

CHANGES INDUCED BY PHYSICAL EXERCISE AND THERAPEUTIC SWIMMING ON THE HEALTH STATUS OF MENOPAUSAL AND POSTMENOPAUSAL WOMEN WITH OSTEOPOROSIS

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Abstract

The increase in life expectancy implies a greater attention to the prophylaxis of pathology specific to geriatrics (cardiovascular, osteoarticular) Menopause, a natural process, involves hormonal changes such as insomnia, irritability and anxiety Methods: The batch of this study included 106 women who were divided into 2 groups: the study group (G1) with 54 patients, who followed a program of controlled physical exercises, on land and in water, and the control group (G2) with 52 people, who performed only controlled physical exercises on land. The parameters body mass, height, Body Mass Index), systolic blood pressure, diastolic blood pressure, heart rate) were evaluated. (3) Results: After performing physical exercises on land and in water, the systolic blood pressure improved by 11.46% in the G1 group compared to 1.14% in the G2 group, the diastolic blood pressure recorded a reduction of 14.78% in the G1 group and by 0.7% in the G2 group, and heart rate improved by 15.15% in the G1 group compared to 11.84% in the G2 group. (4) Conclusions: Anthropometric and hemodynamic parameters can be improved by regular physical exercises, on land and in water, performed by premenopausal and postmenopausal women. The improvement of blood pressure and heart rate values is due to regular physical exercises, individualized and adapted to the age group and pathology.

Keywords: menopause; physical activities; health condition; therapeutic swimming, quality of life

1. Introduction

As people live longer, there's more focus on preventing diseases related to aging, like heart conditions and joint problems [1,2]. Menopause, a natural process [3,4], brings hormonal shifts [2,5] and symptoms like insomnia, irritability, anxiety, and depression. In Asian women, it typically occurs around age 42, while in Western women, it's around age 50.

Menopause, spanning about a third of a woman's life, involves a decline in ovarian function and risks like increased abdominal fat, higher chances of diabetes, hypertension, atherosclerosis [6,7], stroke, and inflammatory rheumatic diseases [8].

In Romania, menopause happens 10 years earlier than the global average,

raising the risk of osteoporosis. Studies indicate a high rate of osteopenia, over 10%, compared to international standards, possibly due to inadequate nutrition during bone development [9]. Osteoporosis makes bones extremely brittle, meaning even simple actions like coughing or minor movements can lead to fractures [10].

Cardiovascular diseases, particularly during menopause, are a leading cause of death in women [11] due to declining estrogen levels [12]. Additionally, factors like excess weight [12], blood pressure changes, and decreased bone density [13] impact women's quality of life during menopause. Body Mass Index (BMI) serves as an indicator of body fat and disease risk. When BMI surpasses 27.3 kg per square meter,

women may face higher risks of developing conditions such as diabetes, hypertension, coronary heart disease, and osteoporosis [7,14].

During menopause, hormonal shifts can elevate blood pressure and heighten activity in the sympathetic nervous system [14]. Postmenopausal women often experience moderately elevated blood pressure, partly due to decreased elasticity in blood vessels from aging, atherosclerosis, and increased peripheral vascular resistance [15].

The onset of menopause disrupts the balance between bone formation and resorption, primarily due to estrogen deficiency [5,16,17,18]. This imbalance leads to heightened loss of bone mass density and mineral content [19,20,21], increasing the risk of fractures [16,20,22] and bone fragility in women [9,21].

Other factors identified in literature as contributing to falls include sarcopenia (muscle loss), obesity, decreased walking speed, and a history of falls without fractures [23]. These factors can increase the likelihood of falls and related injuries.

Osteoporosis is linked to higher morbidity rates, diminished quality of life, and increased healthcare costs [24]. Managing and treating osteoporosis effectively is crucial for maintaining overall well-being and reducing the burden on healthcare systems.

Engaging in regular physical exercise can mitigate the effects of aging and help prevent the advancement of disabling diseases [12] like cardiovascular disease, cancer [25,26], anxiety, osteoporosis, and depression. Additionally, it can enhance both physical and mental health, ultimately extending life expectancy [27,28].

Regular physical exercise can also lessen the severity of certain health issues [29] by influencing changes in the body's metabolism and hormonal balance [4,7,25,26]. It plays a vital role in maintaining overall health and well-being.

Martinez's study [18] highlights the correlation between physical exercise and health, demonstrating its positive impact on muscle function, balance, reflexes, and reducing the risk of stroke, dementia, and mortality. Engaging in physical activity enhances both physical and mental well-being, thereby improving overall quality of life [17,30]. Physical exercise involves the movement of body segments driven by skeletal muscle action, which expends energy and aims to maintain or enhance physical abilities [31]. In the treatment of osteoporosis, along with medication, incorporating physical exercise, particularly in water, is crucial [32]. This helps prevent bone loss and lowers the risk of fractures, especially in postmenopausal women [7,13].

Studies underscore the positive impact of physical exercise on bone health, joint mobility, and overall quality of life [3,33,34,35,36]. Therapeutic swimming [37], especially beneficial for postmenopausal women experiencing bone loss [36,38], enhances calcium absorption, bone formation [39], and secretion of sex hormones [40,41], further contributing to improved bone health. Therapeutic swimming holds significant importance, particularly for post-menopausal women dealing with bone loss. It can help improve bone health, joint mobility, and overall well-being. Therapeutic swimming not only aids in bone formation and calcium absorption but also promotes the secretion of sex hormones, contributing to overall bone health in post-menopausal women.

Encabo's study [42] indicates that engaging in aerobic exercise for 300 minutes per week results in a smaller decrease in total bone mass density in postmenopausal women compared to exercising for 150 minutes per week. Also Sharif's study [4] suggests that women who engage in reduced physical activity may experience more severe menopausal symptoms. Physical activity plays a crucial role in managing menopausal symptoms

and promoting overall well-being during this stage of life.

Studies [38,43,44] emphasize the effectiveness of regular [10], adapted, and individualized physical exercise across different age groups and physical abilities. This approach helps improve posture, prevent falls, and reduce the risk of fractures, considering that over 90% of hip fractures are caused by falls [9,45,46].

Other authors [47] emphasize that factors related to both static and dynamic balance play a significant role in human mobility at higher levels. Maintaining balance is crucial for various activities and overall mobility.

The World Health Organization (WHO) recommends exercise as a key physical therapy for preventing and treating osteoporosis in the elderly [48,49]. Exercise helps increase bone remodeling, reduce bone resorption [50], and improve bone angiogenesis [51], ultimately promoting bone health and reducing the risk of fractures.

Other research [52] has indicated that physical exercise is beneficial for individuals with osteoporosis, as long as the program does not focus solely on endurance activities.

Tailoring the exercise regimen to include a variety of activities can help improve bone health and overall well-being in individuals with osteoporosis.

Osteoporosis can lead to fractures, particularly in the hip, which not only increase mortality rates but also reduce functional capacity and overall quality of life. Managing osteoporosis effectively is crucial for maintaining independence and well-being as we age.

Studies [53] demonstrate that movement is a complex process involving all structures of the myo-arthro-kinetic apparatus, including muscles, tendons, ligaments, and joints. Each component plays a crucial role in facilitating smooth and coordinated movement.

Maintaining an adequate morphophysiological state involves keeping the body's structure and function in a healthy balance. Engaging in physical activity, along with consuming sufficient dietary and medical calcium [37,54,55], can help prevent fractures caused by falls associated with osteoporosis [56,57].

Our study aimed to assess the impact of therapeutic swimming exercises on cardiovascular fitness in postmenopausal women.

The hypothesis of this study was to determine whether significant differences exist in the effects of physical exercise versus therapeutic swimming in postmenopausal women, and whether the observed changes can be sustained over a longer period, specifically two months

2. Materials and Methods

2.1. The study batch

The batch of this study, which took place on an outpatient basis, included a number of 106 women, who agreed to participate in the study and who were evaluated clinically, functionally and imaging, at the time of the start of the program (T1-baseline evaluation), at its completion 10 weeks after the first evaluation (T2) and after 20 weeks after the intervention-(T3).

Knowing that participants to successfully form a habit (and to keep it) need 59 to 66 days, we set the treatment periode to 10 weeks, expecting routine modifications leading to cardiovascular changes, that we can asses [58].

The inclusion criteria were: diagnosis of hypertension, menopause and post menopause, osteoporosis ($T \geq 2.5Ds$)

The exclusion criteria were: decompensated heart diseases, other pathologies in a decompensated state, medical contraindications (heart diseases, atrial fibrillation, myocardial infarction, arterial hypertension stage III), uncooperative patients.

All participants (patients and evaluators) in the study were informed of

the purpose of the study and the exercise program, the collected data being used only for this study.

The study participants were divided into 2 groups: the first 22 participants, in order of registration, were assigned to group G1; the next 20 participants in group G2.

The study group (G1) included 54 patients with an average age of 66.8 years (± 4.4), who followed a controlled exercise program on land and in the water, and the control group (G2) included 52 people with an average age of 66.2 years (± 3.9), who performed physical exercise on land.

The participants were asked to continue their daily activities, the diet, without performing physical exercises outside of those included in the study program.

Specific indications for each group:

- Group G 1 followed a controlled program of exercises on land and in water

- Group G2 – followed an exclusive program of exercises on land

All participants continued the pharmacological treatment for hypertension and osteoporosis indicated by the doctor.

2.2. Procedures

The procedure consists of physical exercise and is applied to the study group-G1 study group of 54 patients.

2.2.1. Work program

Day 1 - Initial evaluation of the anthropometric parameters body mass (G), height, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) at the beginning of the procedure. The program adopted in this study lasted 10 weeks and involved physical therapy on land and therapeutic swimming

2.2.1.1. The kinetotherapeutic program (Table I)

Table I. Kinetotherapeutic programme

General objectives of the kinetic program on land	Physical activity plan
1. Reducing pain and maintaining joint flexibility.	A. Preparing the body for effort: Warm-up and Flexibility Exercises (5-7 minutes)
2. Improving joint mobility and suppleness, muscle strength and endurance	Analytical segmental and posture exercises (5-10 minutes)
3. Improving functional parameters (heart rate, respiratory rate, blood pressure) and maintaining an optimal level of fitness	B. The fundamental part: Cardio exercises (10-15 minutes)
4. Influencing correct posture through kinetic means	Strength or endurance exercises (15-20 minutes)
5. Stimulating the desire and awareness of patients to practice physical exercises on land	C. Recovery of the body after exercise: Progressive muscle relaxation and breathing exercises (5-7 minutes) Communicating the final ideas: Motivating and cultivating the interest of patients to be aware of the positive impact that kinetic exercises have on health (3-5 minutes) Duration: 35-40 minutes/session Frequency: 3 sessions/week Intensity of effort: moderate Volume: 2-3 reps/exercise

In developing the kinetic programs, both in water and on land, we focused on adapting them according to the individual biological peculiarities, functional capacities, level of physical and technical training, as well as the health status of the patients.

2.2.1.2. Therapeutic swimming program

Swimming program objectives are (Table II)

Table II. Therapeutic swimming program

Swimming program		
Stage I		
Characteristics	Duration	2 weeks
	Frequency	2 sessions/week
	Time	35 minutes (body preparation for effort: between 7 and 10 minutes, the fundamental part of the therapeutic swimming lesson: 20 minutes and recovery after effort 5 minutes)
	Volume	250-350 m intensity of effort: an average rhythm of execution between 14-20 movements per minute is recommended.
Water acclimatization exercises T: 0-29.5°C	Content: Examples of static and dynamic exercises Auxiliary materials (belt, cork, baton, balls) • Face and body washed (getting familiar with the water temperature)	• Splashing with water (getting the body used to water) • Walking through water (involves the body moving forward against the resistance of the water while having a low impact on the joints) over different distances 25m, 50m with arms in different positions. • Immersion of the body up to the level of the neck and head including the mouth, nose and eyes. (getting used to the feeling of water on the face and gaining control during water activities). • Front float and back float (these positions are to maintain a certain buoyancy in the water. This is done by relaxing the body and using breathing to keep the head above the water. Light movement of the lower and upper limbs can be used to maintain buoyancy. • Walking a certain distance with the face in the water (requires coordination between the lower limbs and the upper limbs to ensure efficient progress in the water)
Stage II		
Characteristics	Duration	4 weeks
	Frequency	2 sessions/week
	Time	40 minutes (body preparation for exercise: between 7 and 10 minutes, the fundamental part of the therapeutic swimming lesson: 30 minutes and recovery after exercise 5 minutes)
	Volume	350-500 m intensity of effort: an average rhythm of execution between 16-20 movements per minute is recommended.
Exercises for stability, balance and flexibility T: 0-29°C	Content: Examples of static and dynamic exercises from the three swimming strokes: breaststroke, backstroke and breaststroke	1. Sequences of movements performed with the legs • With support at the edge "break the wave" alternative leg movements • From the position of floating on the water with the arms resting on the raft, alternating movements of the legs in the vertical plane 2. Sequences of exercises performed with the arms • From sitting with the trunk bent, rowing movement of the arms in the bras process • From the supine position, alternate rowing of the back arms

Auxiliary materials
(belt, cork, wand,
paws)

3. Simple coordination of arms and legs

- Walking with the arms up, on the 6th step rowing the collar with one arm is performed.
- From the fundamental position of floating arms, the execution of three cycles of the legs, coordinated with a rowing of the arms.

4. Coordination (arms-legs-breathing)

- Arms-legs-breathing coordination in the neck, back and breaststroke procedure over certain distances 12.5m, 25m, 50m, 100m.

5. Stretching in water

Light stretching of the chest and shoulder muscles

- With the support of the hands at the edge "breaks the wave" bending the right/right leg from the knee joint bringing the heel as close as possible to the buttock-maintain 20-30 seconds
- Sitting with your back against the wall, bringing the bent leg from the knee joint as close as possible to the chest - hold for 20-30 seconds

Stage III

Characteristics	Duration	4 weeks
	Frequency	2 sessions/week
	Time	45 minute (body preparation for effort: between 7 and 10 minutes, the fundamental part of the therapeutic swimming lesson: 35 minutes and recovery after effort 5 minutes)
	Volume	500-700 m intensity of effort: an average rhythm of execution between 12-16 movements per minute is recommended.
Exercise for endurance and strength T: 0-29.5°C	Content: Examples of static and dynamic exercises Assistive materials (stick, cork, paws, pullpush dumbbells, round aqua dumbbells)	• Jogging through water reduces the pressure exerted on the joints during running, engages and works multiple muscle groups, improves the cardiovascular system; strengthens and tones the muscles) over different distances 12.5m, 25m, 50m. • Treading water (this action involves exerting pressure on the water by moving the legs slightly to the side, simultaneously with the movement of the arms to keep the head above the surface of the water. It can be performed on the spot (10, 20 seconds, 30 seconds) and while moving on different distances 25m, 50m, 75m, 100m, 150m. • Running different distances (50m, 100m, 150m, 200m) in breaststroke, backstroke and breaststroke. I swim in the breaststroke over a distance of 50m with breathing in 2 or 3 arms. Swimming in the backstroke over the distance of 150m with one arm up, the other next to the thigh, coordinated leg movements in six beats with changing arm positions. Swimming in the breaststroke over the distance of 100m, one breath is performed for one cycle of arms. • Sequences of exercises for arms, trunk and legs with weight. For arms: -Standing apart with the arms bent at the elbow joint, immersed under the surface of the water, grasping the middle wand. The stretching of the arms is performed energetically downwards with a return to the initial position. -From the supine position, the baton positioned under the armpits with the arms at the sides, immersed under water, with the ends of the baton grasping, back leg movements are performed. - From standing apart with the side of the body r./stg. at the edge of the basin, with the support of the hand dr./stg. on the edge "break the wave" with the arm bent at the elbow joint, raising the right/left leg. forward, return to the initial position, raise the left leg laterally, return to the initial position, raise the leg back with a slight tilt of the trunk forward, return to the initial position. Small weights of 1-2 kg are added to the legs.

Note:

*The water temperature (T) must be between 28°C – and 30°C: it is a comfortable temperature for most patients following the therapeutic swimming program.

*The safety of patients during the therapeutic swimming program is ensured by the presence of a specialized physiotherapist or a lifeguard. They will provide clear and precise instructions for the correct performance of the exercises in the water. In case of emergency, the lifeguard will provide first aid, manage the situation until the arrival of the ambulance, if necessary.

- Maintaining an optimal state of health of patients (improving circulation, blood pressure, respiratory system and maintaining a healthy level of general fitness

- Stimulating the desire and awareness of patients to practice physical exercises in water (explaining the benefits of these exercises, providing information on how they contribute to health, stimulating the desire to actively participate in such programs)

- Improving joint mobility and suppleness, muscle strength and endurance (water provides a safe supportive environment for exercises, reducing the impact on the joints)

- Influencing correct posture through water exercises (since water provides resistance and support, patients can work on their posture without being subjected to excessive pressure or stress on the joints or spine.)

- Improving coordination capacity (exercises in water can improve patients' psychomotor skills, especially coordination and balance)

Pain is frequent in osteoporotic patients, due to microfractures.

The systolic and diastolic blood pressure values were monitored using a Rossmax digital blood pressure monitor, a clinically validated device. Blood pressure measurements (mmHg) were performed for all patients in the physical therapy room, at an appropriate temperature, after 5 minutes maintaining a resting position sitting on a chair, and leaning on the back, with the left arm in support. The evaluation was done before the start of the recovery program and 5 minutes after the end of the physical program. The heart rate was assessed with the pulse oximeter, applied to the index finger, the nail polish applied to the finger being removed. The

accuracy of the measurement was $\pm 2\%$ for the pulse.

For the anthropometric parameters, TANITA 780 MA-N- Body fat monitor was used to assess body mass, fat percentage, body mass index (BMI), body fat percentage, body hydration percentage, and height was assessed with the help of a thaliometer, expressed in centimeters. Participants stood barefoot with their arms at their sides and their heels, buttocks, and head in contact with the wall. TANITA uses the BIA method, the bioelectrical impedance analysis method, it is a device with medical validation and offers a segmental body analysis in a few seconds. The patients received the recommendation 24 hours before the measurement not to consume alcohol, 4 hours before not to make intense physical effort, not to consume coffee and food, and 2 hours before the measurement to consume 2-4 glasses of water, to ensure hydration. These indications are also valid for the other measurements.

2.3. Statistical analysis

The collected data were analyzed using SPSS. Microsoft Excel 10 was used to calculate some statistical variables, the median, standard deviation and the t-student test, and the accepted statistical significance was $p < 0.05$ for a 95% confidence interval. The t-student test was applied to compare the parameters at the three evaluation moments, as well as to compare the values of the parameters between the two groups.

For data analysis, linear regression and ANOVA were used to compare within the group and between groups, the mean values for each variable. Two way analysis of variance (ANOVA) was performed using OriginPro 2024b statistical software, for $p < 0.05$ – 95% probability.

3. Results

For the duration of the program and the control, differences were recorded at the evaluation times, greater in the EXPERIMENTAL-G1 study group compared to the CONTROL-G2 control group.

In the G1 group, body mass-decreased by 1.55% at the T2 time and by 1.42% at the T3 time compared to the G2 group, where the decrease was 0.63% at the T2 and T3 times. Between time T1 and time T3, body weight decreased by 2.97% in the G1 group and by 1.27% in the G2 group.

The Body Mass Index (BMI) values decreased in the G1 group by 2.19% at T2 and by 0.73% at T3, while in the G2 group the reduction was 0.35% at T2 and 1.75% at T3. Between the moments T1-T3, the body mass index decreased by 2.93% in the G1 group and by 2.10% in the G2 group.

And the percentage of adipose tissue decreased by 1.65% in the G1 group at the time of T2 and by 0.71% at the time of T3, compared to the G2 group where the decrease was 0% at the time of T2 and 1.20% at the time of T3. Between the moments T1-T3, the reduction of adipose tissue was 3.31% in the G1 group and 1.20% in the G2 group.

Hemodynamic parameters also showed differences between the start of treatment and control.

For systolic blood pressure (SBP), the reduction was in the G1 group of 5.33% at T2 and 1.75% at T3, compared to the G2 group where the reduction was 1.64% at T2 and 2.79% at T3. Between T1-T3 moments, the reduction of systolic blood pressure values in the G1 group was

11.46%, while in the G2 group it was 1.14%.

The diastolic blood pressure (DBP) in the G1 group registered a decrease of 6.94% at the time of T2 and of 7.83% at the time of T3, compared to the group G2 in which the decrease in values was of 2.57% at the time of T2 and of 3.27% at the time of T3. Between the moments T1-T3, the diastolic blood pressure values were 14.78% in the G1 group and 0.7% in the G2 group.

The values recorded for the heart rate (HR) in the G1 group were reduced by 8.15% at the T2 time and by 7% at the T3 time, and in the G2 group the reduction was 6.57% at the T2 time and 5.26% at the T3 time. Between the moments T1 and T3, the heart rate decreased by 15.15% in the G1 group and by 11.84% in the G2 group.

The pain was assessed using the Visual Analogue Scale (VAS) in which 0 is the minimum value and corresponds to the absence of pain, and 10 represents unbearable pain.

In the G1 group, there was a decrease in pain by 37.57% at the time of T2 and by 29.29% at the time of T3 compared to the group G2 where the decrease was 24.25% at the time of T2 and 27.09% at the time of T3. Between the moments T1-T3 the pain was reduced in the G1 group by 66.87%, while in the G2 group it was reduced by 51.35%.

The t-student test was applied to all measured parameters for each batch, the result being statistically significant, having $p < 0.05$ at all evaluation moments. The working hypothesis was verified in both groups, the results obtained being significant for the evaluated parameters, except for the pain parameter (**Table III**).

Table III. Parameters values at baseline (T1), at 10-weeks (T2) and at 20-weeks (T3) (postmenopausal)

G1	T1 AVG(SD)	T2 AVG(SD)	p value	T2 AVG(SD)	T3 AVG(SD)	p value	T1 AVG(SD)	T3 AVG(SD)	p value
Body weight	77.3(8.3)	76.1(8.2)	0.0026	76.1(8.2)	75(8.2)	0.0027	77.3(8.3)	75(8.2)	0.0053
BMI	27.3(2.2)	26.7(2.7)	0.0001	26.7(2.7)	26.5(2.2)	0.0021	27.3(2.2)	26.5(2.2)	0.0053
(%AT)	42.2(2.3)	41.5(2.4)	0.0031	41.5(2.4)	40.8(2.5)	0.0034	42.2(2.3)	40.8(2.5)	0.0064
VAS	8.3(0.5)	5.2(0.6)	0.0111	5.2(0.6)	2.8(0.8)	0.0250	8.3(0.5)	2.8(0.8)	0.0034
SBP	136.9(5)	129.6(4.7)	0.0087	129.6(4.7)	110(4.8)	0.0012	136.9(5)	110(4.8)	0.0019

DBP	89.3(4.3)	83.1(3.3)	0.0102	83.1(3.3)	76.1(3.6)	0.0151	89.3(4.3)	76.1(3.6)	0.0252
HR	87.1(6.4)	80(5.2)	0.0119	80(5.2)	73.9(4.1)	0.0109	87.1(6.4)	73.9(4.1)	0.0228
G2	T1 AVG(SD)	T2 AVG(SD)	p value	T2 AVG(SD)	T3 AVG(SD)	p value	T1 AVG(SD)	T3 AVG(SD)	p value
Body weight	78.5(9.6)	78(9.6)	0.0013	78(9.6)	77.5(9.7)	0.0014	78.5(9.6)	77.5(9.7)	0.0027
BMI	28.5(3.7)	28.4(3.7)	0.0013	28.4(3.7)	27.9(3.8)	0.0031	28.5(3.7)	27.9(3.8)	0.0043
(%AT)	41.5(2.6)	41.4(2.6)	0.0012	41.4(2.6)	40.9(2.6)	0.0014	41.5(2.6)	40.9(2.6)	0.0026
VAS	7.8(1.1)	5.9(1.3)	0.0086	5.9(1.3)	3.8(1.1)	0.0301	7.8(1.1)	3.8(1.1)	0.0039
SBP	137.3(4.3)	139.6(5.4)	0.0015	139.6(5.4)	135.7(5.1)	0.0044	137.3(4.3)	135.7(5.1)	0.0029
DBP	83.3(3.8)	85.5(4.8)	0.0023	85.5(4.8)	82.7(4.2)	0.0043	83.3(3.8)	82.7(4.2)	0.0021
HR	85.3(6)	80.8(5.4)	0.0004	80.8(5.4)	77.3(5.5)	0.0078	85.3(6)	77.3(5.5)	0.0158

Note 1: Data are expressed as mean (95% confidence interval)

Note 2: VAS – Visual Analog Scale

Note 3: SBP- systolic blood pressure

Note 4: DBP -diastolic blood pressure

Note 5: HE -heart rate

Note 6: Student's t-test was used to evaluate the differences between groups at the baseline

Regarding body mass and body mass index values, we can appreciate the following:

In group G1

- At the time of T1, there were 8 (14.82%) normal weight, 40 (74.07%) overweight and 6 (11.11%) obese.

- At the time of T2, there were 12 (22.22%) normal weight people, 37 (68.51%) overweight and 5 (9.25%)

with obesity

- At the time of T3, there were 14 (25.92%) normal weight people, 35 (64.81%) overweight and 5 (9.25%)

with obesity.

To group G2

- At the time of T1, there were 9 (17.31%) normal weight people, 27 (51.92%) overweight and 16 (30.77%)

with obesity.

- At the time of T2, there were 10 (19.23%) normal weight people, 28 (53.84%) overweight and 14 (26.93%)

with obesity

- At the time of T3, there were 10 (19.23%) normal weight people, 29 (55.77%) overweight and 13 (25%)

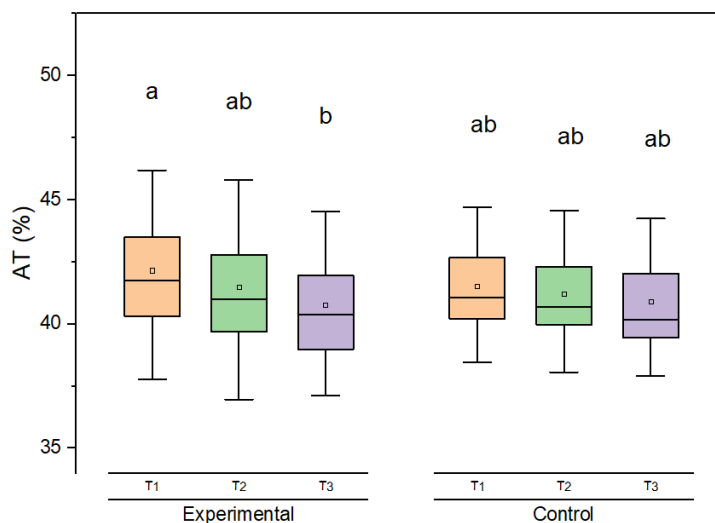
with obesity

Two way analysis of variance (ANOVA) was performed using OriginPro 2024b statistical software,

for $p < 0.05$ – 95% probability.

Looking at this chart on adipose tissue percentage, we notice a relevant difference between T1 and T3 in the

EXP-G1 (Figure 1)



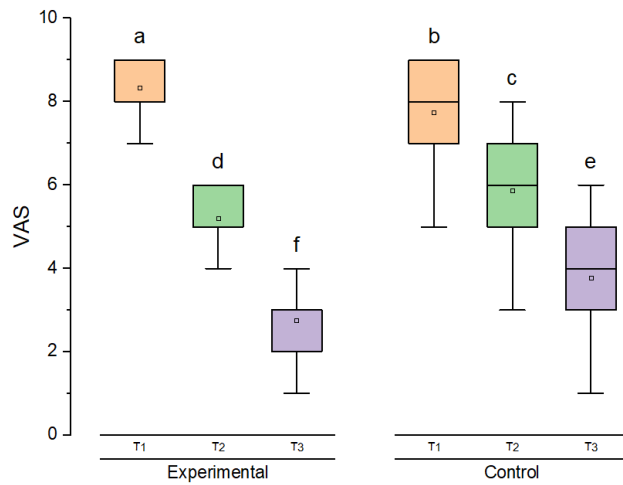
Note 1: T1-baseline evaluation

Note 2: T2 10 weeks after the initial moment

Note 3: T3 10 weeks after the intervention

Figure 1 Dynamics of adipose tissue percentage values

The highlight of our study was the significant decrease in pain scores in EXP=G1 and CON-G2 groups, underlining the effect of exercise in pain management and control (Figure 2)



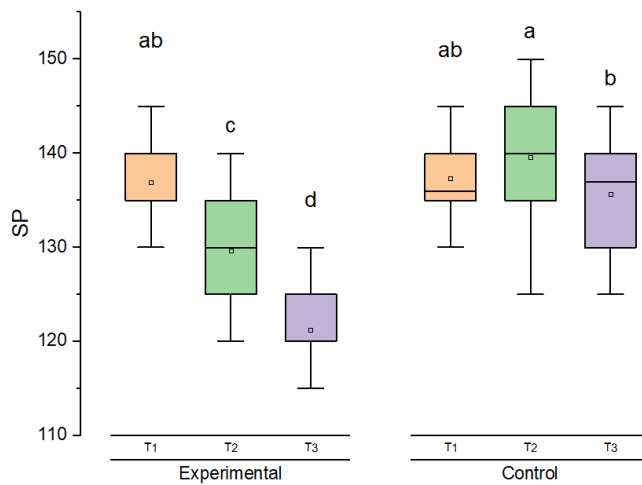
Note 1: T1-baseline evaluation

Note 2: T2 10 weeks after the initial moment

Note 3: T3 10 weeks after the intervention

Figure 2 Dynamics of pain scale (VAS) values

Systolic pressure (SP) recorded significant negative evolution from a relatively similar starting value in G1 and G2. Also diastolic pressure (DP) dropped in value (Figure 3).



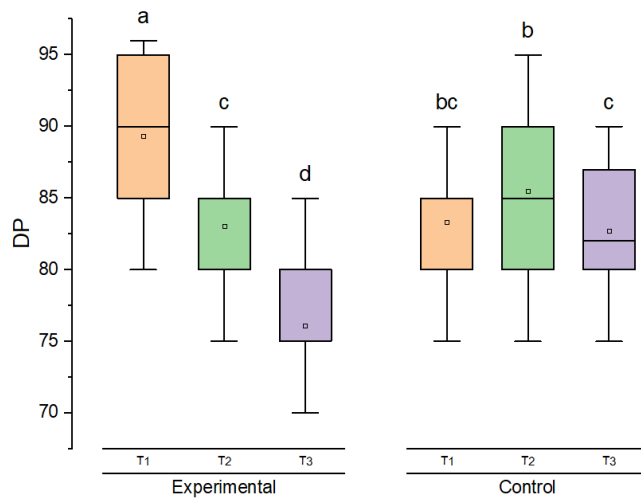
Note 1: T1-baseline evaluation

Note 2: T2 10 weeks after the initial moment

Note 3: T3 10 weeks after the intervention

Figure 3 Dynamics of systolic pressure (SP) values

Also diastolic pressure (DP) dropped in value (Figure 4).



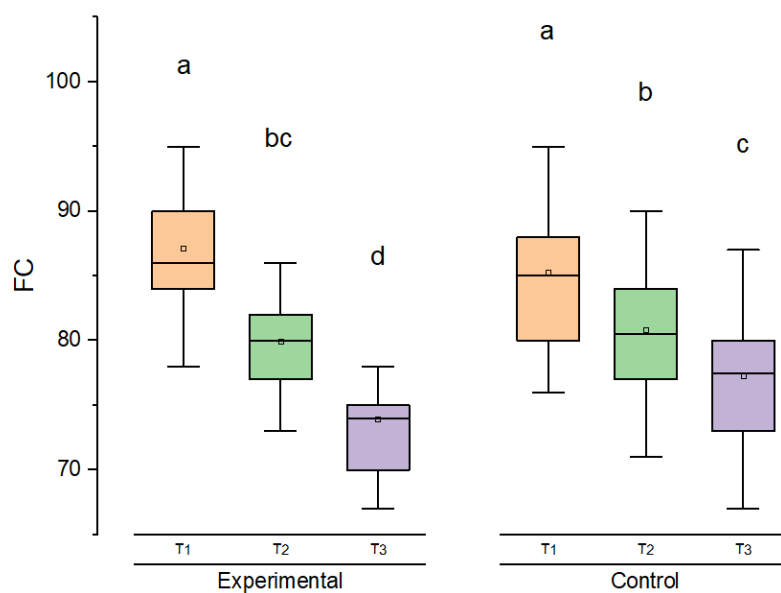
Note 1: T1-baseline evaluation

Note 2: T2 10 weeks after the initial moment

Note 3: T3 10 weeks after the intervention

Figure 4 Dynamics of diastolic pressure (DP) values

Also there was a significant difference between the initial and final measurements in group EXP G1 and CON -G2 (Figure 5).



Note 1: T1-baseline evaluation

Note 2: T2 10 weeks after the initial moment

Note 3: T3 10 weeks after the intervention

Figure 5 Dynamics of heart rate (HR) value

Study group G1

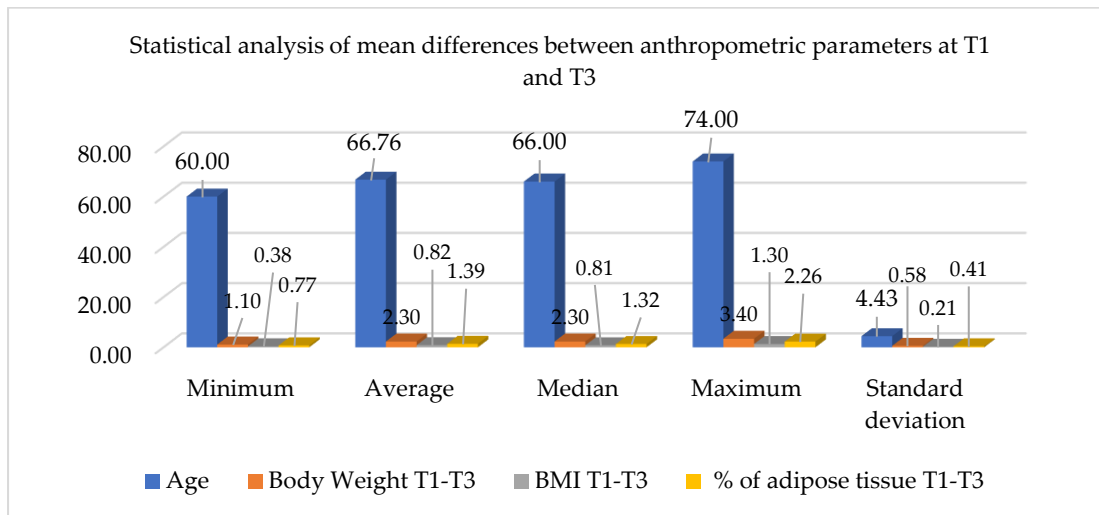


Figure 6 Statistical analysis of mean differences between anthropometric parameters

Student's t-test results for each of the measured parameters (body mass, BMI, percentage of adipose tissue, systolic and diastolic blood pressure, heart rate) show significant differences between the initial (T1) and subsequent (T3) samples. The p-values obtained for each parameter are less than the 0.05 significance level, indicating that there is a significant change between the two measurement tests for each of these aspects.

Body mass at T3 and BMI at T3 ($r = 0.77$) - there is a strong and positive correlation. The higher the body mass, the higher the associated BMI. Body mass at the time of T3 and % of adipose tissue at the time of T3 ($r = 0.64$) - there is a significant and positive correlation. This means that a higher weight is associated with a higher percentage of adipose tissue.

The standard error of the mean (SEM) for the various measured variables is quite small, reflecting greater consistency around the estimated sample means.

Parameters: height, body mass at T1 and T3 testing, BMI at T1 and T3 testing, and systolic blood pressure at T1 and T3 testing have relatively small SEMs (below 1), indicating better precision in estimating the mean sample for these parameters. The standard error of the mean is larger for percentage of adipose tissue at T1 and T3, diastolic blood pressure at T1 and T3, and

heart rate at T1 and T3, signaling slightly greater variation around the estimated means. We suggest that there is relatively good consistency and precision of the sample of 54 cases in estimating the population mean for most of the measured parameters.

Analysis of these data indicates that there is significant inter-assay variation for all parameters. The standard error of the mean (SEM) for most measurements is relatively small, reflecting greater precision in estimating the sample mean despite the dispersion of the data. BSP, DBP and HR parameters show larger dispersions, suggesting extensive variation in the data, and the relatively small SEM indicates a precise estimate of the sample mean.

Control group G2

Values of $p < 0.05$ suggest that the differences observed for weight, BMI, percentage of adipose tissue, systolic and diastolic blood pressure and heart rate are considered statistically significant.

For T3 body mass and T3 BMI ($r = 0.78$) - there is a strong and positive correlation at T3. The higher the weight, the higher the associated BMI.

For body mass T3 and % adipose tissue T3 ($r = 0.45$) - there is a moderate and positive correlation with T3.

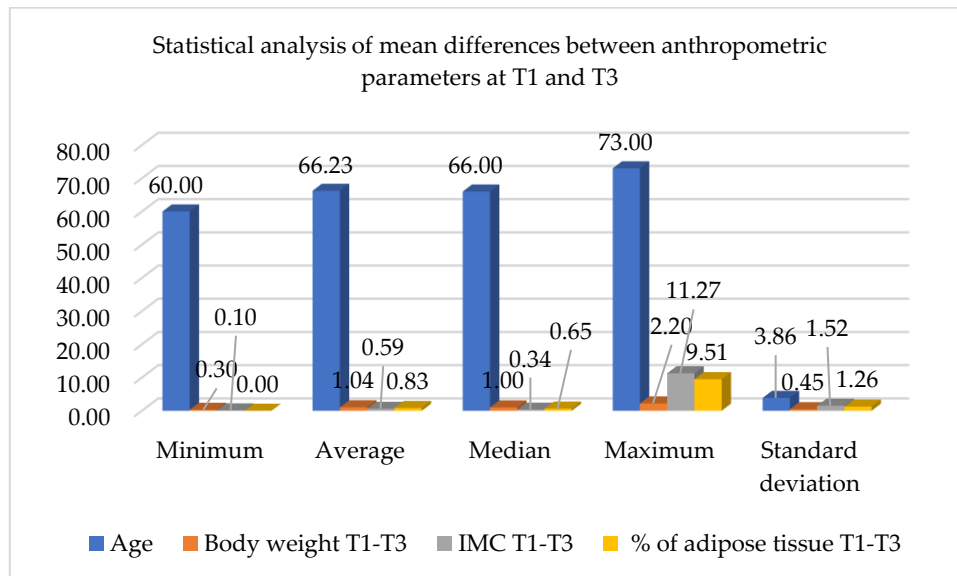


Figure 7 Statistical analysis of mean differences between anthropometric parameters at T1 and T3

In other words, a higher weight is associated with a higher percentage of adipose tissue.

These data suggest that the variability is quite significant for most measurements, with considerable standard deviations. However, the relatively small SEMs indicate an accurate estimate of the sample mean for these parameters, even though the data are variable. Weight-related variables (T1, T3, and the difference between them), BMI, and percent adipose tissue have relatively small SEMs, indicating better precision in estimating the sample mean.

For Systolic blood pressure, the standard errors are: 0.60 for T1, 0.71 for T3 and 0.57 for T1-T3. For Diastolic blood pressure, the standard errors are: 0.52 for T1, 0.58 for T3 and 0.27 for T1-T3. For Heart rate, the standard errors are: 0.83 for T1, 0.76 for T3 and 0.37 for T1-T3.

The difference between batches

For the body mass parameter, the differences show a variation from 0.80 to 1.20, with a mean of 1.27 and a low standard deviation of 0.14. This small standard deviation suggests that the differences in weight are relatively consistent between the two test times.

For BMI, the range in differences is from 0.28 to 0.20, with a mean of 0.23 and a

higher standard deviation of 1.29. This larger standard deviation indicates a wider variation in BMI differences between the two time points.

For % of adipose tissue, the differences show a considerable variation, from 0.77 to 7.24, with a mean of 0.58 and a standard deviation of 0.89. This indicates a large variability between the differences in percentage of adipose tissue recorded between the two measurements.

For Systolic/Diastolic blood pressure, both blood pressures show notable differences between measurements from G1 and G2, with variations from 5.00 to 15.00. The standard deviations are relatively low, 0.41 for systolic blood pressure and 2.45 for diastolic blood pressure, indicating some consistency in the differences recorded.

For the Heart rate parameter, the differences for heart rate range from 1.00 to 7.00, with a mean of 4.89 and a standard deviation of 0.90. This suggests moderate variation in the differences between the two measurements.

4. Discussion

A 2015 review in medical literature [48] highlights the advantages of consistent physical exercise for the health of middle-aged and postmenopausal women. It helps alleviate anxiety, lowers the risk of

osteoporosis, prevents and manages obesity, and reduces hypertension. Physical activity encompasses exercises aimed at enhancing cardiovascular fitness, improving flexibility, and sustaining balance.

In our study the kinetotherapeutic program was structured in such a way as to ensure and increase the level of physical condition, a decrease in peripheral resistance, and decrease in anxiety and stress [59].

Though this program, the national resistance offered by the water, determines the increase in muscle work more intensively than during the physical exercise performed on land, and the results obtained are in accordance with those published in Sony's study [60].

The Therapeutic Swimming Program was divided into three stages, with exercises progressively increasing in difficulty, mirroring the approach taken in the 2021 study [60].

During the initial two-week stage, exercises of low difficulty were conducted to facilitate adaptation to the aquatic environment. This gradual adjustment helps alleviate bone pain, improve joint mobility, and aligns with findings in specialized literature regarding decreased pain and increased joint mobility [61].

During the second stage, exercises focused on stability, balance, and flexibility were conducted to promote proper posture and enhance coordination skills. Therapeutic swimming, with its movements involving both upper and lower limbs, aids in improving coordination and balance, crucial for fall prevention and reducing fracture risk. After implementing the Therapeutic Swimming Program, it was observed that the intended objectives were achieved, consistent with findings in specialized literature.

During the third stage, exercises focused on building resistance and strength, resulting in improved physical fitness and muscle strength development. This led to

enhancements in circulation, as well as changes in blood pressure and heart rate values, consistent with findings in Drogomeretski's article [62].

The average age of post-menopausal women in our study, over 55 years old [3], aligns with findings from other studies. Our results affirm that both physical activity and therapeutic swimming contribute to enhancing the quality of life for individuals.

In the case of our study, following the application of regular physical activity and therapeutic swimming, statistically significant results were found for the parameters evaluated at the end of the program and at the re-evaluation, compared to the initial moment.

The hemodynamic parameters improved significantly in the study group compared to the control group, which is consistent with Mei Ling's study [63]. He concludes that menopause is considered an aggravating factor for the development of metabolic syndrome and cardiovascular diseases in women, physical exercise having significant benefits on body fat and the normalization of blood pressure. Other studies [4,15] indicate that regular physical activity can prevent heart diseases and intervene in the regulation of blood pressure

In our study, the study group consisted of 20 individuals with moderate hypertension, compared to 17 individuals in the control group. We observed a reduction in blood pressure, particularly in those who engaged in regular physical activity, consistent with findings in specialized studies [17]. Additionally, following physical exercise and therapeutic treatment, there was a tendency towards normalization of anthropometric variables such as body weight and body mass index, which was more pronounced in the study group, in line with findings in specialized literature [64].

Thus, in the G1 group at the time of T1 there were 8 normal weight participants, 40 overweight and 6 with obesity, at the time of T2 there were 12 normal weight

people, 37 overweight and 5 with obesity, and at the time of T3 there were 14 underweight people, 35 overweight and 5 with obesity.

In the G2 group at the time of T1 there were 9 normal-weight, 27 overweight and 17 obese participants, at the time of T2 there were 10 normal-weight, 28 overweight and 15 with obesity, and at the time of T3 there were 10 underweight, 29 overweight and 14 with obesity.

Regular physical exercise has positive effects on mental and social health [65], improving physical and psychological symptoms [4]. It was found that the application of the complex physiotherapy-therapeutic swimming program had effects on the evaluated parameters: body weight, body mass index, percentage of fat mass, pain, blood pressure and heart rate. In our study, there is no significant correlation between the 2 groups between the level of physical activity and the evolution of the analyzed parameters.

Our study also has limitations. First of all, the patients had a body mass index $<30 \text{ kg/m}^2$ (with the exception of 6/54 patients in the G1 group and 17/53 patients in the G2 group).

In menopausal and postmenopausal women, as BMI increases, night sweats and hot flashes increase [66]. Li [67] shows in his study that the North American Menopause Society [66] estimates that by the year 2025 the number of postmenopausal women will increase substantially, and people who are overweight and obese will need additional clinical care and intervention in regarding the weight. This population group requires increased attention to prevent these prospective trends. This study highlighted in menopausal women, with obesity and sedentary (exercises $< 1 \text{ hour/week}$), but also in normal weight but sedentary women, that there is a risk of coronary heart disease, compared to the group of menopausal women with normal BMI, but physically active, something also supported in another study [64].

We chose physical exercise on land and in therapeutic swimming of moderate intensity, to stay within the cardiovascular safety range. There are studies that show the effectiveness and safety of therapy through moderate to high intensity exercises compared to low intensity exercises, which would provide patient safety [68,69]. The authors highlight the superior effectiveness of the moderate/high intensity exercises in improving the BMD [70,71] of the lumbar spine than through moderate or low intensity exercises. The same effects were not found on the femoral neck.

In our study, therapeutic swimming took place 3 times/week for 10 weeks. Zitzmann's meta-analysis [72] showed that in people with osteoporosis practicing physical exercises more than 2 times/week is has superior benefits in improving BMD compared to performing physical exercise once/week.

The study conducted by Rotstein [73] also showed that practicing therapeutic swimming 3 times/week for 7 months, with medium to vigorous intensity, lasting 60 minutes in postmenopausal women with normal BMD, can have positive effects on BMD.

The results of the meta-analysis conducted by Simas [74] suggest that engaging in therapeutic swimming can be a beneficial alternative to land-based physical exercise. This practice appears to mitigate age-related bone loss in postmenopausal women, potentially increasing bone mass density and positively influencing bone metabolism and muscle strength. However, it's important to note that these findings may not be applicable to the entire population with this condition due to limitations such as the small number of patients included in the study (106). Further research is needed to validate these results. Additionally, our study's short duration of 20 weeks is another limitation, as a longer study period may yield additional insights.

The specialized literature [7] emphasizes the importance of regular physical exercise in maintaining bone health and increasing bone mineral density [75] in the lumbar spine and femoral neck among elderly individuals. Therefore, it is crucial to incorporate regular, individualized physical exercise into one's routine to reap the benefits for both physical and mental well-being.

The World Health Organization recommends at least 150 minutes of moderate-intensity physical activity per week (or equivalent), in periods of at least 10 consecutive minutes [76]. Such a recommendation is identified to lead to a reduction in the risk of all-cause mortality and disease-specific morbidity and mortality. This dose-response effect encompasses components of the physical activity performed, including: mode, intensity, duration and frequency, and the expected response of improved health and well-being [76].

Our study highlighted that carrying out a controlled and individualized physical activity reduced the percentage of body fat and the body mass index, reduced the values of systolic and diastolic blood pressure, as Julian's study also shows [76].

Osteoporosis poses a significant public health concern necessitating early diagnosis to optimize therapeutic

approaches and mitigate subsequent social, medical, and economic burdens.

Our study underscored the effectiveness of implementing controlled and individualized physical activity, which resulted in reductions in body fat percentage and body mass index, as well as in systolic and diastolic blood pressure values, consistent with findings from Julian's study [76].

5. Conclusions

Anthropometric and hemodynamic parameters can be enhanced through age-specific physical activity practiced by menopausal and postmenopausal women. Improvements in blood pressure values and heart rate are attributed to regular, individualized physical activity tailored to the age group and health condition.

Implementing a controlled physical program can lead to reductions in body weight, body mass index, and adipose tissue percentage, thus benefiting cardiovascular health, which is often a concern during menopause. Further research is warranted to determine the optimal duration of physical activity programs and their impact on additional health parameters. These findings hold potential to enhance the quality of life for menopausal and postmenopausal women and inform the development of targeted programs in this regard.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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