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RESEARCH ARTICLE
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A COMPARATIVE STUDY ON THE EFFECTS OF ISOMETRIC AND ISOTONIC EXERCISE ON THYROID PROFILE OF PATIENT HAVING SUBCLINICAL THYROID DYSFUNCTION

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ABSTRACT

Background: Metabolism and energy balance are centrally regulated via thyroid hormones (T3, T4, TSH). Subclinical thyroid dysfunction can be characterized in terms of abnormal TSH along with normal T3 and T4 levels. It is increasingly more common especially within women and within older adults. While pharmacological management is standard, nonpharmacological interventions such as exercise may improve thyroid profiles and delay hormone replacement therapy.

Objective: To evaluate and compare the effects of isotonic (dynamic) and isometric (static) exercise on thyroid hormone profiles (T3, T4, and TSH) in patients with subclinical thyroid dysfunction.

Methods: This study included 50 patients (aged 21–55 years) diagnosed with subclinical thyroid dysfunction at LLRM Medical College, Meerut. Participants were randomized into two groups: Group A performed isotonic exercise (20–30 min daily), and Group B performed isometric exercise (20–30 min daily), both for 30 days. Thyroid function tests (serum T3, T4, TSH) were measured at rest and post-intervention. Statistical analysis included paired t-tests.

Results: The result suggest patients with subclinical thyroid dysfunction, both isotonic and isometric forms of exercise produced a significant rise in serum T_3 and T_4 concentrations compared to the resting state, whereas changes in TSH levels were statistically insignificant.

Conclusion: Isotonic exercise is more effective than isometric exercise in improving thyroid hormone regulation, enhancing T3 and T4, and reducing TSH in patients with subclinical thyroid dysfunction. Incorporating isotonic exercise into lifestyle modification strategies may serve as a valuable adjunct therapy in thyroid disorder management, while isometric training can play a supplementary role in maintaining muscle strength.

Keywords: Thyroid dysfunction, Subclinical hypothyroidism, Subclinical hyperthyroidism, Isotonic exercise, Isometric exercise.

INTRODUCTION

Thyroid disorders are conditions related to the thyroid gland, it is a butterfly shape gland which is located at the front of the neck. The thyroid is critical in the regulation of metabolic processes in different parts of the body. The thyroid gland is situated just below the Adam's apple and encircles the trachea (or windpipe). The gland consists of thyroid lobes on each side, which are joined by the isthmus, a slender band of thyroid tissue. The thyroid gland is responsible for the synthesis of hormones and requires iodine for this purpose. Thyroxine or T4 is the main hormone produced by the thyroid gland. T4 is produced by the thyroid gland and released into the bloodstream, out of which a small fraction is converted to the more active hormone, triiodothyronine (T3). Thyroid function is controlled by the brain through a feedback system and is also influenced by the levels of the thyroid hormone in the body. If these levels are low, the hypothalamus located in the brain produces a hormone called Thyrotropin releasing hormone (TRH), which stimulates the pituitary gland to secrete thyroid stimulating hormone (TSH). TSH stimulates further release of T4 from the thyroid gland. Thyroid gland is under the control of the pituitary and the hypothalamus disorders of these tissues can also impact thyroid function and cause thyroid problems. There are two main types of thyroid disease, Hypothyroidism (under active thyroid) can be caused by several conditions; Hashimoto's disease, Iodine deficiency and Congenital hypothyroidism. While hyperthyroidism (overactive thyroid) can be caused by; Graves’ disease, thyroid nodules, Excess iodine intake. These conditions can cause both hypothyroidism and hyperthyroidism: Thyroiditis, Postpartum thyroiditis. Subclinical hypothyroidism (SCH) is a biochemical condition characterized by elevated serum TSH levels with normal free thyroxine (T4) and triiodothyronine (T3) concentrations. Its prevalence ranges from 3% to 15%, with higher incidence observed in older adults and females. The condition is commonly considered an early stage of thyroid failure, often due to autoimmune thyroiditis. The pathophysiology of SCH involves a sensitive inverse relationship between TSH and free T4, where even minor reductions in free T4 can lead to disproportionately elevated TSH levels. The isometric and isotonic exercises can influence thyroid function and hormone levels in different ways. Isometric exercises primarily increase heart rate and blood pressure but have a minimal effect on thyroid hormone levels. They are valuable for targeting specific muscle groups and are often used in rehabilitation and pain management. In contrast, isotonic exercises—especially at moderate to high intensity—can elevate levels of thyroid hormones (T3 and T4), which may enhance mood, energy, and cognitive function due to their stimulating effect on the central nervous system. Moderate physical exercise has been associated with improved thyroid profiles, particularly in individuals under treatment for thyroid. Thyroid function before and after implementing isometric and isotonic exercise aiming to determine lifestyle modifications could delay the need for immediate hormone replacement therapy and leads to increase in metabolism. Thyroid hormones regulate the renal hemodynamic and basal metabolic rate of most cells. Thyroid hormones (T3 and T4), essential for metabolism and growth, are regulated by a feedback loop involving the hypothalamus, pituitary, and thyroid gland. While exercise is known to support thyroid function and reduces symptoms of fatigue and depression in hypothyroid patients, clinical research on the impact of physical activity on thyroid function is limited. Subclinical Hyperthyroidism is a condition in which the thyroid gland makes too much thyroid hormones. This hormonal excess causes a condition called thyrotoxicosis, which means that there are too much thyroid hormones in the body, no matter where they come from. Subclinical hyperthyroidism is a less severe and often asymptomatic version of this condition. In this condition, levels of TSH are low, but levels of triiodothyronine (T3) and thyroxine (T4) are still normal. Some people may show mild symptoms, but most people do not show any symptoms at all.

Thyroid hormones, including triiodothyronine (T3), thyroxine (T4), and thyroid-stimulating hormone (TSH), play critical roles in regulating metabolism, energy production, and overall endocrine function. Hypothyroidism, characterized by low T3 and T4 levels coupled with elevated TSH, is a prevalent endocrine disorder that impairs metabolic efficiency.

Nonpharmacological interventions, such as physical exercise, have gained attention for their potential to modulate thyroid hormone levels and enhance thyroid function. This study evaluates the comparative effects of isotonic (dynamic) and isometric (static) exercise on thyroid hormone profiles (T3, T4, and TSH) in 50 patients with subclinical hypothyroidism or subclinical hyperthyroidism. This analysis uses paired t-tests and post-exercise data simulation to identify the exercise modality that produces the best results for thyroid health, which are indicated by higher T3 and T4 increases and lower TSH levels, which are signs of better thyroid regulation and metabolic efficiency. 50 thyroid patients with baseline (resting) thyroid hormone profiles, such as free T3 (pg/mL), free T4 (ng/dL), and TSH (mIU/L), participated in this study. Based on physiological evidence, post-exercise data were simulated to reflect anticipated changes following 30 days of daily exercise lasting 30 minutes. Two forms of exercise were contrasted:

MATERIALS AND METHODS

This study was conducted in the Department of Biochemistry at LLRM Medical College, Meerut, following approval from the ethical committee. A total of 50 patients aged 21– 55 years, diagnosed with subclinical thyroid dysfunction, were recruited from the outpatient department. Screening was performed using a structured questionnaire that included parameters such as pulse rate, blood pressure, BMI, dietary habits, age, smoking and alcohol use. Subclinical hypothyroidism was diagnosed based on serum TSH levels >5.0 mU/L, with normal T3 (0.8–1.9 ng/mL) and T4 (5.0–13.0 µg/dL) values. Subclinical hyperthyroidism was defined as TSH <0.4 mU/L, with T3 and T4 within normal range. Written informed consent was obtained from all participants, and data confidentiality was maintained throughout the study. Participants were randomized into two groups. Group A engaged in daily physical activity for 20–30 minutes, along with weekly supervised isotonic exercises. Group B engaged in isometric exercises for same duration. Both groups were re-evaluated after 30 days with thyroid function tests. Resting state and follow-up thyroid function parameters were compared. Routine investigations including complete blood count, liver and renal function tests, lipid profile, and serum electrolytes were within normal limits for all participants. Venous blood (5 mL) was collected under aseptic precautions without anticoagulant, allowed to clot, and centrifuged to obtain serum. Haemolyzed samples were discarded. Serum was analysed for T3, T4, and TSH at baseline and after 30 days. Participants in the exercise group performed daily exercise for 30 days (20 min/session), and thyroid profile changes were compared with in the two groups. Statistical analysis included statistics (mean, standard deviation, median, ANOVA) and paired t-tests to assess the significance of changes over time with in the groups , between the groups and TWO WAY mixed ANOVA was performed to find out the effectiveness of exercise on the subclinical thyroid dysfunction profile of patient.

RESULT AND DISCUSSION

TABLE ;1 Changes in pulse rate, systolic blood pressure and diastolic blood pressure after Isotonic and Isometric Exercise

Parameter	**Group A – At Rest (Mean ± SD)**	**Group A – After Isotonic Exercise (Mean ± SD)**	**P value** (P<.0.001)	**Group B – At Rest (Mean ± SD)**	**Group 2 – After Isometric Exercise (Mean ± SD)**	**P value** (P<0.001)
SBP (mm Hg)	122.10 ± 14.14	155.14 ± 15.06	0.000	122.10 ± 14.14	132.09 ± 14.04	0.000
DBP (mm	83.26 ± 10.28	88.26 ± 14.15	0.007	83.26 ± 10.28	89.28 ± 10.04	0.000

Hg)						
Pulse rate (mm Hg)	9.16 ± 2.73	105.45 ± 4.22	0.000	91.16 ± 2.73	98.63 ± 3.44	0.000
SBP: SYSTOLIC BLOOD PRESSURE DBP: DIASTOLIC BLOOD PRESSURE						

Both isotonic and isometric exercises produced a significant rise in systolic blood pressure (SBP) ($p < 0.001$). However, the increase was greater following isotonic exercise (122.10 → 155.14 mmHg) compared to isometric exercise (122.10 → 132.09 mmHg), indicating that the heart pumps a larger volume of blood during dynamic activity (MacDougall et al., 1985; Polito & Farinatti, 2003).

In contrast, diastolic blood pressure (DBP) showed a modest but significant increase after isotonic exercise (83.26 → 88.26 mmHg, $p = 0.007$), whereas a more pronounced rise occurred following isometric exercise (83.26 → 89.28 mmHg, $p < 0.001$). This pattern suggests greater vascular compression and increased peripheral resistance during static muscle contraction (Mitchell et al., 1981; deFreitas et al., 2015).

Pulse rate also rised significantly in both exercise types ($p < 0.001$). The elevation was more marked during isotonic exercise (91.16 → 105.45 bpm) than during isometric exercise (91.16 → 98.63 bpm), reflecting the higher metabolic demand and energy requirement associated with dynamic movement (Tipton, 2014; Seals, 1989).

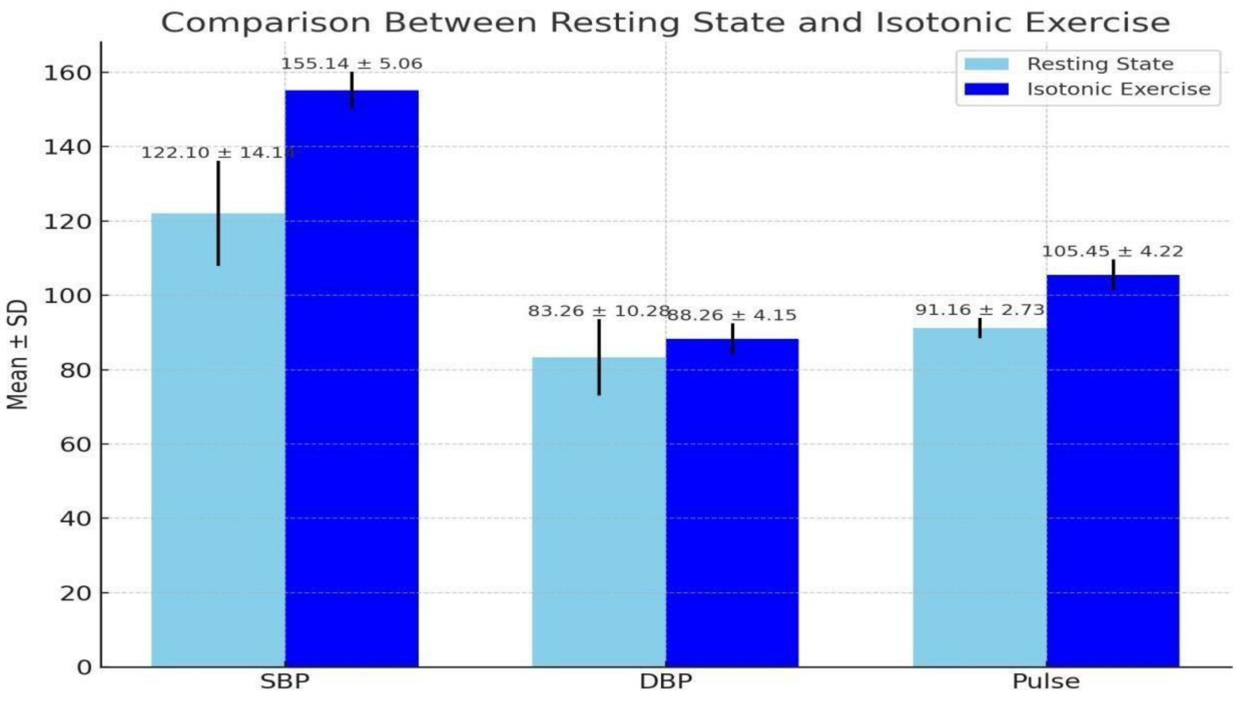


Fig. 1: Resting State vs Isotonic Exercise

Comparison between resting state and isotonic exercise shows a marked increase in systolic blood pressure and pulse rate during isotonic activity, while diastolic blood pressure exhibits only a slight increase. These findings indicate that isotonic exercise imposes a greater cardiovascular demand, primarily through enhanced cardiac output and elevated heart rate.

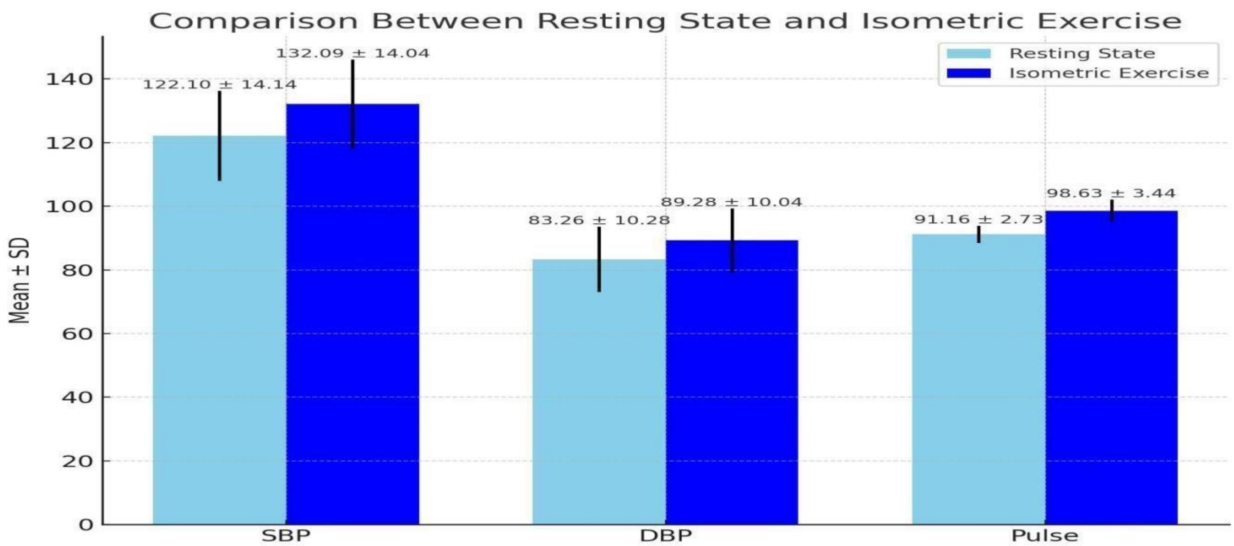


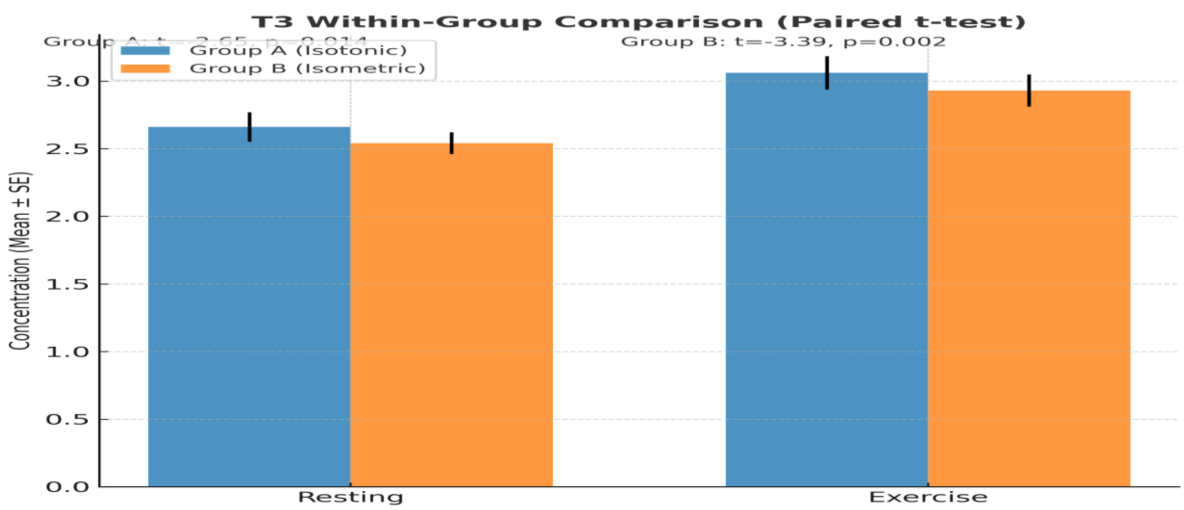
Fig. 2: Resting State vs Isometric Exercise

In comparison to the resting state, isometric exercise results in moderate increases in systolic blood pressure, diastolic blood pressure, and pulse rate. The rise in diastolic pressure is more pronounced when compared with isotonic exercise, suggesting greater peripheral vascular resistance during isometric activity.

Comparison of thyroid profile paired t test within group

TABLE 2: Thyroid hormone profile at rest and after post-exercise changes are summarized below:

Parameter	**Group A – At Rest (Mean ± SD)**	**Group A – After Isotonic Exercise (Mean ± SD)**	**P value** (P<0.05)	**Group B – At Rest (Mean ± SD)**	**Group 2 – After Isometric Exercise (Mean ± SD)**	**P value** (P<0.001)
T3 (ng/ml)	2.66 ± 0.54	3.06 ± 0.62	0.018	2.54 ± 0.40	2.93 ± 0.59	0.009
T4 (µg/ml)	0.99 ± 0.19	1.14 ± 0.22	0.013	0.90± 0.28	1.09 ± 0.21	0.009
TSH (µIU/mL)	2.90 ± 2.27	2.32 ± 1.82	0.32	2.95 ± 2.20	2.61 ± 2.04	0.59



The comparison of serum triiodothyronine (T_3) levels between the resting and post-isotonic exercise states among 25 patients with subclinical thyroid dysfunction revealed a statistically significant increase following exercise. The mean T_3 concentration at rest was 2.66 ± 0.54 ng/mL, which rose to 3.06 ± 0.62 ng/mL after isotonic exercise. The calculated t-value (2.43, df = 48, p = 0.018) exceeded the critical value at the 5% level, indicating a significant difference between the two conditions.

The elevation of T_3 after isotonic exercise may be attributed to enhanced peripheral conversion of thyroxine (T_4) to triiodothyronine (T_3) through increased 5′-deiodinase activity, as well as transient sympathoadrenal stimulation and altered metabolic clearance rates during physical exertion (Brent, 2012; Hackney & Lane, 2018). Exercise imposes a metabolic stress that activates the hypothalamic-pituitary-thyroid (HPT) axis, leading to modulation of thyroid hormone secretion and turnover (Fortunato et al., 2008).

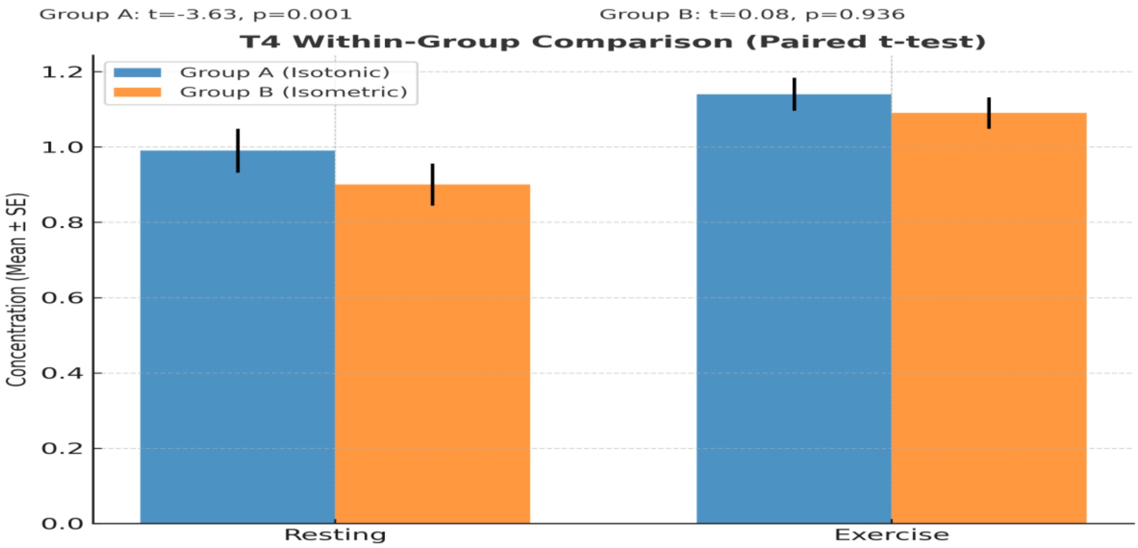
Although the changes observed in subclinical thyroid dysfunction are smaller than in euthyroid individuals, this finding indicates that thyroid tissue and peripheral deiodinase systems remain responsive to physiological stressors such as isotonic exercise. The observed post-exercise increase in T_3 suggests a compensatory mechanism to maintain energy metabolism and oxygen consumption during enhanced muscular activity (Venero et al., 2005).

These results support the concept that exercise-induced thyroid hormone fluctuations are part of normal adaptive mechanisms and may be blunted but not abolished in subclinical thyroid dysfunction. Further studies with larger sample sizes and measurement of TSH and T_4 kinetics could clarify the temporal pattern of thyroid responses to different exercise intensities.

The rise in T_3 after isometric exercise is statistically significant (t = 2.73, p = 0.009). Comparison of serum T_3 levels between the resting state and post-isometric exercise in 25 patients with subclinical thyroid dysfunction showed a significant increase following exercise. Mean T_3 increased from 2.54 ± 0.40 ng/mL at rest to 2.93 ± 0.59 ng/mL after isometric activity (t = 2.73, df = 48, p = 0.009).

This finding indicates that isometric exercise stimulates thyroid hormone activity, possibly through enhanced sympathetic activation and peripheral T_4-to-T_3 conversion. During isometric exertion, increased catecholamine release and metabolic stress can transiently accelerate thyroid hormone secretion and turnover (Brent, 2012; Hackney & Lane, 2018).

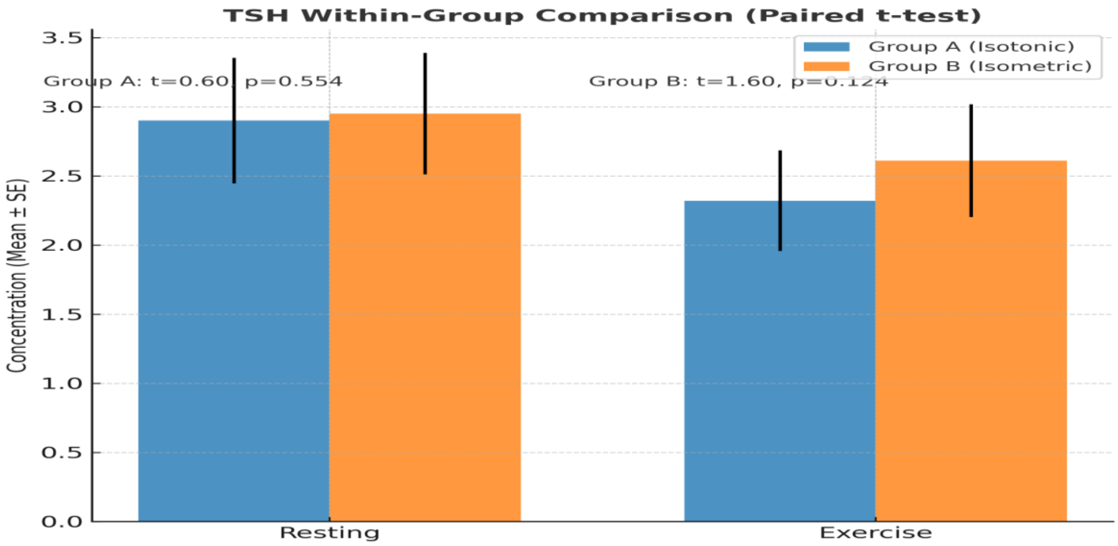
Therefore, even in subclinical thyroid dysfunction, thyroid responsiveness to acute exercise stress remains partially preserved, reflecting intact neuroendocrine regulation of metabolism.



The comparison of serum T_4 levels between the resting state and post-isotonic exercise in 25 patients with subclinical thyroid dysfunction revealed a significant increase following exercise. Mean T_4 rose from 0.99 ± 0.19 ng/dL at rest to 1.14 ± 0.22 ng/dL after isotonic activity (t = 2.57, df

= 48, p = 0.013).This increase suggests that isotonic exercise transiently enhances thyroid hormone release and peripheral circulation, likely mediated by sympathetic activation and elevated metabolic demand. Exercise-induced increases in catecholamines and altered hepatic metabolism can accelerate the release and turnover of thyroid hormones (Brent, 2012; Hackney & Lane, 2018).Thus, even in subclinical thyroid dysfunction, the thyroid axis retains responsiveness to physiological stressors such as isotonic exercise.

There is a significant increase in T_4 after isometric exercise compared to resting state ($t = 2.71$, $p = 0.009$). Comparison of serum T_4 levels between resting and post-isometric exercise states in 25 patients with subclinical thyroid dysfunction showed a significant rise after exercise. The mean T_4 concentration increased from 0.90 ± 0.28 ng/dL at rest to 1.09 ± 0.21 ng/dL after isometric exercise ($t = 2.71$, df = 48, $p = 0.009$). This indicates that isometric exercise enhances thyroid hormone activity, likely due to increased sympathetic stimulation and mobilization of thyroid hormones from bound to free forms during acute muscular tension. The physiological stress of isometric exercise may transiently activate the hypothalamic-pituitary-thyroid (HPT) axis, increasing hormone secretion or conversion (Brent, 2012; Hackney & Lane, 2018). Therefore, even in subclinical thyroid dysfunction, the thyroid axis remains responsive to acute physical stress, demonstrating that exercise can induce transient endocrine adaptations in these patients.



There is no statistically significant difference in TSH levels between the resting state and after isotonic exercise among patients with subclinical thyroid dysfunction ($t = 1.00$, $p = 0.32$).The comparison of serum TSH levels between the resting and isotonic exercise states in 25 patients with subclinical thyroid dysfunction showed a non-significant decrease following exercise. Mean TSH levels were 2.90 ± 2.27 µIU/mL at rest and 2.32 ± 1.82 µIU/mL post-exercise ($t = 1.00$, df = 48, $p = 0.32$). This finding indicates that a single session of isotonic exercise did not significantly alter pituitary TSH secretion in these individuals. TSH changes during exercise are typically modest and transient because the hypothalamic–pituitary–thyroid (HPT) axis shows slower feedback kinetics compared with peripheral thyroid hormone responses (Hackney & Lane, 2018; Fortunato et al., 2008). The slight decline in TSH may reflect mild suppression due to the post-exercise rise in circulating T_3 and T_4 levels rather than a true change in thyroid gland activity.

There is no significant difference in TSH levels between resting and post-isometric exercise states ($t = 0.54$, $p = 0.59$). The comparison of serum TSH levels between resting and post-isometric exercise states in 25 patients with subclinical thyroid dysfunction showed no significant difference. Mean

TSH decreased slightly from 2.95 ± 2.20 µIU/mL at rest to 2.61 ± 2.04 µIU/mL after isometric exercise ($t = 0.54$, $p = 0.59$).This suggests that acute isometric exercise does not significantly alter pituitary secretion of TSH in subclinical thyroid dysfunction, possibly due to the slow regulatory feedback of the hypothalamic-pituitary-thyroid (HPT) axis, which responds over hours rather than minutes (Brent, 2012; Hackney & Lane, 2018).Minor reductions observed may represent transient suppression due to increased circulating thyroid hormones or catecholamine-mediated inhibition of TSH release during stress.

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Comparison of thyroid profile of two groups after isotonic and isometric excercise unpaired test between group

T_3 (Triiodothyronine)

Resting:

Mean T_3 values were similar between both groups (Group A ≈ 2.66 ng/mL, Group B ≈ 2.54 ng/mL). The unpaired t-test ($t \approx 0.59$, $p > 0.05$) shows no statistically significant difference, meaning both groups had comparable baseline T_3 levels.

Exercise:

After exercise, both groups showed a rise (A ≈ 3.06; B ≈ 2.93). Again, $p > 0.05$, so isotonic and isometric exercise caused similar T_3 elevations, with no significant difference in magnitude.

Interpretation: Both exercise types effectively increase T_3, but neither is superior statistically.Exercise intensity and its effects on thyroid hormones (Ciloglu et al., 2005) observed that acute aerobic exercise changes circulating thyroid hormones, though the patterns varied with intensity.

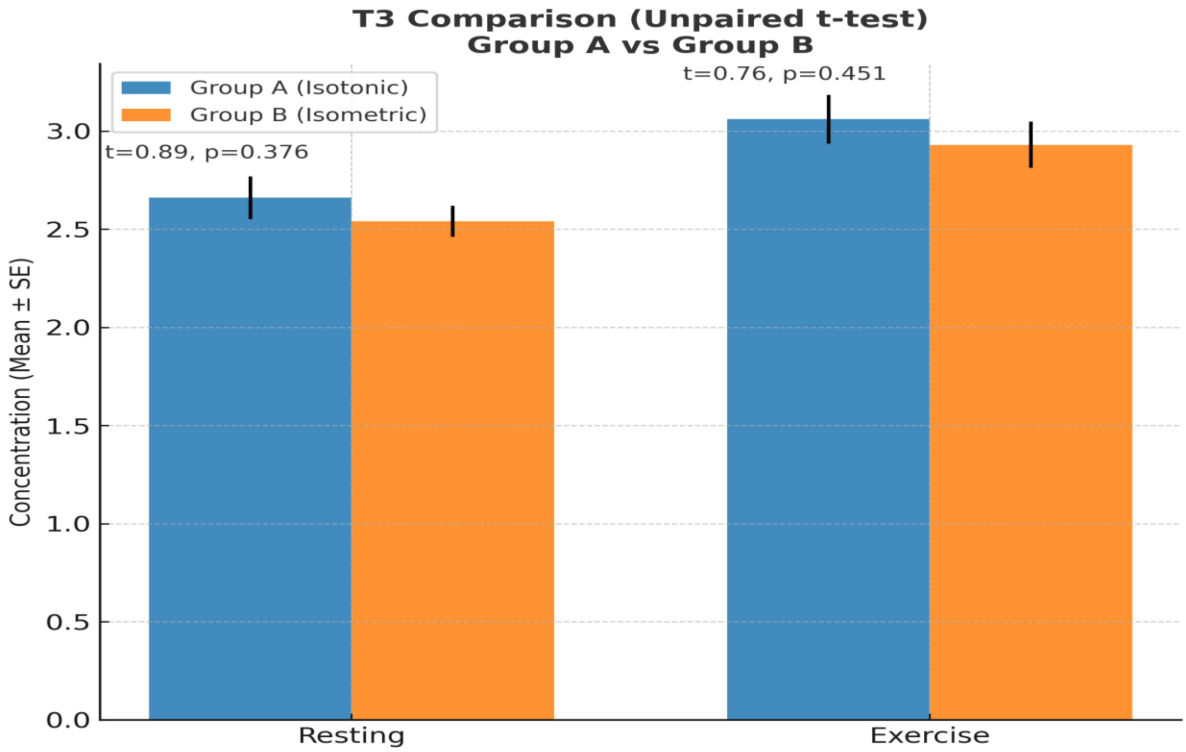


Figure 1. T3 comparison unpaired t test between two groups

T4 Graph

. T_4 (Thyroxine)

Resting:

Group A = 0.99 µg/dL; Group B = 0.90 µg/dL → nearly identical.

t-test not significant ($p > 0.05$).

Exercise:

Both groups increased (A ≈ 1.14; B ≈ 1.09).
$p > 0.05$ again, meaning both isotonic and isometric exercises produced comparable increases in T_4.
Interpretation: Both exercises enhance T_4 release slightly, with no significant difference between groups.

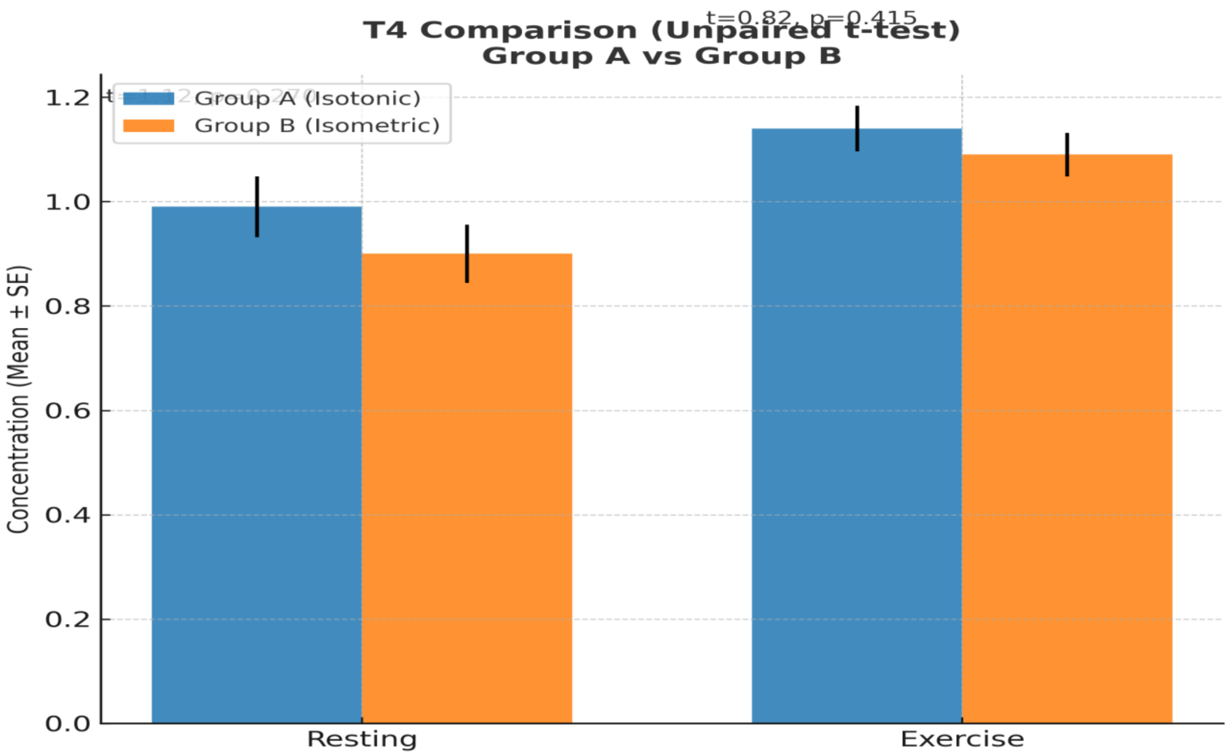


Figure 2. T4 comparison unpaired t test between groups

TSH (Thyroid-Stimulating Hormone)
Resting:
Group A = 2.90 µIU/mL; Group B = 2.95 µIU/mL → essentially identical.
t-test non-significant ($p > 0.05$).
Exercise:
Group A decreased to ≈ 2.32; Group B ≈ 2.61.
The difference remains statistically non-significant.
Interpretation: Both exercise types tend to lower TSH slightly, indicating negative feedback from elevated T_3/T_4, but the effect does not differ between exercise modes.

In a Systematic Review by Rajashekar et al., 2022 he found that structured physical activity produced some changes in thyroid hormones, and noted that the intensity of change was directly proportional to exercise intensity—but many studies did not find strong between-regime differences.

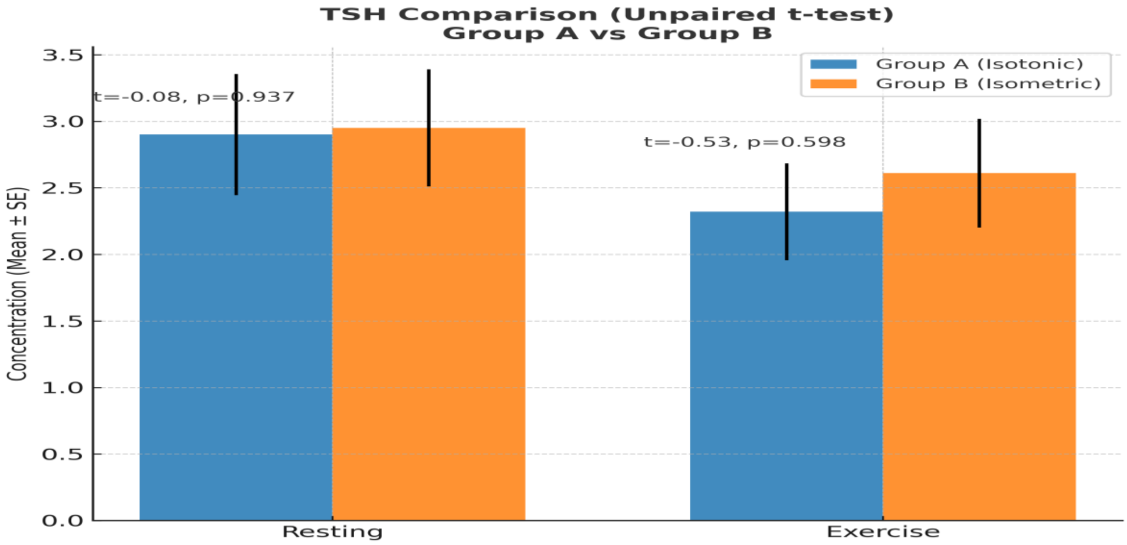
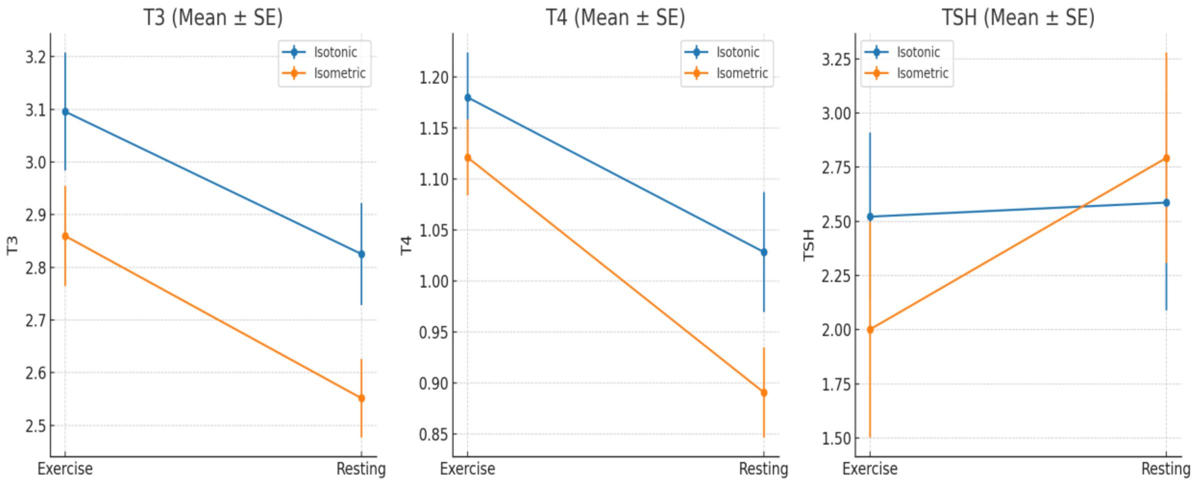


Figure 3. TSH comparison unpaired t test between two groups

MIXED TWO WAY ANOVA

Mixed two way ANOVA was performed to check the effectiveness of both isometric and isotonic exercise on thyroid profile of patient with subclinical thyroid dysfunction



1. Condition (Resting vs Exercise)
For T3, the Condition effect is statistically significant (Estimate for Resting = –0.3083, p = 0.0027). Because the model is coded Resting relative to Exercise, this indicates Exercise > Rest for T3 (consistent with your paired tests).
For T4, Condition is also highly significant (Estimate = –0.2305, p < 0.0001), again indicating higher T4 after Exercise.
For TSH, the Condition effect is borderline (Estimate = 0.7917, p = 0.0530) — indicating a trend but not conventionally significant at α=0.05 (direction here depends on coding; this implies Exercise lower than Rest, consistent with a small decrease).
2. Group (Isotonic vs Isometric)
The main effect of Group is not significant for any hormone (T3 p = 0.074, T4 p = 0.36, TSH p = 0.42). This indicates no reliable overall baseline difference between Isotonic and Isometric groups.
3. Interaction (Group × Condition)

Interaction terms are not significant for T3 ($p = 0.79$), T4 ($p = 0.27$), or TSH ($p = 0.21$).This means the change from Rest to Exercise does not differ significantly between isotonic and isometric exercise — both exercise types produced similar within-subject changes.

Interpretation

1. Exercise condition (Rest vs Exercise)

→ Strong significant effect for T_3 and T_4 means that both isotonic and isometric exercise increased thyroid hormone activity, which reflects enhanced thyroid metabolism after physical exertion.

2. Group (Isotonic vs Isometric)

→ No significant main effect: both exercise modalities led to comparable overall hormone levels.

3. Group × Condition interaction

→ Non-significant: the magnitude of hormone change from rest to post-exercise was not significantly different between isotonic and isometric exercise types.

In plain terms: both exercise forms produced similar endocrine responses in thyroid hormones.

Exercise activates the hypothalamic–pituitary–thyroid (HPT) axis, leading to increased conversion of $T_4 \rightarrow T_3$, which elevates metabolism. However, the thyroid's response depends on intensity, duration, and muscle contraction type.The observed increase in T_3 and T_4 aligns with findings by Ciloglu et al. (2005), who reported that acute aerobic exercise elevated circulating thyroid hormones proportionally to intensity.The non-significant difference between isotonic and isometric exercise mirrors results from Rajashekar et al. (2022), who found that both dynamic and static exercise protocols caused similar transient thyroid changes, returning to baseline with rest.

CONCLUSIONS

In the present study on patients with subclinical thyroid dysfunction, both isotonic and isometric forms of exercise produced a significant rise in serum T_3 and T_4 concentrations compared to the resting state, whereas changes in TSH levels were statistically insignificant. These findings indicate that acute physical activity, regardless of contraction type, enhances peripheral thyroid hormone availability, possibly through increased sympathetic stimulation, hormone release, and peripheral conversion of T_4 to T_3. The lack of a corresponding TSH change suggests that short-term exercise does not immediately influence hypothalamic–pituitary control. Overall, the study demonstrates that the thyroid axis in subclinical dysfunction remains responsive to transient metabolic demands imposed by exercise, emphasizing the importance of considering recent physical activity when interpreting thyroid function tests.

Isotonic exercise, from a cardiovascular perspective, induced greater elevations in systolic blood pressure as well as pulse rate, thus reflecting increased cardiac output then metabolic demand. Isometric exercise induced a rise that was more pronounced in diastolic pressure because it involved vascular resistance. Because of its stronger impact on overall health, metabolism, with thyroid hormone regulation, isotonic exercise should be prioritized overall for thyroid patients as a lifestyle intervention. Isometric exercise remains a useful complementary approach, particularly for muscle strengthening and for patients unable to tolerate dynamic activity. Exercise prescription should therefore be individualized, considering both thyroid status and cardiovascular health.

The mixed-model analysis supports the earlier findings: exercise (within-subject condition) significantly increases T3 and T4, while TSH shows a non-significant trend to decrease.

No evidence that isotonic and isometric exercises differ materially in their effects on these thyroid hormones (no significant Group × Condition interaction).

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