

# The Role of Thyroid Hormones in Cardiovascular Health

Pieter Melnichenko\*

Department of Biological Sciences, University of Campania "L. Vanvitelli", 81100 Caserta, Italy

## Introduction

Thyroid hormones, primarily Thyroxine (T4) and Triiodothyronine (T3), play a vital role in regulating various physiological processes, including metabolism, growth, and development. Beyond these well-known functions, thyroid hormones are also crucial in maintaining cardiovascular health. The heart and vascular system are highly responsive to thyroid hormone levels, which influence cardiac output, heart rate, vascular resistance, and overall cardiovascular function [1]. Both hyperthyroidism (excess thyroid hormone) and hypothyroidism (insufficient thyroid hormone) can lead to significant cardiovascular complications, underscoring the importance of maintaining thyroid hormone balance for optimal heart health. These hormones, produced by the thyroid gland, also play a crucial role in cardiovascular health, impacting the heart and vascular system. The balance of thyroid hormones is essential for maintaining normal cardiovascular function, as both excess and deficiency can lead to significant cardiac and vascular abnormalities. The intricate relationship between thyroid function and cardiovascular health has been the subject of extensive research, revealing that thyroid hormones influence heart rate, cardiac output, vascular resistance, and overall cardiovascular function. Understanding this relationship is vital for early detection and management of thyroid-related cardiovascular disorders.

## Description

Thyroid hormones exert their effects on the cardiovascular system through genomic and non-genomic mechanisms. Genomic actions involve the regulation of gene expression, which influences cardiac myocyte function, while non-genomic actions affect cellular processes such as ion channel function and mitochondrial activity [2]. These hormones increase heart rate (chronotropy), enhance the force of cardiac contraction (inotropy), and improve diastolic relaxation (lusitropy), leading to increased cardiac output. Hyperthyroidism is characterized by elevated levels of thyroid hormones, resulting in increased heart rate, heightened myocardial contractility, and reduced systemic vascular resistance. This condition can lead to tachycardia, atrial fibrillation, and even heart failure if left untreated. Conversely, hypothyroidism, marked by low levels of thyroid hormones, results in bradycardia, reduced cardiac output, and increased systemic vascular resistance. Patients with hypothyroidism are at risk of developing hypertension, atherosclerosis, and other cardiovascular diseases. Thyroid hormones also influence lipid metabolism, with hypothyroidism often associated with elevated cholesterol levels and hyperthyroidism with reduced cholesterol levels. Thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3), play a pivotal role in regulating cardiovascular health through their profound effects on cardiac function, vascular tone, and overall hemodynamics.

These hormones influence heart rate, myocardial contractility, blood pressure, and vascular resistance, thus maintaining cardiovascular homeostasis. T3, the active form of thyroid hormone, exerts its effects by

binding to Thyroid hormone Receptors (TRs) in various tissues, including the heart and vascular system [3]. In the myocardium, T3 enhances the expression of genes involved in calcium cycling and contractile proteins, leading to increased heart rate and force of contraction. This results in improved cardiac output and efficiency. Additionally, T3 modulates the expression of beta-adrenergic receptors, enhancing the heart's responsiveness to sympathetic stimulation. In the vascular system, thyroid hormones promote vasodilation by increasing the production of nitric oxide and reducing systemic vascular resistance. They also influence lipid metabolism, reducing levels of Low-Density Lipoprotein (LDL) cholesterol and triglycerides, which are beneficial for vascular health. Deregulation of thyroid hormone levels can lead to significant cardiovascular consequences. Hypothyroidism, characterized by low levels of thyroid hormones, is associated with bradycardia, reduced myocardial contractility, increased systemic vascular resistance, and diastolic hypertension.

It can also lead to elevated levels of LDL cholesterol and triglycerides, contributing to atherosclerosis and increased cardiovascular risk. Conversely, hyperthyroidism, marked by elevated thyroid hormone levels, can cause tachycardia, increased myocardial contractility, and decreased systemic vascular resistance, potentially leading to atrial fibrillation, heart failure, and increased risk of thromboembolism. Both hypo- and hyperthyroidism can result in alterations in blood pressure regulation and cardiac rhythm abnormalities [4]. The interplay between thyroid hormones and cardiovascular function underscores the importance of maintaining euthyroid status for optimal cardiovascular health. Moreover, subclinical thyroid dysfunction, where hormone levels are within normal ranges but TSH is abnormal, can also impact cardiovascular outcomes. Subclinical hypothyroidism, for instance, is linked to increased arterial stiffness and endothelial dysfunction, while subclinical hyperthyroidism is associated with a higher risk of atrial fibrillation and heart failure. Emerging evidence suggests that even minor deviations in thyroid hormone levels can have significant cardiovascular implications, highlighting the need for vigilant monitoring and management of thyroid function in patients with cardiovascular disease.

Advances in our understanding of the molecular mechanisms underlying thyroid hormone action have opened new avenues for therapeutic interventions [5]. Novel approaches aim to selectively target TRs in the cardiovascular system to harness the beneficial effects of thyroid hormones while minimizing adverse effects. For example, TR-beta selective agonists are being explored for their potential to lower cholesterol levels without inducing hyperthyroidism-related cardiac effects. These innovations hold promise for improving cardiovascular outcomes in patients with thyroid dysfunction. These changes in lipid profiles further impact cardiovascular risk. Additionally, thyroid hormone imbalances can affect endothelial function, vascular smooth muscle cell proliferation, and the overall health of the vascular system.

## Conclusion

Thyroid hormones play a pivotal role in cardiovascular health, influencing heart rate, cardiac contractility, vascular resistance, and lipid metabolism. Both hyperthyroidism and hypothyroidism are associated with significant cardiovascular risks, highlighting the importance of maintaining thyroid hormone homeostasis. Understanding the intricate relationship between thyroid function and cardiovascular health is essential for the early detection and management of thyroid-related cardiovascular disorders. Thyroid hormones are integral to cardiovascular health, influencing heart rate, myocardial contractility, vascular resistance, and lipid metabolism. The delicate balance of thyroid hormone levels is crucial for maintaining

\*Address for Correspondence: Pieter Melnichenko, Department of Biological Sciences, University of Campania "L. Vanvitelli", 81100 Caserta, Italy; E-mail: pieter@melnichenko.it

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cardiovascular homeostasis, with both hypothyroidism and hyperthyroidism leading to significant cardiac and vascular complications. Advances in our understanding of the molecular mechanisms of thyroid hormone action and the development of targeted therapies promise improved management of cardiovascular risks associated with thyroid dysfunction. Maintaining euthyroid status through vigilant monitoring and appropriate treatment is essential for optimizing cardiovascular health and preventing the adverse outcomes associated with thyroid hormone imbalances.

As research continues to uncover the intricate relationships between thyroid function and cardiovascular health, tailored therapeutic strategies that leverage the beneficial effects of thyroid hormones while mitigating risks will enhance patient care and outcomes. On-going research into the molecular mechanisms of thyroid hormone action on the cardiovascular system promises to uncover new therapeutic targets and strategies to improve cardiovascular outcomes in patients with thyroid dysfunction. The interplay between thyroid health and cardiovascular well-being underscores the need for integrated care approaches to optimize both thyroid and heart health.

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None.

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## Conflict of Interest

None.

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