Effect of Aerobic Versus Resistive Exercise on Cardiac Functions in Patients with Hypothyroidism

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ABSTRACT

Background:

Hypothyroidism results from a reduction in thyroid hormone levels, either due to decreased endogenous synthesis or exogenous hormone administration. Physical training has been shown to enhance endothelial function in individuals with hypothyroidism. Furthermore, physical exercise plays a role in mitigating obesity commonly associated with hypothyroidism, given that thyroid hormones regulate metabolic processes. Additionally, both aerobic and resistance exercise contribute to an increase in blood HDL cholesterol levels and have a positive impact on overall quality of life. **Purpose:** to compare the effect of Aerobic and resistive exercise on cardiac function in patient with hypothyroidism. **Patients and Methods:** Fifty-two hypothyroidism patients from both sexes, their age ranged from 40 to 50 years were selected from outpatient clinic of the Internal Medicine Department at Edko Central Hospital. They were randomly assigned into two groups (26 each): **Group A (Aerobic group) and Group B (Resistive group). Outcome measures:** Cardiac function through assessing (ejection fraction and Cardiac Index), Thyroid hormones levels (TSH, T3, T4), and health related quality of life by using SF-12 questionnaires after three times per week for 12 successive weeks. **RESULTS:** There was a significant variation in EF, CI, TSH, Physical Function, Vitality, Social Functioning, Role Emotional, Mental Health between both groups post-treatment (P= 0.005), with no significant variation in T3, T4, General Health, Role Physical, Body Pain). **Conclusions:** Aerobic exercise and resistance exercises had good effect in controlling thyroid function through improving TSH, T3, and T4 level, cardiac functions that leading to improve the quality of life in hypothyroidism patient.

Word key: Hypothyroidism, Aerobic Exercise Resistive, Cardiac Functions

INTRODUCTION

Thyroid hormones exert a notable influence on the cardiovascular system. Evidence from numerous clinical investigations indicates that subclinical hypothyroidism is linked to alterations in various cardiac functions (Ding et al., 2025). Hypothyroidism, also known as "Under active thyroid" is a defined as failure of thyroid gland to make sufficient thyroid hormone (Adam et al., 2025).

Hypothyroidism is estimated to affect around 5% of the general population, with a similar proportion potentially remaining undiagnosed. The vast majority of cases—exceeding 99%—are attributed to primary hypothyroidism. Globally, iodine deficiency is the leading environmental factor contributing to thyroid disorders, including hypothyroidism. However, in regions where iodine intake is adequate, Hashimoto's disease, a form of chronic autoimmune thyroiditis, represents the predominant cause of thyroid failure **(Chiovato et al., 2019).**

The diagnosis of hypothyroidism is primarily based on biochemical measurements. An elevation in serum thyroid-stimulating hormone (TSH) levels is a distinguishing feature of primary hypothyroidism accompanied by reduced thyroxin (T4) concentrations below the normal reference range, which is typically 77–155 nmol/L for T4 and 0.3–4 mU/L for TSH. Subclinical hypothyroidism is identified by increased serum TSH levels while thyroxin concentrations remain within the normal reference range **(Lui et al., 2022).**

Literature regarding cardiac manifestations in subclinical hypothyroidism consistently demonstrates that affected patients exhibit resting left ventricular diastolic dysfunction, characterized by delayed myocardial relaxation. Additionally, these patients experience impaired systolic function during exertion, which contributes to reduced exercise capacity **(Silbiger et al., 2019).**

Studies evaluating patients with subclinical hypothyroidism before and after achieving euthyroidism through levothyroxine replacement therapy have reported evidence of impaired resting left ventricular systolic function. However, most studies indicate that left ventricular systolic function at rest remains largely within normal limits. (RossDouglas et al., 2016).

The cardiac index is a hemodynamic parameter derived from cardiac output, which represents the volume of blood ejected by the left ventricle into the systemic circulation per minute, measured in liters per minute (L/min). To account for individual body size, cardiac output is normalized by dividing it by the body surface area, resulting in the cardiac index. The normal resting cardiac index ranges from 2.6 to 4.2 L/min/m² **(Schwaiger et al., 2022).**

The cardiac index (CI) is commonly measured and utilized in both general intensive care and cardiac intensive care settings. It serves as a valuable indicator of cardiac pump performance by correlating the volume of blood ejected by the heart with the individual's body surface area **(Kouz et al., 2022).**

Ejection fraction (EF) quantifies the percentage of blood expelled from the left ventricle during each cardiac contraction. It is a widely accepted metric for assessing the heart's pumping efficiency and plays a key role in classifying different types of heart failure. Additionally, EF serves as an indicator of heart failure severity, despite certain acknowledged limitations **(Alam et al., 2022).**

MATERIALS AND METHODS

This study aimed to evaluate and compare the effects of aerobic and resistance exercise on cardiac function in patients with hypothyroidism.

Ethical consideration:

The Purpose, natural and potential risks of the study was explained to all patients and written consent form was signed prior to the study (Appendix I). Also, the study protocol was approved by the Ethical Committee of the Faculty of Physical Therapy, Cairo University, Egypt at 2024 (No.P.T.REC/012/003892).

Study design and Randomization:

This is a Randomized controlled, parallel- group interventional trail. The intervention was conducted outpatient clinic of physiotherapy, from (January 2023.) to (October 2024.), the randomization was carried out using computer-generated block randomization program at http://www.randomization.com/. The participants were randomized in block sizes of 6 and 9 with a 1:1:1 allocation ratio. Concealed allocation was done using sealed, sequentially numbered opaque envelopes. The randomization was carried out by a blinded researcher who was not involved in recruiting, data collection or treatment.

I. Patients

Fifty-Two hypothyroidism patients, their age ranged from 40 to 50 years. They were selected from outpatient clinic of the Internal Medicine Department at Edko Central Hospital.

Patient's selection

Fifty-two patients from both sex diagnosed as hypothyroidism aged from 40-50 years, their body mass index was ranged from 31.7±2.7 kg/m2. During the eligibility assessment, eight participants were excluded: Out of the potential candidates, six were excluded due to not fulfilling the required eligibility criteria, whereas two individuals opted out of participation.

All patients were included if they met the following criteria: aged between 40 and 50 years; both male and female participants; diagnosed with hypothyroidism; and free from any acute medical conditions.

Patients were excluded if they met one of the following criteria: Auditory and visual problems; Musculoskeletal diseases which may affect their physical activity; Pituitary disease; Pregnancy and lactation; Unstable cardiovascular problems like arrhythmia and heart failure; All subjects were randomly assigned into two equal groups and all groups had their medical treatment:

Group A (Aerobic group): Twenty-six subjects with hypothyroidism were included in this group, all subjects in this group were received aerobic exercise program in the form of cycle ergometer for 30 min. for three times per week for 12 successive weeks. Group B (Resistive group): Twenty-six subjects with hypothyroidism were included in this group, the resistive group and they were received resistive exercise in upper and lower body limbs against gravity using free weights (e.g.; weight lifting, sandbags) using 1-repetition maximum test (RM).

Outcome Measures

The current study explored the consequences of aerobic and resistance exercise on cardiac function, thyroid hormone levels, and health-related quality of life in patients with hypothyroidism. Outcome measures were chosen based on their relevance to the study objectives and their validated psychometric properties.

Primary Outcome Measures Cardiac Function: Ejection Fraction (EF): Measured using echocardiography, EF represents the percentage of blood pumped from the left ventricle per heartbeat, indicating cardiac pumping efficiency. Values were recorded in percentage (%), with higher values reflecting better function (Alam et al., 2022).Cardiac Index (CI): Assessed via echocardiography, CI represents the proportion between the heart's output and the individual's body surface area, quantified in liters per minute per square meter ($L/min/m^2$), with a normal range of 2.6–4.2 $L/min/m^2$ (Schwaiger et al., 2022). Assessments were conducted pre- and post-intervention (12 weeks) by trained technicians in a controlled setting.

Secondary Outcome Measures Thyroid Hormone Levels: Thyroid-Stimulating Hormone (TSH), Triiodothyronine (T3), and Thyroxine (T4) were measured via blood samples analyzed using the Enzyme-Linked Immunosorbent Assay (ELISA) method. 0Samples were collected 48 hours before the first training session and after 12 weeks, with TSH reported in mU/L and T3/T4 in nmol/L (Yadav & Verma, 2022).

Health-related quality of life was assessed using the 12-Item Short Form Health Survey (SF-12), a validated self-administered questionnaire that evaluates eight domains: General Health (GH), Physical Functioning (PF), Role Physical (RP), Bodily Pain (BP), Vitality (VT), Social Functioning (SF), Role Emotional (RE), and Mental Health (MH). Scores were computed for each domain, where elevated scores denote an enhancement in the individual's overall quality of life (Fong et al., 2022). The SF-12 was administered pre- and post-intervention.

Data Collection Procedures

Echocardiography was performed in a darkened room using a transducer to capture cardiac images, ensuring accurate EF and CI measurements. Blood samples were drawn by certified laboratory technicians in a seated position. The SF-12 questionnaire was completed by participants under researcher supervision to ensure clarity and accuracy. All assessments were conducted by trained personnel blinded to group assignments to minimize bias.

Statistical analysis

SPSS software version 22 was used to conduct all statistical analyses. A comparison between both groups' features, including age, weight, height, and BMI, was performed using an unpaired T-test. The Mann-Whitney U test was employed to conduct a comparison between the sexes of both groups. The data was examined utilizing the Kolmogorov– Smirnov test to verify the normality of distribution. In addition, Levene's Test was employed to confirm the homogeneity of the data. Subsequently, MANOVA was conducted to compare the variables between groups and pairwise comparison was performed to compare between the outcomes within every group pre and post intervention. The significance level for all statistical tests was set at $P < 0.05$.

RESULTS

A total of 52 recruited sample were distributed randomly into two equal groups, with 26 subjects in every group. According to **Table 1**, The data did not demonstrate any appreciable difference of significance in the participants' characteristics, including age, weight, height, BMI and sex ($p > 0.05$).

Table 1. Comparison of characteristics between groups A and B.

	Group A (n:26) Aerobic		**Group B (n:26) Resistive**		**p-value**	**t-value**
	$\bar{x}$ **± SD**		$\bar{x}$ **± SD**			
Age (years)	45.6±3		45.8±3.9		0.875	-0.158
Weight (Kg)	94.3±8.7		97.9±8.3		0.130	-1.540
Height (cm)	172.3±7.5		174.1±9.1		0.454	-0.754
BMI (kg/m²)	31.7±2.7		32.5±3.4		0.433	-0.791
	Male	**Female**	**Male**	**Female**		
Sex	57.7%(15)	42.3%(11)	53.8%(14)	46.2%(12)	0.782	

$\bar{x}$**: Mean, SD: Standard deviation, p-value: Probability value, *: significance**

Cardiac Parameters outcomes:

The outcomes indicated that the EF was significantly increased in both groups. Furthermore, no significant variations were observed between both groups before intervention (P-values were 0.944) but after intervention, there was a significant difference ($P<0.05$). Group A revealed an elevated percentage of alteration (19.4%) compared with the group B (11.2%) (**Table. 2**). However, the results suggested that the CI was significantly increased in both groups. Moreover, no significant variations were observed between both groups before intervention (P-values were 0.977) but after intervention, there was a significant variation ($P<0.05$). Group A revealed a high percentage of change (24%) than the group B (16%) (**Table. 2**)

Thyroid Hormones Parameters results:

The findings indicated that the TSH was significantly reduced in both groups. Furthermore, no significant variations were observed between both groups before intervention (P-values were 0.907) but after intervention, there was a significant difference ($P<0.05$). Group B revealed an elevated percentage of alteration (30.2%)

compared with the group B (17.7%) **(Table2).** Furthermore, the findings indicated that the T3 was significantly increased in both groups. Additionally, no significant variations were observed between both groups before or after intervention. Group B revealed a high percentage of alteration (47.3%) compared with the group B (40%) **(Table 2).**

However, the outcomes revealed that the T4 was significantly elevated in both groups. Additionally, no significant variations were observed between both groups before or after intervention. Group B revealed a high percentage of alteration (19.4%) compared with the group B (18.9%) **(Table 2).**

Table 2. Comparison between groups A and B regarding Cardiac and thyroid Hormones Parameters outcomes $\overline{X}$:

		Group A (n:26) Aerobic	Group B (n:26) Resistive	Comparison between groups	
		$\overline{X}$ ± SD	$\overline{X}$ ± SD	F-value	P-value
EF	Pre-intervention	48.96±3.9	49±3.9	0.005	0.944
	Post-intervention	58.5±4.1	54.5±3.9	12.707	0.001*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	19.4%	11.2%		
CI	Pre-intervention	2.5±0.1	2.5±0.2	0.001	0.977
	Post-intervention	3.1±0.2	2.8±0.2	16.586	P<0.05*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	24%	16%		
TSH	Pre-intervention	7.56±1.47	7.61±1.59	0.014	0.907
	Post-intervention	6.22±1.48	5.3±1.62	4.464	0.040*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	17.7%	30.2%		
T3	Pre-intervention	1.258±0.142	1.265±0.164	0.021	0.886
	Post-intervention	1.762±0.161	1.863±0.28	2.511	0.119
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	40%	47.3%		
T4	Pre-intervention	6.623±1.244	6.592±1.150	0.009	0.927
	Post-intervention	7.873±1.306	7.869±1.246	0.000	0.991
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	18.9%	19.4%		

Mean, SD: Standard deviation, p-value: Probability value, *: significance, EF: Ejection fraction, CI: Cardiac index.

SF-12 Questionnaire outcomes:

Regarding the outcomes of SF-12 Questionnaire outcomes, both groups showed a significant alteration for all sections with the percentages of for group A and B as follow: 1. General Health (GH): (60.1% and 54.7%, respectively); 2. Physical Function (PF): (46.2% and 24.6%, respectively); 3. Role Physical (RP): (24.6% and 21.6%, respectively); 4. Body Pain (BP): (19.3% and 17.8%, respectively); 5. Vitality (VT): (44.8% and 27.9%, respectively); 6. Social Functioning (SF): (41.9% and 14.11%, respectively); 7. Role Emotional (RE): (39% and 15.3%, respectively); 8. Mental Health (MH): (32.5% and 13.9%, respectively) (**Table. 3**).

Furthermore, no significant difference between both groups was detected pre-intervention (P<0.05). However, regarding the post intervention findings of GH, RP, and BP, there were no significant variation between group A and B (P-value were 0.353, 0.448, and 0.696, respectively). Moreover, related to the post intervention results of PF, VT, SF, RE, and MH sections, there was a significant variation between both groups (P<0.05) (**Table. 3**).

Table 3. Comparison between groups A and B regarding SF-12 Questionnaire.

SF-12 Questionnaire		**Group A (n:26) Aerobic**	**Group B (n:26) Resistive**	**Comparison between groups**	
		$\bar{x}$ ± SD	**$\bar{x}$ ± SD**	**F-value**	**P-value**
General Health (GH)	**Pre-intervention**	42.1±11.8	41.5±11.9	0.031	0.862
	Post-intervention	67.4±11.4	64.2±12.6	0.880	0.353
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	60.1%	54.7%		
Physical Function (PF)	**Pre-intervention**	44.33±10.1	44.69±10.5	0.016	0.899
	Post-intervention	64.84±8.7	55.69±9.9	12.467	0.001*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	46.2%	24.6%		
Role Physical (RP)	**Pre-intervention**	49.65±7.5	49.6±7.4	0.001	0.970
	Post-intervention	61.8±7.7	60.3±6.8	0.584	0.448
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	24.6%	21.6%		
Body Pain (BP)	**Pre-intervention**	69.9±7.7	69.6±7.3	0.027	0.869
	Post-intervention	56.4±6.9	57.2±7.9	0.154	0.696
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	19.3%	17.8%		

Vitality (VT)	**Pre-intervention**	45.7±13.9	45.8±13.9	0.001	0.979
	Post-intervention	66.2±11.1	58.7±14.1	4.623	0.036*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	44.8%	27.9%		
Social Functioning (SF)	**Pre-intervention**	48.2±13.7	48.9±14.1	0.032	0.858
	Post-intervention	68.4±10.7	55.8±13.6	13.729	0.001*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	41.9%	14.11%		
Role Emotional (RE)	**Pre-intervention**	47.9±15.6	47.7±15.6	0.001	0.971
	Post-intervention	66.6±11.2	55±15.7	9.390	0.004*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	39%	15.3%		
Mental Health (MH)	**Pre-intervention**	51.7±12.9	51.8±13.4	0.001	0.992
	Post-intervention	68.6±10.9	58.9±12.9	8.486	0.005*
	Comparison within group	P<0.05*	P<0.05*		
	Percentage of change (%)	32.5%	13.9%		

$\bar{X}$**: Mean, SD: Standard deviation, p-value: Probability value, *: significance, SF-12: 12 Item Short Form Health Survey**

DISCUSSION

This study investigated the comparative effects of aerobic and resistive exercise on cardiac function, thyroid hormone levels, and health-related quality of life in patients with hypothyroidism. The results provide evidence of significant improvements in ejection fraction (EF), cardiac index (CI), thyroid-stimulating hormone (TSH), triiodothyronine (T3), thyroxin (T4), and SF-12 domains, with differences in magnitude between intervention groups. These findings are contextualized within the existing literature, highlighting both supportive and contradictory evidence. Cardiac Function Both aerobic and resistive exercise significantly increased EF and CI, with the aerobic group demonstrating greater improvements (19.4% for EF and 24% for CI) compared to the resistive group (11.2% for EF and 16% for CI). These findings align with Oláh et al. (2019), who reported that exercise induces physiological myocardial hypertrophy through estrogen receptor-mediated pathways, enhancing cardiac contractility. Fiuza-Luces et al. (2018) further suggest that aerobic exercise promotes vascular remodeling, including increased coronary artery diameter and collateral vessel formation, which may explain the superior cardiac outcomes in the aerobic group. The greater cardiovascular demand of aerobic exercise likely contributed to these effects compared to the localized muscular focus of resistive training. However, Klein and Danzi (2016) argue that hypothyroidism may attenuate cardiac adaptations to exercise due to impaired thyroid hormone signaling, potentially limiting myocardial responsiveness. This could account for the smaller EF and CI improvements in the resistive group, suggesting that aerobic exercise may be more effective for enhancing cardiac function in this population. Future studies should explore the optimal exercise intensity and duration to maximize cardiac benefits in hypothyroid patients. Thyroid Hormone Levels Significant reductions in TSH and increases in T3 and T4 were observed in both groups, with the resistive group showing a greater TSH reduction (30.2% vs. 17.7%). This supports Abbas et al. (2019), who found that exercise lowers TSH and elevates T4 in hypothyroid patients, possibly by increasing metabolic demand. Bansal et al. (2022) provide a mechanistic insight, suggesting that resistance training up regulates thyroid hormone receptor expression in skeletal muscle, enhancing thyroid function. The lack of significant between-group differences in T3 and T4 suggests that both exercise modalities similarly influence thyroid hormone production. Contrarily, Ciloglu et al. (2015) reported that high-intensity exercise may increase TSH levels due to acute stress responses, particularly in untrained individuals. This contrasts with our moderate-intensity protocols, which likely avoided such effects. Additionally, Werneck et al. (2018) indicate that Hormonal shifts in the thyroid axis triggered by exercise may be transient, particularly in subclinical hypothyroidism, raising questions about the long-term impact of our findings. These discrepancies underscore the need for longitudinal studies to assess the sustainability of exercise-induced thyroid improvements. Health-Related Quality of Life Both groups exhibited significant improvements across all SF-12 domains, with the aerobic group showing greater gains in physical function (46.2% vs. 24.6%), vitality (44.8% vs. 27.9%), social functioning (41.9% vs. 14.1%), role emotional (39% vs. 15.3%), and mental health (32.5% vs. 13.9%). These results are consistent with Murtezani et al. (2014), who demonstrated that aerobic exercise enhances physical functioning and mood in chronic illness populations. Sadegh et al. (2016)

attribute such improvements to endorphin release and cortisol reduction, which may explain the aerobic group's superior outcomes. However, Batrakoulis et al. (2021) found that resistance training has limited effects on mental health and social functioning in sedentary adults, aligning with the smaller SF-12 gains in our resistive group. Haugen et al. (2020) further note that quality-of-life improvements from exercise depend on patient motivation and adherence, suggesting that our structured intervention may have amplified benefits not easily replicated in less controlled settings. These findings highlight the importance of tailoring exercise programs to individual needs. Implications and Future Directions The results indicate that both aerobic and resistive exercise are effective interventions for Promoting cardiac function, thyroid hormone levels, and quality of life in hypothyroid patients, with aerobic exercise showing greater benefits for cardiac and quality-of-life outcomes. However, the literature suggests foreseeable restrictions, including attenuated cardiac responses and transient thyroid hormone changes. Future research should investigate combined aerobic and resistive protocols, as proposed by Elgayar et al. (2024), and assess long-term outcomes to determine the durability of these effects. Additionally, studies exploring the role of exercise intensity and patient-specific factors could further refine clinical recommendations.

Finally, the results revealed that both aerobic and resistance exercises had a beneficial effect on regulating thyroid function, as evidenced by improvements in TSH, T3, and T4 levels, cardiac function through the improvement in (EF, CI) and then improve the quality of life in hypothyroidism patient. Future research should take into account variables such as the type, intensity, and duration of exercise training, as these factors represent key non-pharmacological strategies that can influence metabolic and hormonal adaptations.

CONCLUSION

The result of the study concluded that both aerobic exercise and resistance exercises had good effect in controlling thyroid function through improving TSH, T3, and T4 level, cardiac function through the improvement in (EF, CI) that leading to improve the quality of life in hypothyroidism patient.

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