

Application Research on Hemodynamic and Metabolic Abnormalities in Patients with Subclinical Hypothyroidism

Juan Luo, Jiaqi Chen, Jingfeng Li, Nengwen Lin

Loudi Central Hospital, Loudi 417000, Hunan, China

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Objective: To explore the clinical application value of abnormal hemodynamic and metabolic indicators in patients with subclinical hypothyroidism (SCH), and to provide clinical evidence for early intervention of SCH and prevention of cardiovascular complications. Methods: A total of 40 SCH patients were enrolled as the study group (Group 1), and another 40 subjects with normal thyroid function were selected as the control group (Group 0). General clinical data (gender, age, height, weight) and hemodynamic indicators (epicardial adipose tissue thickness, aortic pulse wave velocity, carotid intima-media thickness) were collected, respectively. The differences of each indicator between the two groups were compared, and the correlation among indicators was analyzed by statistical methods. Results: The thickness of epicardial adipose tissue and carotid intima-media thickness in the study group were significantly higher than those in the control group ($p < 0.05$), while the aortic pulse wave velocity was significantly lower ($p < 0.05$). The body mass index (BMI) of the study group was higher than that of the control group, with more middle-aged and older adults and a higher female proportion. Conclusion: SCH patients present obvious hemodynamic disturbance and metabolic imbalance. Epicardial adipose tissue thickness, aortic pulse wave velocity, and carotid intima-media thickness can be used as indicators to evaluate cardiovascular risk in SCH patients. Early monitoring and intervention of the above indicators are beneficial for improving patients' prognosis.

Keywords: Subclinical hypothyroidism; Hemodynamics; Metabolic abnormalities

Online publication: Jun 30, 2026

1. Introduction

Subclinical hypothyroidism (SCH) is an endocrine and metabolic disorder characterized by elevated serum thyroid-stimulating hormone (TSH) levels, normal serum free thyroxine (FT4) levels, and the absence of typical clinical manifestations of hypothyroidism. In recent years, with the development of thyroid function detection technology, the detection rate of SCH has increased year by year. The prevalence rate in the general population ranges from 4% to 10%, rising with age and positive thyroid autoantibodies, and the prevalence in

females is significantly higher than that in males ^[1].

Although SCH has no obvious clinical symptoms, long-term mild thyroid dysfunction can affect body metabolism and blood circulation through multiple pathways, resulting in a series of health problems. Existing studies have shown that SCH is associated with lipid metabolic disorder, atherosclerosis, and cardiovascular diseases. The potential mechanism is that elevated TSH impairs vascular endothelial function, enhances oxidative stress, and increases low-density lipoprotein synthesis, thereby causing hemodynamic abnormalities and metabolic imbalance, and increasing the risk of coronary heart disease, heart failure, and other cardiovascular events ^[2].

Hemodynamic indicators are non-invasive parameters for evaluating vascular lesions and cardiac structure and function. Increased carotid intima-media thickness is an early marker of atherosclerosis; increased epicardial adipose tissue thickness is related to abnormal cardiac metabolism; decreased aortic pulse wave velocity suggests reduced vascular elasticity ^[3].

2. Materials and methods

2.1. Research subjects

From August 2020 to August 2023, 40 inpatients and outpatients diagnosed with SCH in our hospital were selected as the experimental group (Group 1), and 40 healthy subjects with normal thyroid function undergoing physical examination during the same period were enrolled as the control group (Group 0). All participants signed informed consent, and this study was approved by the Ethics Committee of Loudi Central Hospital ^[4].

Inclusion criteria: Meeting the diagnostic criteria of SCH; serum TSH > 6.8 mIU/L; FT4 within the normal reference range; no typical hypothyroidism symptoms such as fatigue, cold intolerance, and weight gain. Referring to the 2023 clinical guidelines of the Korean Thyroid Association, patients with a personal or family history of thyroid diseases were excluded ^[5].

General baseline data of the two groups: Study group (Group 1): 28 females and 12 males; aged 18–45 years, mean age (36.8 ± 7.2) years; height 157–175 cm, mean (161.3 ± 5.8) cm; weight 47–70 kg, mean (56.9 ± 6.3) kg. Control group (Group 0): 26 females and 14 males; aged 22–47 years, mean age (35.6 ± 8.1) years; height 158–175 cm, mean (162.5 ± 6.1) cm; weight 48–65 kg, mean (55.7 ± 5.9) kg ^[6].

There was no significant difference in general data (gender, age, height, weight) between the two groups ($p > 0.05$), indicating comparable baseline conditions.

2.2. Research methods

First, general data collection: Electronic medical records and physical examination reports were used to collect gender, age, height, weight, outpatient number, and follow-up times. BMI was calculated as:

$$\text{BMI} = \text{weight (kg)} / \text{height squared (m}^2\text{)}.$$

Second, hemodynamic index detection: All subjects were examined under a fasting state after 30 minutes of quiet rest, without strenuous exercise, emotional fluctuation, smoking, or drinking. Qualified sonographers performed color Doppler ultrasonography. Epicardial adipose tissue thickness: measured at end-diastole in parasternal long-axis view, averaged from 3 measuring points; Aortic pulse wave velocity: averaged from three measurements of ascending aortic blood flow velocity; Carotid intima-media thickness: averaged from 1–2 cm proximal to the bifurcation of bilateral common carotid arteries ^[7].

All detections were performed in strict accordance with ultrasonic specifications to ensure accuracy.

Third, thyroid function detection: Fasting venous blood 5 mL was collected, and serum was separated after centrifugation. Serum TSH and FT4 levels were determined by chemiluminescence immunoassay. Instruments and reagents met clinical standards, and operations followed manufacturer instructions strictly to ensure reliable results [8].

2.3. Statistical methods

SPSS 26.0 statistical software was adopted for data analysis. Measurement data were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$), and an independent sample t-test was used for inter-group comparison; enumeration data were expressed as percentage (%), and a Chi-square (χ^2) test was applied; Pearson correlation analysis was used for correlation analysis. $p < 0.05$ was considered statistically significant [9].

3. Results

3.1. Comparison of thyroid function indicators between two groups

The serum TSH level of the study group was significantly higher than that of the control group, while FT4 was significantly lower ($p < 0.05$), consistent with SCH diagnostic criteria.

Study group: TSH (8.92 ± 2.15) mIU/L, FT4 (11.25 ± 1.36) pmol/L;

Control group: TSH (3.85 ± 1.02) mIU/L, FT4 (13.68 ± 1.52) pmol/L.

3.2. Comparison of hemodynamic indicators between two groups

The study group had significantly greater epicardial adipose tissue thickness and carotid intima-media thickness, and significantly lower aortic pulse wave velocity than the control group ($p < 0.001$) [10]. See Table 1.

Table 1. Comparison of hemodynamic indicators between two groups

Group	Case number	Epicardial adipose tissue thickness (cm)	Aortic pulse wave velocity (cm/s)	Carotid intima-media thickness (cm)
Study group (Group 1)	40	0.243 ± 0.058	42.85 ± 8.62	0.235 ± 0.061
Control group (Group 0)	40	0.201 ± 0.047	56.93 ± 9.15	0.138 ± 0.052
<i>t</i> value	—	3.825	-6.732	8.157
<i>p</i> value	—	< 0.001	< 0.001	< 0.001

3.3. Comparison of general metabolic indicators between two groups

The BMI of the study group was (21.8 ± 3.2) kg/m², significantly higher than (20.7 ± 2.8) kg/m² of the control group ($p < 0.05$).

In age distribution, the study group was mainly aged 35–45 years (65.0%, 26/40), while the control group was mainly aged 25–35 years (60.0%, 24/40). The female proportion was 70.0% (28/40) in the study group and 65.0% (26/40) in the control group. There was no statistical difference in gender and age distribution ($p > 0.05$), but the proportions of middle-aged and elderly population, as well as females, were slightly higher in the study group.

4. Discussion

SCH is an early stage of hypothyroidism, mainly characterized by elevated TSH and normal FT4 without typical clinical symptoms. Long-term mild thyroid dysfunction can affect metabolic level and hemodynamic stability, and increase the risk of cardiovascular diseases ^[11]. By comparing indicators between SCH patients and euthyroid subjects, this study confirmed obvious metabolic abnormalities and hemodynamic disturbances in SCH patients, which are consistent with previous research findings.

SCH patients had higher body weight and BMI, indicating that SCH is closely related to metabolic disorders. The possible mechanism is that elevated TSH reduces basal metabolic rate and energy consumption, and regulates adipocyte differentiation and lipid metabolism to cause fat accumulation, thus increasing BMI ^[12]. In addition, SCH is often accompanied by lipid metabolism disorder with elevated total cholesterol and triglyceride levels, which supports the elevated BMI result in this study and indicates that metabolic abnormality is an important feature of SCH associated with increased cardiovascular risk.

In terms of hemodynamic abnormalities, SCH patients showed increased epicardial adipose tissue thickness and carotid intima-media thickness, as well as decreased aortic pulse wave velocity, which were correlated with TSH levels. Epicardial adipose tissue can secrete inflammatory factors; its thickening is associated with cardiac metabolic disorder and inflammatory response, affecting myocardial blood supply, inducing cardiac hypofunction, and increasing heart failure risk ^[13]. Carotid intima-media thickness is an early sensitive marker of atherosclerosis. Elevated TSH upregulates inflammatory adhesion molecules in vascular endothelial cells, inhibits nitric oxide synthase activity, damages endothelial function, and accelerates atherosclerotic progression. Reduced aortic pulse wave velocity indicates decreased vascular elasticity and increased arterial stiffness, raising the risk of cardiovascular events.

Correlation analysis showed that TSH level was positively correlated with epicardial adipose tissue thickness and carotid intima-media thickness, and negatively correlated with aortic pulse wave velocity, suggesting that elevated TSH is one of the causes of hemodynamic abnormalities in SCH patients ^[14]. The underlying mechanism may be that increased TSH activates the sympathetic nervous system, raises vascular resistance, and reduces vascular elasticity; meanwhile, it triggers an inflammatory response and oxidative stress to damage endothelial function and alter hemodynamic indicators. Metabolic disorders such as fat accumulation induced by high TSH further affect hemodynamic stability, forming a vicious cycle.

Epidemiological studies show that SCH prevalence is higher in females and middle-aged/elderly populations, which is consistent with the demographic characteristics in this study. Regular monitoring of thyroid function and hemodynamic indicators should be strengthened for high-risk groups. It is also found that SCH patients with TSH > 10 mIU/L have significantly increased cardiovascular risk. The average TSH of the study group was 8.92 ± 2.15 mIU/L (mild SCH), but obvious hemodynamic abnormalities were already present, suggesting that early intervention is necessary even for mild SCH.

5. Conclusion

SCH patients are characterized by increased epicardial adipose tissue thickness and carotid intima-media thickness, decreased aortic pulse wave velocity, and higher BMI compared with euthyroid individuals. Serum TSH level is correlated with hemodynamic indicators and serves as an important influencing factor of hemodynamic stability in SCH patients ^[15].

Epicardial adipose tissue thickness, aortic pulse wave velocity, and carotid intima-media thickness can be used as non-invasive indicators to evaluate cardiovascular risk in SCH patients. Early monitoring of thyroid function and the above hemodynamic indicators, together with timely intervention on metabolic and hemodynamic abnormalities, can reduce cardiovascular complications and improve prognosis. Thyroid function screening should be carried out among high-risk populations such as females and middle-aged/older adults to realize early detection and intervention and improve clinical diagnosis and treatment efficacy.

Funding

Hunan Natural Science Foundation (Project No.: 2024JJ7424, 2026JJ80373); Fund of Loudi Municipal Bureau of Science and Technology (Project No.: 2024-17); 2025 Hospital-Level Research Fund of Loudi Central Hospital (Project No.: Loudi City Y2025-24)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Jiang Q, 2025, Therapeutic Effect of Levothyroxine in Subclinical Hypothyroidism Patients Complicated with Cardiovascular Diseases. *Chinese Journal of Practical Medicine*, 20(22): 90–92.
- [2] Han X, 2025, Analysis of TCM Syndrome Elements and Prognostic Influence of Heart Failure with Preserved Ejection Fraction Complicated with Subclinical Hypothyroidism, thesis, Tianjin University of Traditional Chinese Medicine.
- [3] Wang L, 2025, Correlation Study on Gut Microbiota Characteristics in Type 2 Diabetes Mellitus Combined with Subclinical Hypothyroidism, thesis, Ningxia Medical University.
- [4] Zhang Y, 2024, Effects of Gestational Subclinical Hypothyroidism on Fetal Cardiac Function and Peripheral Vascular Hemodynamics, thesis, Kunming Medical University.
- [5] Yi L, 2024, Clinical Study of Tongyuan Acupuncture on Pregnancy Outcome of Recurrent Implantation Failure Patients with Subclinical Hypothyroidism, thesis, Guangzhou University of Chinese Medicine.
- [6] Zhang X, 2024, Lesion Characteristics and TCM Syndrome Features of Coronary Heart Disease Complicated with Subclinical Hypothyroidism, thesis, Tianjin University of Traditional Chinese Medicine.
- [7] Zou J, 2024, Influence of Sleep Disorders on Bone Mineral Density in Patients With Subclinical Hypothyroidism, thesis, Lanzhou University.
- [8] Hou L, 2023, Influence of TSH Level on Coronary Artery Lesions and Thromboembolic Events in Coronary Heart Disease Patients with Subclinical Hypothyroidism, thesis, Jining Medical University.
- [9] Xi X, Hou T, Wang H, et al., 2022, Meta-Analysis of the Relationship Between Subclinical Hypothyroidism and Prognosis in Patients with Chronic Systolic Heart Failure. *Clinical Focus*, 37(10): 905–911.
- [10] Zhang X, 2022, Treatment Strategy of Chronic Heart Failure Combined with Subclinical Hypothyroidism, thesis, Peking Union Medical College.
- [11] Bai M, Muyaier M, Liu H, et al., 2022, Relationship Between Subclinical Hypothyroidism and Central Aortic Pressure-Related Indices as Well as Pulse Wave Velocity in Essential Hypertension Patients. *Journal of Clinical Cardiology*, 38(04): 318–322.

- [12] Liu Y, 2022, Influence of Subclinical Hypothyroidism on Prognosis and Risk Factors in Elderly Patients After Percutaneous Coronary Intervention, thesis, Hebei Medical University.
- [13] Bai M, 2022, Correlation Between Subclinical Hypothyroidism and Central Aortic Pressure Indexes and Pulse Wave Velocity in Essential Hypertension Patients, thesis, Xinjiang Medical University.
- [14] Zhou X, 2021, CCTA Study on Coronary Atherosclerotic Plaque Characteristics in Patients with Subclinical Hypothyroidism, thesis, Sichuan University.
- [15] Yang Z, 2021, Influence of Subclinical Hypothyroidism on Acute Kidney Injury After Emergency Coronary Intervention in Patients with Acute Coronary Syndrome, thesis, Southeast University.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.