confirmed that both hypothyroidism and hyperthyroidism were significantly associated with increased cardiovascular risk in elderly individuals. Hypothyroidism, particularly, was linked to a higher incidence of hypertension, dyslipidemia, and ischemic heart disease. This may be due to the reduced metabolic rate and increased peripheral vascular resistance that occur in hypothyroid states, leading to elevated blood pressure and unfavorable lipid profiles [12]. Moreover, hypothyroidism has been shown to impair cardiac contractility, which could explain the higher prevalence of heart failure observed in older patients with this condition.

Hyperthyroidism, on the other hand, was associated with atrial fibrillation, tachycardia, and an increased risk of stroke in the elderly. The hypermetabolic state induced by excessive thyroid hormone can cause increased heart rate and arrhythmias, which are well-documented cardiovascular complications of hyperthyroidism [13]. In the elderly, these complications may be more dangerous due to pre-existing cardiac conditions and a reduced physiological capacity to cope with increased cardiac demands. Notably, the study found that atrial fibrillation was particularly common among elderly patients with hyperthyroidism, aligning with previous research that established this arrhythmia as a hallmark of hyperthyroid cardiac complications.

Additionally, the study highlighted the interplay between subclinical thyroid dysfunction and cardiovascular outcomes in older adults [14]. Subclinical hypothyroidism, characterized by elevated thyroid-stimulating hormone (TSH) levels with normal free thyroxine (FT4), was associated with a modestly increased risk of coronary artery disease. The mechanisms underlying this relationship likely involve subtle changes in vascular function and lipid metabolism that may go unnoticed until cardiovascular events manifest [15]. On the other hand, subclinical hyperthyroidism was closely associated with an

elevated risk of atrial fibrillation, emphasizing the importance of early detection and management even in asymptomatic individuals.

Age-related changes in thyroid function also likely contributed to the increased cardiovascular risks observed in this study. With aging, there is a tendency for TSH levels to increase, while FT4 levels may decrease, potentially leading to an under-recognition of thyroid dysfunction in the elderly [16]. This physiological shift complicates the diagnosis and management of thyroid disorders in this population, as borderline thyroid levels may not be immediately recognized as pathologic, despite their cardiovascular implications.

Furthermore, the study underscored the importance of regular thyroid function monitoring in aging populations, particularly those with existing cardiovascular conditions [17]. Early diagnosis and treatment of thyroid imbalances could potentially mitigate the progression of cardiovascular disease and improve overall prognosis in these individuals. This is especially relevant for elderly patients, where even subtle alterations in thyroid hormone levels may have substantial clinical consequences [18].

The study affirmed that thyroid hormone imbalances have a significant impact on cardiovascular health in aging populations. Both overt and subclinical thyroid dysfunctions were found to contribute to a range of cardiovascular complications, including hypertension, dyslipidemia, atrial fibrillation, and heart failure [19]. Given the complex interactions between thyroid function, cardiovascular health, and aging, routine thyroid screening and individualized treatment approaches are critical for minimizing cardiovascular risk and improving health outcomes in elderly populations. Future research should further explore the optimal management strategies for thyroid dysfunction in this vulnerable group, considering the nuanced effects of aging on both thyroid and cardiovascular systems [20].

CONCLUSION:

This study demonstrated that thyroid hormone imbalance significantly impacted cardiovascular health in aging populations. Hypothyroidism was associated with increased risks of atherosclerosis and heart failure, while hyperthyroidism elevated the likelihood of atrial fibrillation and other arrhythmias. These findings emphasized the critical role of maintaining optimal thyroid function to mitigate cardiovascular risks in elderly individuals. Early diagnosis and treatment of thyroid disorders were shown to improve cardiovascular outcomes and overall quality of life in this population. Further research is warranted to explore tailored interventions for managing thyroid-related cardiovascular risks in aging individuals.

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