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Effect of Pilates Versus Aerobic Exercises on Depression and Functional Capacity in Women with Hypothyroidism

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ABSTRACT

Background: Numerous symptoms of hypothyroidism, or an underactive thyroid, include fatigue, joint discomfort, heart palpitations, and sadness. Additionally, hypothyroidism slows down metabolism in general, increasing a person's risk of weight gain. Exercise helps increase muscle mass and cardiovascular health while easing many hypothyroidism symptoms.

Objective: This research examines the influence of Pilates and aerobic exercise on depression, life' quality, and functional capacity in women diagnosed with hypothyroidism.
Methods: Sixty adult women with a history of controlled primary hypothyroidism were randomly subdivided into three groups (A, B, C). **Group(A)**(n=25) received Pilates in addition to medication and nutritional advice, **Group(B)** (n=25) received aerobic exercises in addition to medication and nutritional advice. **Group(C)**, the control group (n=10), received medication and nutritional advices only. The assessment of functional capacity involved the measurement of the 6-minute Walk Distance, quality of life was assessed by the SF-36 scale, and depression was evaluated by Primary care Screening Questionnaire for Depression PSQ4D**.**
Results: 6-minute Walk Distance and SF-36 scale significantly elevated ($p \leq 0.05$), and primary care screening questionnaire for depression ($p \leq 0.05$), the scores of the three groups exhibited a significant decrease when compared to the baseline. The results of the inter-group comparison proved that both group A and group B exhibited significantly greater scores compared to group C in relation to the final 36-Item Short Form Survey scale, 6-minute Walk Distance, and primary care screening questionnaire for depression.
Conclusion: 12 weeks of training with Pilates exercises had a more significant effect on functional capacity and quality of life than aerobic exercise or medications only. Both Pilates and aerobic exercises had the same effect on depression levels.
Keywords: Hypothyroidism, Pilates, aerobic exercise, primary care screening questionnaire for depression, 6-minute Walk Distance, 36-Item Short Form Survey scale

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Introduction

Thyroid dysfunction is a prevalent pathological condition distinguished by atypical thyroid stimulating hormone (TSH) levels. In accordance with a previous study, 1.3% of the population had hyperthyroidism, and 4.6% had hypothyroidism. [1] When the thyroid gland produces fewer thyroid hormones than it should, Primary hypothyroidism results, which results in a compensatory rise in TSH. Pituitary abnormalities that result in decreased TSH release and low T3/T4 levels are the cause of secondary hypothyroidism. Tertiary hypothyroidism is

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brought on by abnormalities of the hypothalamus, which lower TRH levels, TSH levels, and T3/T4 levels.[1]

In addition, Hypothyroidism has a prevalence of approximately 5% within the general population, with a further 5% of instances remaining undiagnosed. More than 99% of those affected have primary hypothyroidism. The primary etiology of various thyroid disorders, encompassing hypothyroidism, is environmental iodine shortage worldwide, while in areas of iodine sufficiency, the primary factor that occurs with the highest frequency of thyroid failure is Hashimoto disease (chronic autoimmune thyroiditis). [2]

There are numerous etiologies, clinical manifestations, and symptoms of hypothyroidism. Weight gain, hair loss, cold intolerance, tiredness, constipation, dry skin, and voice changes are the most clinical symptoms. The clinical manifestations and indications of hypothyroidism vary depending on the patient's age, gender, illness severity, and other factors. [3]

It may also raise the risk of cognitive impairment, pregnancy complications, hypertension, dyslipidemia, cardiac malfunction, and, in rare circumstances, myxedema coma. [4]

The correlation between levels of thyroid hormone and cerebral function is widely recognized. Strong biological interactions between intracranial receptors and intra-cerebral processes are mediated by thyroid hormones. Anxiety-depression symptoms and thyroid hormone levels are typically connected in hypothyroid individuals. It is generally documented that anxiety disorders, severe depression, and psychosis, respectively, affect 30%, 40%, and 5% of hypothyroidism patients. The development of mood disorders and potential impacts on mood have both been related to thyroid problems. [5]

There is evidence linking hypothyroidism with depression. It has been shown that somatostatin and serotonin have an effect on the hypothalamus-pituitary-thyroid axis, which connects hypothyroidism to depression. Numerous research studies have shown that people with hypothyroidism who receive an inaccurate diagnosis, insufficient care, or no therapy at all are more likely to experience sadness. A higher incidence of depression is also linked to autoimmune thyroiditis. Thyroid-stimulating hormone (TSH), anti-thyroglobulin (TgAb), and thyroid peroxidase antibodies. There is evidence linking hypothyroidism with depression. It has been shown that somatostatin and serotonin have an effect on the hypothalamus-pituitary-thyroid axis, which connects hypothyroidism to depression. Numerous investigations have shown that people with hypothyroidism who receive an inaccurate diagnosis, insufficient care, or no therapy at all are more likely to experience sadness. A rise in the number of suicides. [6]

The thyroid hormone (TH) is essential for preserving homeostasis and controlling metabolism and energy expenditure. About 20 to 30 percent of the resting metabolic rate is contributed by skeletal muscles. The expression of myocyte-specific genes, which encode myosin isoforms, Na+-K+ ATPase pumps, and Ca-ATPase canals in the sarcoplasmic reticulum, is regulated by TH.

Lactic acid buildup during exercise inhibits muscular performance due to faulty proton ejection and pyruvate oxidation in hypothyroidism. Muscle glycolysis outperforms mitochondrial oxidation, boosting the conversion of pyruvate to lactate, raising the levels of lactic acid, and causing intracellular acidosis. Myosin rapidly increased by TH. and fast-twitch fibers present in skeletal muscle exhibit reduced efficiency in utilizing oxygen during contraction when compared to slow-twitch muscle fibers, thereby elucidating the compromised exercise tolerance [7].

The incorporation of regular physical exercise is of significant value in the management of hypothyroidism. Physical exercise has the potential to facilitate thyroid function and

promote the secretion of hormones by the thyroid gland. The influence of acute exercise on the hypothalamic-pituitary-thyroid axis can lead to alterations in the circulating concentration of hormones. Nevertheless, chronic exercise elicits a physiological response that triggers energy conservation and reduces the hypothalamic-pituitary-thyroid axis activity. When physical activity is performed in a repetitive manner at specific intervals, it triggers a coordinated response between the pituitary gland and the thyroid gland, leading to an increase in the metabolism of thyroid hormones[8].

The goal of pilates-based physical exercise is to strengthen the core, which is the center of the trunk that supports the body and is made up of the rectus abdominis, erector spine, transverse abdomen, diaphragm, and pelvic floor muscles. Centralization, concentration, control, precision, breathing, and flow are the six guiding principles of the approach [9]**.**

In young, healthy subjects, acute aerobic exercise can effectively elevate levels of thyroid hormones and reduce arterial stiffness. Acute aerobic exercise reduced euthyroid and subclinical hypothyroidism patients' serum TSH levels as well as arterial stiffness **[10].**

Dietary factors also have an influence on thyroid role and the etiology of thyroid disorders. Iodine, vitamin D, selenium, and total energy intake and status are some of these. Additionally, a multivitamin may assist in guaranteeing proper consumption of selenium and iron [11]**.**

Material and methods

Participants

A pre-and post-test group randomized controlled trial (RCT), single-blind study was organized. The research was conducted between 15 June 2022 and 15 September 2022. Before the initiation of the research, all participants were provided with comprehensive information regarding the objectives of the research as well as any potential risks that they may encounter. Every participant in the study signed a consent form. The present study has obtained ethical approval from the Ethical Committee of the Physical Therapy Faculty at Cairo University. The provided reference number is P.T.REC/012/004302.Sixty women with a History of controlled primary hypothyroidism (TSH between 0,5 to 4,6 ml U/L and T4 between 5.1 to 14.1Ug/dl). Their BMI was (25-30Kg/M2), and their age ranged from(30-45) years old; they were recruited from the patient-internal clinic of Idko Hospital, Elbaheria Governorate, to participate in this study and referred by the physician of internal medicine. Patients who had Pituitary disease (low TSH, low thyroid hormone level), Unstable cardiovascular problems like arrhythmia and heart failure, and Metabolic disorders. (Diabetes),Chronic chest disease.(Asthma, chronic obstructive pulmonary diseases (COPD), Auditory and visual problems, Pregnancy and lactation, and Musculoskeletal diseases, which may affect their physical activity. Individuals using drugs that reduce muscle strength, such as steroids, Peripheral vascular diseases, and Renal and hepatic disorders, were excluded.

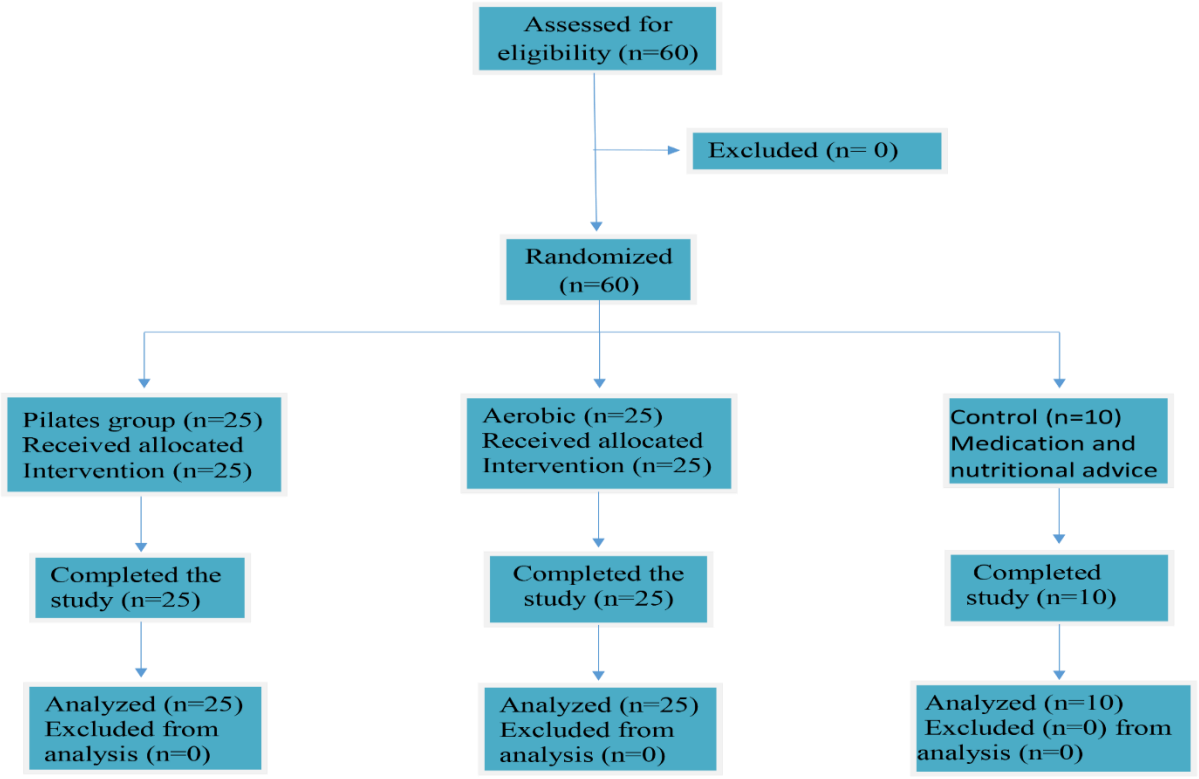
Procedures

All participants were subjected to a physical assessment by a qualified physiotherapist at the beginning of the trial to determine their eligibility for participation. A survey was utilized for gathering demographic data. Each participant's height (cm) and weight (kg) were noted, and body mass index (BMI) was determined.

Randomization to receive Pilates training or aerobic exercise or only medication and nutritional advices was performed by closed envelope; the patients had an equal chance of being allocated to the three groups. A blinded researcher saw the envelope and allocated the patients according to their groups. **(Fig. 1)**

Allocation Follow up Analysis

Figure 1. is a flowchart illustrating the selection criteria.



Outcome measure

Analog weight and Height scale

It was utilized for the purpose of measuring weight and height in order to calculate body mass index of each patient, thereby ensuring that they met the inclusion criteria of the study, which specified a BMI range of 25-30 kg/m2. [12]

Quality of life (QOL)

The Short Form 36 Quality of Life Questionnaire is a widely employed instrument utilized for the evaluation of health-related quality of life (HRQL). It comprises 36 items that are categorized into eight domains: Physical Functioning, Vitality, Bodily Pain, Physical Role Functioning, General Health Perceptions, Social Role Functioning, Emotional Role Functioning, and Mental Health. The scoring of items is conducted using different scales, including a 2-point scale (yes/no), a 3-point scale, and primarily a 5-point scale. These scales are utilized to assess the items in relation to the previous month. The scoring for each section ranges from 0 (worst QOL) to 100 (best QOL). The calculation of a physical composite score

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(PCM) and a mental composite score (MCS) involves assigning scores ranging from 0 (worst QOL) to 100 (best QOL) [13].

Depression level

Depression questionnaire as the first line of treatment Depression Screening Questionnaire (PSQ4D). The initial three components of the PSQ4D were derived from the three primary indicators associated with diminished emotional state, diminished interest, and lack of energy. There was an additional fourth insomnia-related item[14].

Functional capacity and endurance.

The 6-minute walk test is designed to gauge one's capacity for functional exercise. Participants are asked to walk for 6 minutes as quickly as they can on a hard, level surface to measure their distance (in meters) covered per minute. The level of individual motor performance during the 6MWT will be represented by the mean distance attained for each subinterval **[15].**

Interventions

The Pilates mat exercise group: Got pilates, which included hundred, One leg kick, swimming, one leg circle, roll up, roll down, single leg stretch, double leg stretch, saw (spinal rotation), leg up and down, and spine stretch forward are all exercises that can be done for 45 minutes each, three times per week for a total of 12 weeks, with four sets per session. Exercise intensity increased by about 5% per week, from 50% to 55% of maximum heart rate in the first week to 75 to 80% of maximum heart rate in the last twelve. In order to effectively regulate exercise intensity, it is recommended to employ the maximum heart rate formula, which calculates the peak heart rate by subtracting the individual's age from 220. Additionally, the utilization of heart rate monitoring is advised. Each session comprised pre-pilate warm-up exercises, consisting of a 10-minute duration dedicated to breathing, shoulder, hip, and spine alignment. This was followed by a 30-minute Pilates session, focusing on general fitness utilizing the classic Pilates repertoire of exercises suitable for individuals at beginner and intermediate levels. The Pilates session primarily involved mat Pilates exercises. Finally, the session concluded with a 5-minute cool-down period involving breathing exercises. Every Pilates exercise was done in a single sequence of repetitions, with the number of reps increasing as the person improved at completing the exercise [16] .

The Aerobic exercise group received aerobic exercises in the form of 45 minutes of walking on the electrical treadmill in addition to medication and nutritional advices, three sessions per week, for 12 successive weeks. The following Karvonen formula was used to compute a moderately intense aerobic workout (at a level of 60–75% of HR max): (Maximal heart rate = 220 age in years). Duration: 45(10 minutes for warming up, 30 minutes for the active stage, and 5 minutes for cooling down). All participants used an HR monitor (pulse oximeter) to track their heart rates throughout each training session, and coaches constantly checked in to make sure the HR was staying within the desired range [17] .

The Control group received medication plus nutritional advices. Levothyroxine has historically served as the primary therapeutic intervention for the management of hypothyroidism, and it

holds a prominent position as one of the most extensively prescribed pharmaceutical agents globally.

Nutritional recommendations for three distinct groups: It is recommended to consume multiple servings of diverse vegetables and fruits on a daily basis. It is advisable to construct meals around starchy foods with higher fiber content, such as potatoes, bread, rice, or pasta. It is recommended to consume dairy or dairy alternatives. Consume a variety of protein-rich foods such as beans, pulses, fish, eggs, and meat. It is advisable to opt for unsaturated oils and spreads, consuming them in moderation, alongside a diet rich in Vitamin D, Calcium, Iodine, Selenium, and Zinc, as these have been suggested to enhance thyroid functionality. [18]

Statistical analysis

The statistical analyses were conducted using SPSS software version 22. A comparison between the groups' features, including age, weight, height, and BMI, was performed using ANOVA. Paired T-test was used to detect the differences before and after intervention within every group in 6MWT (M), and MANOVA was utilized to compare these variables between groups; in addition, Post Hoc Tests were applied to multiple comparisons. Wilcoxon test was employed to evaluate the variations before and after training within every group regarding SF-36 and PSQ4D scales, and the Kruskal-Wallis test was conducted to compare between the three groups pre and post-intervention regarding this variable and multiple comparisons were performed utilizing Mann-Whitney U test. The significance level for all statistical tests was set at $P < 0.05$.

Results :

Overall, 60 patients were included and randomly distributed into groups A, B, and C. **Table 1** shows no significant difference in the participants' characteristics, including age, height, weight, and BMI (P-value was 0.586, 0.055,0.312, and 0.124, respectively).

Table 1. Patient demographic data in three groups.

	Pilates group Mean±**SD**	Aerobic group Mean **±SD**	Control group Mean**±SD**	F-value	P-value
Age (years)	35.16±3.66	34.44±3.82	35.9±4.77	0.539	0.586
Height (cm)	162.3±4.49	162.3±5.2	166.6±5.78	3.061	0.055
Weight (Kg)	78.2±4.6	78.4±5.2	80.9±5.3	1.188	0.312
BMI (kg/m²)	29.6±0.64	29.6±0.6	28.9±1.7	2.162	0.124

SD: standard deviation.

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Regarding depression, the scores of PSQ4D decreased significantly between before and after aining in groups A, B, and C, with respective percentage changes of 92% ,92% and52.5%(P≤ 0.05)(**Table2**)

Regarding the quality of life, the scores of the SF-36 scale increased significantly between before and after training in groups A, B, and C, with respective percentage changes of 48.9%,45.3% and13.7%(P≤ 0.05)(**Table 2).**

Table 2. SF-36 and PSQ4D comparison within and between groups A, B, and C.

Variables		Group A	Group B	Group C	Comparison between groups
		$\overline{X}$ **± SD**	$\overline{X}$ **± SD**	$\overline{X}$ **± SD**	**P-value**
SF-36	**Pre-Treatment**	41.7±11.2	43.5±11.1	41.57±10.5	0.792
	Post-Treatment	62.1±10.7	63.2±9.9	47.3±11.8	P=0.004*
	Percentage of change	48.9%	45.3%	13.7%	
	Comparison within Group	P≤ 0.05*	P≤ 0.05*	P=0.012*	
PSQ4D	**Pre-Treatment**	4±0	4±0	4±0	1.000
	Post-Treatment	0.32±0.48	0.32±0.47	1.9±1.8	P=0.013*
	Percentage of change	92%	92%	52.5%	
	Comparison within Group	P≤ 0.05*	P≤ 0.05*	P=0.024*	
Multiple Comparisons (post-treatment)					
		Post-SF-36 P-value		**Post-PSQ4D P-value**	
Group A vs. B		0.705		1.000	
Group A vs. C		0.005*		0.009*	
Group B vs. C		0.001*		0.009*	

$\overline{X}$**: Mean, SD: Standard deviation, MD: mean difference, p-value: Probability value, *: significance**

Regarding functional capacity, the scores of 6MWD increased significantly between before and after training in groups A, B, and C, with respective percentage changes of 15.4% ,12.9% and 3.5%(P≤ 0.05)(**Table 3**).

Pre-training PSQ4D, SF-36 scale, and 6MWD scores (1.000, 0.792, and 0.77, respectively) showed no statistically significant variations between the three groups. After training, the inter-group comparison showed that the Pilates and aerobic group had significantly better scores than the control group in terms of the final 6-MWD, SF-36 scale, and PSQ4D (P value ≤ 0.05, P=0.004* and P=0.013*, respectively).

Table 3. 6MWT comparison within and between groups A, B, and C.

Variables		Group A	Group B	Group C	Comparison between groups	
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	$\bar{X}$ ± SD	F-value	P-value
6MWT (M)	**Pre-Treatment**	456±40.2	453±29.4	427.5±26.5	2.684	0.77
	Post-Treatment	526.2±60.6	511.8±30.4	442.5±43.8	11.47	P≤ 0.05*
	Percentage of change	15.4%	12.9%	3.5%		
	Comparison within Group	P≤ 0.05* T=10.76	P≤ 0.05* T=25.81	P=0.107 T=1.793		

Post Hoc tests, Multiple Comparisons (post-treatment)

	Post-Treatment Weight (Kg)	
	MD	**P-value**
Group A vs. B	14.4	0.564
Group A vs. C	83.7	P≤ 0.05*
Group B vs. C	69.3	0.001*

$\bar{X}$: Mean, SD: Standard deviation, MD: mean difference, p-value: Probability value, *: significance

Discussion

The main objective of this research was to compare the influence of Pilates and aerobic exercises on depression levels and functional capacity in patients with hypothyroidism. PSQ4D and 6MWT were the main outcome measures. Chronic hypothyroidism has the potential to alter the brain permanently. Numerous symptoms, including sweating, palpitations, and dyspnea, can be seen in those who have thyroid dysfunction and experience panic episodes. However, it's still unclear how anxiety problems are related to thyroid dysfunction [19].

The results of this investigation demonstrated that pilates exercises and aerobic exercise had a valuable and significant effect on depression.

And functional capacity in hypothyroid patients, but Pilates had more significant differences than aerobics and medication only.

Exercise improves mood by increasing neurotransmitters. The vibration training may reduce depression in postmenopausal women with hypothyroidism by increasing serum serotonin and norepinephrine levels[20].

Pilates is advocated as a mind-body exercise regimen that emphasizes the importance of controlled breathing and the attainment of optimal muscle strength, flexibility, trunk stability, and posture. Over the past decade, a significant number of clinical investigations have been undertaken to explore the impact of Pilates on pain management. These studies have consistently reported that Pilates demonstrates efficacy in alleviating diverse forms of pain. Pilates may serve as a viable alternative physical training modality for individuals who are overweight or obese due to its potential to elicit significant improvements in cardiorespiratory fitness, body composition, and performance on functional assessments [19].

The findings of the prior investigation demonstrated that a duration of eight weeks of engaging in Pilates exercises led to a significant decrease in anthropometric measurements and a concurrent enhancement in subjective well-being aspects, including emotional, psychological, and social well-being, among a group of middle-aged women who were classified as obese[21].

Engaging in physical exercise of moderate intensity has been shown to yield significant health advantages, enhancing overall well-being and mitigating the likelihood of developing oxidative stress-related ailments. Furthermore, there is a correlation between engaging in physical exercise and a decrease in cognitive complications. Additionally, physical exercise has been found to be connected to an increase in neurogenesis, as well as the survival, differentiation, and migration of neurons[22].

Prior research has indicated that engaging in aerobic exercise leads to a notable elevation in the levels of thyroxine, triiodothyronine, and thyrotropin-releasing hormone, as well as certain subscales associated with quality of life. Additionally, exercise induces a notable reduction in the level of thyroid-releasing hormone, thereby indicating the impact of physical activity on hormone secretion [17].

In relation to the measure of well-being and satisfaction in one's life, A previous study has demonstrated that engagement in exercise training leads to an enhancement in HRQoL following a 16-week period of aerobic activities conducted three times per week. The assessment of HRQoL was conducted using the SF-36 questionnaire at the beginning and conclusion of a four-month period. The findings of the study indicated that the subclinical hypothyroidism-training group (sHT-Tr) demonstrated improvements in functional capacity, general health, emotional aspects, and the mental and physical components of HRQoL following the training period. In contrast, the sHT-Sed group (control) did not exhibit any significant changes in these domains[23].

In a separate randomized controlled trial, a group of researchers conducted a comparative analysis of the impacts of aerobic (AT), resistance (RT), and a combination of both exercises (AT/RT) on thyroid function, lipid profile, exercise capacity, and quality of life (QoL) among a cohort of sixty women between the ages of 35 and 45 who were diagnosed with hypothyroidism. The researchers reached a conclusion that in females diagnosed with hypothyroidism and undergoing levothyroxine treatment, all AT, RT, and a combination of both (AT/RT) were equally effective in enhancing T4 levels, lipid profile, and quality of life-related to physical health. Nevertheless, the combined AT/RT regimen demonstrated the most significant enhancements in TSH levels and QoL related to mental health. Conversely, the AT regimen exhibited the most substantial influence on exercise capacity among these individuals ($p < 0.05$)[24].

Conclusions

The findings of this investigation support the importance of Pilates and aerobic exercise to improve life quality, functional capacity, and depression in hypothyroidism patients.

Limitations

This study had a few limitations. Besides, a subset of participants probably did not adhere to the training methodology. In some cases wanted to follow nutritional advices only. Some participants had Coronavirus disease during the study, which affected their ability to exercise, so all of them were excluded from the study.

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