INVESTIGATING THE EFFECTS OF WATER-BASED AND PİLATES EXERCISES ON PAIN THRESHOLD AND BALANCE IN SEDENTARY WOMEN WITH CHRONIC BACK PAIN

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ABSTRACT

Water-based and pilates exercises are commonly used exercises and rehabilitation methods. The aim of this study is to investigated the effect of water-based and pilates exercises on pain threshold according to anthropometric, motor properties, and posture position in sedentary women. A total of 45 volunteer women participated in this research, 15 (33.3%) of whom performed water-based exercises, 15 (33.3%) performed pilates exercises, and 15 (33.3%) served as a control group. The average age of participants in the water-based group was (59.6±7.55) (41-71), the average age of participants in the pilates group was (61.13±6.94) (50-72) and the average age of participants in the sedentary group was (53.93±7.4) (41-68) made up of sedentary women. Body composition analysis was determined using the bioelectrical impedance method. Body weight (bw) and height, waist, hip, chest, thigh measurements, and pain threshold measurements were taken before and after the study for all subjects. For statistical analysis, the paired sample t-test and the Wilcoxon signed-rank test were used. When the pre- and post-exercise values of the groups were compared, significant differences were found in weight, BMI, FAT, FFM, berg balance, and water in the body in the weight, BMI, FAT, FFM, balance variables in the sedentary group ($P>0.05$), but no significant differences were found in the pilates group. In the pilates group, statistically significant differences were found in the chest, waist, hip, and thigh variables between pre-and post-test values, whereas no statistically significant differences were found between pre-and post-test values ($P>0.05$). Upon evaluating the comparisons between groups, statistically, significant differences were found in the change values of weight, BMI, FAT, FFM, chest, waist, hip, thigh, and berg balance variables between pre-and post-test measurements in the research groups. When the intra-group comparisons were evaluated, statistically significant differences were found in the occiput and medial knee variables between pre-and post-test values in the water, pilates, and sedentary groups. Statistically significant differences were found in the upper trapezius variable between pre-and post-test values in the pilates and sedentary groups. However, statistically, significant differences were not found in the upper trapezius variable between pre-and post-test values in the water group. Statistically significant differences were not found in the supraspinatus variable between pre-and post-test values in the water, pilates, and sedentary groups. Statistically significant differences were found in the cervical variable between pre-and post-test values in the pilates group, while no statistically significant differences were found in the cervical variable between pre-and post-test values in the water and sedentary groups.

Keywords: Water-based exercise, Pilates exercise, Pain threshold, Balance

INTRODUCTION

International studies on the improvement of health have indicated that regular physical activity in women can decrease and prevent problems related to the musculoskeletal system. Participation in regular exercise and avoiding sedentary activity is strongly recommended (Warburton et al., 2006). The load-bearing potential of bone in the water is generally considered insufficient to build or protect bone mass. However, water is an ideal exercise environment due to its physiological and physical properties. Hydrostatic pressure and viscosity provide friction or resistance during exercise. As a result, water leads to the strengthening of the skeleton with the opportunity for more physical activity, kinetic feedback, and a sense of security. It can be explained that there is improvement in bones even when exercising in water due to the absence of gravitational force (Lindle, 2006).

Recently, the importance of preventive rehabilitation has been increasing. Health professionals are focused on regular and sufficient physical activity and injury prevention. It is known that adult women participate in different types of exercise; in particular, the demand for exercise such as pilates or core exercises, also known as spinal stabilization exercises, is high among women. It has been stated in the literature that these exercises have many positive effects on the individual, from flexibility to functional capacity (Wells et al., 2012).

Pilates exercises are designed as a comprehensive muscle toning and strength training method, under the philosophy of mind control on the body, with the goal of creating a strong body (Aladro-Gonzalvo et al., 2012). Pilates has been designed as a comprehensive muscle toning and strength training method, under the philosophy of mind control on the body, with the goal of creating a strong body. Lange et al. (2000) have found that pilates exercises provide benefits in physiological factors (such as resistance, strength, and muscle power), psychological factors (such as mood, attention, and motivation), and motor functions (such as balance, static and dynamic posture, overall coordination).

It is known that exercise has an effect on musculoskeletal pain, depression, posture, and body composition (such as body mass index and hip-waist ratio) as stated in separate studies. It is possible that the presence of one of these factors in different studies creates a foundation for another (Eyigor et al., 2010; Yılmaz Yelvar et al., 2015). Therefore, evaluating all these factors comprehensively at the same time can reveal the effect of pilates and water-based exercises in more detail, instead of evaluating them separately. Additionally, it has been found that there is no study, during literature reviews, that has researched all these factors together.

With this information in mind, the study aims to investigate the effect of water-based and pilates exercises on pain threshold, balance, and some physiological parameters in women.

METHOD

The study is a randomized controlled type and subjects were selected from sedentary women who participated in courses at women's culture centers in the province of Çorum, Türkiye, who are between 25-65 years old and do not engage in regular exercise and have been diagnosed with chronic back pain. The number of individuals accepted to participate in the study is n=45. Individuals with inflammatory joint disease or systemic diseases such as cardiovascular or pulmonary were excluded, as well as those who had an injury or surgery that would prevent exercise, those who used corticosteroids or hydrosilation injections in the past 3 months, and those who participated in any physical therapy program in the past, those who used inflammatory, pain and depressions related drugs in the past 2 weeks.

Subjects were evaluated twice, before and after 8 weeks of application. After taking demographic information (age, height, weight) of the individuals, an Algometer device was used to evaluate pain, Algometer, the baseline Dolorimeter is a device with a $1cm^2$ pressure surface and a hand grip, which displays the obtained values in g/cm^2. balance levels were assessed using the data obtained from berg balance Test, and measurements were included in the pre-test and post-test evaluations. Berg Balance scale, developed by Miyamoto (2004) et al. and Turkish validity and reliability study (Şahin et al., 2008) will be used to determine Balance Level. To evaluate body composition, body mass index and also hip-waist ratio were used. Physical Tanita MC 780 Black body analyzer and Bmı, fat, ffm and weight measurements were applied to all three groups in the study twice, before and after exercise. All evaluations were performed by the same person and the evaluator is blind to the groups' distribution.

Implementation:

Pilates exercise: The exercise group underwent an 8-week exercise program that included 2 days of 10-minute warm-up, 30-minute pilates exercise, and 10-minute cool-down. The program focused on exercises targeting the abdominal and back muscles, performed with correct breathing techniques. The specific mat exercises included were: The Hundred, The Roll Up., and Single Leg Circles with bent leg (Patti et al., 2016). Participants progressed from simple movements to more complex ones as they mastered the basics. The number of repetitions was increased from 6 to 20 over the course of the program. The control group did not receive any exercise throughout the 8 weeks.

Water-based exercise: The water-based exercises were conducted in an indoor swimming pool with a water level of 140 cm and a water temperature of approximately 28°C. Before entering the water, the participants in the water-based exercise group were shown the exercises and performed them once. Then, they entered the pool for 3 minutes of acclimatization movements (water walking, sitting in water, standing on one foot in water) followed by 30 minutes of water-based exercises. The exercises included running in place, jumping on one foot then another, one arm pulling, two arm pulling movements, as well as 5 minutes of cool-down. The number of repetitions gradually increased. The exercises were applied at a rate of (0-4 weeks) 2x10 repetitions and (4-8 weeks) 2 minutes x 3x10 repetitions.

Statistical Method

Statistical analyzes of the data obtained from the measurements made according to the anthropometric and posture positions of the participants in our study were performed with the SPSS (Version 22.0, SPSS Inc., Chicago, IL, USA) package program. The normal distribution test of the data was done with the Shapiro-Wilk test. Descriptive statistics of continuous variables obtained by measurement were presented as mean±standard deviation or median (minimum-maximum) depending on the normal distribution of the data. Descriptive statistics of categorical variables were reported using numbers and percentages (%). In the comparison of pretest-posttest measurements in the research groups, depending on the data distribution, the t-test was used for normally distributed data in the dependent groups (paired t-test), and the Wilcoxon signed rank test was used for non-normally distributed data. One-way analysis of variance (ANOVA) was used for normally distributed data, and Kruskal Wallis test was used for data that were not normally distributed in the comparison of the changes in pretest-posttest measurements (posttest-pretest) among the research groups. Statistical significance level was accepted as $P<0.05$.

RESULTS

In the study, data from a total of 45 participants were analyzed, with 15 (33.3%) in the water, 15 (33.3%) in the pilates, and 15 (33.3%) in the sedentary group. The average age of the participants was 58.22±7.79 (41-72). The average age of the participants in the water group was (59.6±7.55) (41-71), the average age of the participants in the pilates group was (61.13±6.94) (50-72), and the average age of the participants in the sedentary group was (53.93±7.4) (41-68).

There was a statistically significant difference in the average ages of the research groups (P=0.025). According to the results of the post hoc multiple comparison tests, the average age of the participants in the pilates group was significantly higher than the average age of the participants in the sedentary group (P=0.026). The average height of the participants was 159±5.47 (150-175). The average height of the participants in the water group was (158.4±4.51) (150-167), the average height of the participants in the pilates group was (159.9±6.75) (150-175), and the average height of the participants in the sedentary group was (158.8±5.19) (152-170). The average heights of the participants in the research groups were statistically similar (P=0.753).

The findings related to the intra-group and inter-group comparisons of the pre-test and post-test values of the anthropometric measurements of the participants are presented in Table 1.

When intra-group comparisons were evaluated, the pre-test and post-test values of weight, BMI, FAT, FFM, and berg balance variables were statistically significant in the water and pilates groups (respectively, P=0.010, P<0.001, P=0.015, P=0.010, P=0.027, P=0.020, P=0.018, P<0.001, P<0.001, P=0.002 Table 1). However, the pre-test and post-test values of weight, BMI, FAT, FFM, and berg balance variables were not statistically significant in the sedentary group (P>0.05). In the pilates group, the pre-test and post-test values of the chest, waist, hip, and thigh variables were statistically significant (respectively, P=0.003, P=0.001, P=0.001, P=0.003; Table 1). However, the pre-test and post-test values of the chest, waist, hip, and thigh variables were not statistically significant in the water and sedentary groups (P>0.05).

When inter-group comparisons were evaluated, the changes in the pre-test and post-test measurements of weight, BMI, FAT, FFM, chest, waist, hip, thigh, and berg balance variables were statistically significant among the research groups (respectively, P<0.001, P=0.011, P=0.002, P<0.001, P<0.001, P=0.003, P=0.005, P=0.001, P<0.001; Table 1). According to the results of the post-hoc test, the change in weight variable in the pre-test and post-test measurements was statistically higher in the pilates group than in the water and sedentary groups (P=0.157, P<0.001; Table 1). The change in weight variable in the pre-test and post-test measurements was statistically higher in the water group than in the sedentary group (P=0.015; Table 1). The change in BMI, FAT, chest, waist, and hip variables in the pre-test and post-test measurements was statistically higher in the pilates group than in the sedentary group (P=0.008, P=0.001, P<0.001, P=0.003, P=0.004; Table 1). The change in FFM and berg balance variables in the pre-test and post-test measurements was statistically lower in the sedentary group than in the water and pilates groups (P=0.018, P<0.001, P<0.001, P=0.019; Table 1). The change in thigh variable in the pre-test and post-test measurements was statistically higher in the sedentary group than in the water group (P=0.044; Table 1). The change in thigh variable in the pre-test and post-test measurements was statistically lower in the sedentary group than in the pilates group (P=0.001; Table 1).

The findings related to the intra-group and inter-group comparisons of the measurements of the participants' posture positions are presented in Table 2.

When intra-group comparisons were evaluated, the pre-test and post-test values of the occiput and medial knee variables were statistically significant in the water, pilates, and sedentary groups (respectively, P=0.001, P=0.001, P=0.005, P=0.001, P<0.001, P=0.044; Table 2). The pre-test and post-test values of the upper trapezius variable were statistically significant in the pilates and sedentary groups (respectively, P=0.001, P=0.037; Table 2). However, the pre-test and post-test values of the upper trapezius variable were not statistically significant in the water group (P>0.05; Table 2). The pre-test and post-test values of the supraspinatus variable were not statistically significant in the water, pilates, and sedentary groups (P>0.05; Table 2). The pre-test and post-test values of the cervical variable were statistically significant in the pilates group (P=0.003; Table 2). However, the pre-test and post-test values of the cervical variable were not statistically significant in the water and sedentary groups (P>0.05; Table 2).

When inter-group comparisons were evaluated, the change values of the pre-test and post-test measurements of the upper trapezius, supraspinatus, and medial knee variables were not statistically significant among the research groups (P>0.05; Table 2). The change values of the pre-test and post-test measurements of the occiput and lower cervical variables were statistically significant among the research groups (respectively, P=0.010, P=0.003; Table 2). According to post-hoc test results, the change in the pre-test and post-test measurements of the occiput variable was statistically higher in the water group than in the sedentary group (P=0.009; Table 2). The change in the pre-test and post-test measurements of the lower cervical variable was statistically higher in the pilates group than in the sedentary group (P=0.002; Table 2).

Table 1. Results of intra-group and inter-group comparisons of pre-test and post-test values of anthropometric measurements for the participants.

	Group	n	Mean ± SD Pre-test	Mean ± SD Post-test	*P value*	Difference (post-test-pre-test)	*P value*	Post-hoc P value
Weight	Water-based (1)	15	71.47±12.49	70.14±12.21	**0.010[a]**	-1.33±1.72	**<0.001[c]**	**1-2:0.157 1-3:0.015 2-3:<0.001**
	Pilates (2)	15	75.36±13.59	73.08±12.63	**<0.001[a]**	-2.27±1.40		
	Sedentary (3)	15	73.4±12.63	73.53±12.48	0.540[a]	0.13±0.82		
BMI	Water-based (1)	15	28.42±4.594	27.9±4.519	**0.015[a]**	-0.5 (-2-0.6) (-0.51±0.71)	**0.011[d]**	1-2:0.752 1-3:0.198 **2-3:0.008**
	Pilates (2)	15	29.1 (22.8-44.1) (29.66±5.39)	28.7 (22.2-42.6) (28.8±4.98)	**0.010[b]**	-0.9 (-4.5-2.3) (-0.85±1.35)		
	Sedentary (3)	15	29.1 (22.8-44.1) (29.8±5.52)	29.4 (22.9-43.7) (29.18±5.06)	0.955[b]	0.1 (-9.9-0.5) (-0.62±2.59)		
FAT	Water-based (1)	15	38.2 (30.5-47.6) (37.64±5.051)	36.9 (30.4-46) (37.02±4.807)	**0.027[b]**	-0.3 (-3.7-0.5) (-0.61±1.04)	**0.002[d]**	1-2:0.655 1-3:0.073 **2-3:0.001**
	Pilates (2)	15	37.2 (20-49.1) (35.67±7.91)	36.6 (23-47) (35.23±6.22)	**0.020[b]**	-1.2 (-3.6-12) (-0.44±3.6)		
	Sedentary (3)	15	37 (23.3-49.1) (36.07±6.12)	37 (24-49.2) (35.85±6.17)	0.064[b]	0.2 (-8.2-1.1) (-0.22±2.24)		
FFM	Water-based (1)	15	44.2±4.142	45.04±4.36	**0.018[a]**	0.833±1.2	**<0.001[c]**	1-2:0.283 **1-3:0.018 2-3:<0.001**
	Pilates (2)	15	47.2±3.911	48.58±4.479	**<0.001[a]**	1.373 ±1.089		
	Sedentary (3)	15	46.2±3.936	46.04±3.901	0.103[a]	-0.166±0.369		
Chest	Water-based (1)	15	109.2±9.143	108.8±8.782	0.353[a]	-1 (-2-2) (-0.33±1.34)	**<0.001[d]**	1-2:0.142 1-3:0.098 **2-3:<0.001**
	Pilates (2)	15	113 (100-129) (112.2±8.82)	112 (98-125) (110.7±8.03)	**0.003[b]**	-2 (-4-1) (-1.53±1.40)		
	Sedentary (3)	15	101 (86-120) (101.4±8.1)	101 (90-119) (102.4±7.33)	0.012[b]	1 (-1-4) (1±1.41)		
Waist	Water-based (1)	15	85.6±16.2	85.06±16.33	0.178[a]	-1 (-3-2) (-0.53±1.45)	**0.003[d]**	1-2:0.059 1-3:0.944 **2-3:0.003**
	Pilates (2)	15	92.73±17.83	90.46±16.94	**0.001[a]**	-2 (-7-1) (-2.26±2.18)		
	Sedentary (3)	15	91 (67-121) (90.3±14.24)	92 (67-119) (90.33±14.34)	1.000[b]	0 (-2-1) (0±1.06)		
Hip	Water-based (1)	15	114.9±10.97	113.8±9.92	0.161[a]	-1 (-8-2) (-1.06±2.78)	**0.005[d]**	1-2:0.183 1-3:0.536 **2-3:0.004**
	Pilates (2)	15	116±8.39	113.6±7.47	**0.001[a]**	-3 (-6-2) (-2.4±2.16)		

	Sedentary (3)	15	109 (97-117) (108.4±6.1)	109 (99-116) (108.7±5.35)	0.317[b]	1 (-1-2) (0.26±1.03)		
Thigh	Water-based (1)	15	58±8.83	57.53±8.65	0.150[a]	-0.46±1.18	**0.001[c]**	1-2:0.253 **1-3:0.044** **2-3:0.001**
	Pilates (2)	15	59.06±6.11	57.86±5.87	**0.003[a]**	-1.2±1.26		
	Sedentary (3)	15	56.13±5.13	56.8±4.52	0.065[a]	0.66±1.29		
Berg balance	Water-based (1)	15	40±2.26	44.46±2.85	**<0.001[a]**	4 (0-9) (4.46±2.69)	**<0.001[d]**	1-2:0.389 **1-3:<0.001** **2-3:0.019**
	Pilates (2)	15	41 (36-47) (41.73±3.43)	45 (39-52) (44.6±4.32)	**0.002[b]**	2 (-1-11) (2.86±2.89)		
	Sedentary (3)	15	42 (21-55) (40.3±11.04)	40.66±10.7 42 (21-56)	0.417[b]	0 (-3-5) (0.33±1.67)		

[a] Paired t-test

[b] Wilcoxon signed-rank test

[c] One-way ANOVA

[d] Kruskal-Wallis test

Table 2. Results of the comparison of the pain threshold measurements taken according to the participants' posture positions, regarding the within-group and between-group comparisons.

			Mean ± SD		*P value*	Difference (post-test-pre-test)	*P value*	Post-hoc P value
	Group	**n**	**Pre-test**	**Post-test**				
Oxiput	Water-based (1)	15	1.163±0.198	1.353±0.224	**0.001[a]**	0.15 (-0.1-0.5) (0.19±0.17)	**0.010[d]**	1-2:1.000 **1-3:0.009** 2-3:0.125
	Pilates (2)	15	1.2 (1-1.6) (1.27±0.16)	1.4 (1.1-1.7) (1.4±0.17)	**0.001[b]**	0.1 (0-0.3) (0.13±0.08)		
	Sedentary (3)	15	1.3 (1-1.7) (1.29±0.22)	1.4 (1-1.7) (1.35±0.21)	**0.005[b]**	0.1 (0-0.2) (0.063±0.061)		
Upper Trapezius	Water-based (1)	15	1.3 (1.2-1.7) (1.35±0.14)	1.45 (1.1-1.7) (1.43±0.14)	0.072[b]	0.1 (-0.35-0.3) (0.08±0.18)	0.114[d]	-
	Pilates (2)	15	1.4±0.19	1.497±0.22	**0.001[a]**	0.1 (-0.1-0.25) (0.096±0.091)		
	Sedentary (3)	15	1.4 (1.1-1.7) (1.39±0.23)	1.5 (1-1.8) (1.45±0.24)	**0.037[b]**	0.05 (-0.1-0.4) (0.06±0.11)		
Supraspinatus	Water-based (1)	15	1.6 (1.2-1.7) (1.47±0.16)	1.5 (1.1-1.7) (1.49±0.2)	0.389[b]	0.1 (-0.5-0.3) (0.016±0.24)	0.562[d]	-
	Pilates (2)	15	1.4 (1.2-1.7) (1.42±0.19)	1.5 (1.2-1.7) (1.48±0.15)	0.220[b]	0.1 (-0.5-0.3) (0.06±0.23)		
	Sedentary (3)	15	1.42±0.18	1.46±0.16	0.274[a]	0.05 (-0.2-0.2) (0.03±0.12)		

Lower Cervical	Water-based (1)	15	1.3 (0.9-1.7) (1.32±0.26)	1.4 (1.1-1.8) (1.37±0.18)	0.268[b]	0.1 (-0.5-0.32) (0.05±0.22)	**0.003[d]**	1-2:0.476
	Pilates (2)	15	1.4 (0.8-1.5) (1.31±0.18)	1.6 (1.1-1.7) (1.47±0.19)	**0.003[b]**	0.2 (-0.2-0.3) (0.15±0.12)		1-3:0.128
	Sedentary (3)	15	1.5 (1.1-1.7) (1.44±0.17)	1.5 (1.1-1.7) (1.47±0.18)	0.153[b]	0.04 (-0.1-0.1) (0.02±0.06)		**2-3:0.002**
Medial Knee	Water-based (1)	15	1.41±0.15	1.56±0.17	**0.001[a]**	0.15 (-0.2-0.45) (0.14±0.13)	0.054[d]	-
	Pilates (2)	15	1.43±0.24	1.53±0.18	**<0.001[a]**	0.1 (0-0.2) (0.09±0.07)		
	Sedentary (3)	15	1.5 (1-1.6) (1.4±0.17)	1.5 (1-1.7) (1.44±0.19)	**0.044[b]**	0.1 (-0.5-0.2) (0.04±0.16)		

[a] Paired t-test

[b] Wilcoxon signed-rank test

[c] One-way ANOVA

[d] Kruskal-Wallis test

DISCUSSION AND CONCLUSION

In this study, it was found that water-based and pilates exercises were effective in improving body mass index, pain, and balance parameters in women. Water-based exercises have the potential to increase performance variables (Miller et al., 2001; Miller et al., 2006) and prevent injury by reducing ground reaction force (Robinson et al., 2004).

This study aimed to determine the effects of water-based and pilates exercises on body weight (bw) and measurements of the waist, hip, chest, thigh circumference, pain threshold, and balance parameters. Pilates-based exercises are included in rehabilitation approaches. After pilates-based practices, it was determined that the back and abdominal muscle strength of individuals developed, joint movement clearances increased, spine-joint mobility increased, and the movement coordination of individuals improved (Cruz-Ferreira et al., 2011). In our study, when group-wise comparisons were evaluated, weight, BMI, FAT, FFM, and balance variables related to the occiput, upper trapez, supraspinatus, lower cervical, and medial knee in the water and pilates groups were found to be statistically significantly different in a positive direction. The change in weight variable between pre-test and post-test measurements was found to be statistically higher in the pilates group compared to the water and sedentary groups. The change in BMI, FAT, chest, waist and hip variables between pre-test and post-test measurements was found to be statistically higher in the pilates group compared to the sedentary group. The change in FFM and balance variables between pre-test and post-test measurements were found to be statistically lower in the sedentary group compared to the water and pilates groups.

In our study, when the intra-group comparisons were evaluated, it was found that there were statistically significant positive differences in weight, BMI, FAT, FFM, and berg balance variables in both water and pilates groups, and the change in weight variable between pre-test and post-test measurements were statistically higher in the pilates group than in the water and sedentary groups, and the change in BMI, FAT, chest, waist and hip variables between pre-test and post-test measurements was statistically higher in the pilates group than in the sedentary group. The change in FFM and berg balance variables between pre-test and post-test measurements were found to be statistically lower in the sedentary group than in the water and pilates groups. When the groups were compared, it was found that the change in FFM and berg balance variables between pre-test and post-test measurements were statistically lower in the sedentary group than in the water and pilates groups. The change in thigh variable between pre-test and post-test measurements was found to be statistically lower in the sedentary group than in the pilates group. Studies on the effects of pilates exercise on anthropometric and physiological parameters and pain have shown that pilates exercises have significant improvements. Kurtul (2020), in his study, examined the effect of aquatic therapy on balance in children with cerebral palsy and found that there was an improvement in the balance of most children, which is parallel to our study . Çetinkaya and İmamoğlu (2018), in their study, found that regular pilates-aerobic exercise resulted in a decrease in body weight and a decrease in body fat percentage. Katayıfçı et al. (2014) in their study, body composition, balance, and cardiovascular endurance measurements were evaluated before and after pilates training, and changes in body fat ratio, waist circumference measurement, hip circumference measurement, and waist-hip ratio were found to be significant.

In this study, the effects of water-based and pilates -based exercises on body weight and height, pain threshold, and balance parameters were evaluated. The results of the within-group comparisons showed that there were statistically significant positive changes in weight, body mass index (BMI), body fat percentage (FAT), fat-free mass (FFM), and berg balance scale variables in both the water-based and pilates groups. Furthermore, the changes in weight, BMI, FAT, chest, waist, and hip circumference measurements were found to be statistically significant in the pilates group compared to the sedentary group. The changes in FFM and berg balance scale variables were found to be statistically significant in the sedentary group compared to the water-based and pilates groups. The changes in thigh circumference measurements were found to be statistically significant in the sedentary group compared to the pilates group. In general, the results of this study suggest that pilates -based exercises can lead to positive changes in anthropometric and physiological parameters and pain threshold.

In the comparison between groups, the change values of oksiput and lower cervical variables in pre-test and post-test measurements were statistically significant. According to post-hoc test results, the change in the oksiput variable in pre-test and post-test measurements was statistically significant and higher in the water group compared to the sedentary group. The change in the lower cervical variable in pre-test and post-test measurements was statistically significant and positive in the pilates group compared to the sedentary group. The literature review showed that studies are in line with our research. Yolgösteren (2006) in his study, water and land-based exercise were effective in reducing pain and functional disorder in postoperative back pain patients. Büyükturan et al. (2021) in their study, showed that water-based plyometric exercises were more effective than land-based plyometric exercises in proprioception and vertical jump test variables. In a study comparing the effects of ai chi exercise program (water exercise) on pain perception, maintenance of balance and functionality, significant differences were observed in pain perception values (Pérez De La Cruz, 2017). Rivas Neira et al. (2017) in their study, 40 women diagnosed with fibromyalgia were treated with water or land-based therapy. Significant differences were found in balance and pain parameters.

The results of the study show that both types of exercise have an effect on different parameters. Therefore, it can be concluded that both types of exercise, pilates, and water-based exercise, can be used and treated for rehabilitation purposes.

REFERENCES

Aladro-Gonzalvo, A. R., Machado-Díaz, M., Moncada-Jiménez, J., Hernández-Elizondo, J., & Araya-Vargas, G. (2012). The effect of Pilates exercises on body composition: A systematic review. *Journal of Bodywork and Movement Therapies*, *16*(1), 109–114. https://doi.org/10.1016/J.JBMT.2011.06.001

Büyükturan, B., Kararti, C., Şaş, S., & Büyükturan, Ö. (2021). Genç yetişkinlerde karada ve su içinde yapılan plyometrik egzersizlerin kas kuvveti ve propriosepsiyon üzerine etkisinin incelenmesi. *Journal of Exercise Therapy and Rehabilitation*, 8(1), 10–17.

Cruz-Ferreira, A., Fernandes, J., Laranjo, L., Bernardo, L. M., & Silva, A. (2011). A systematic review of the effects of pilates method of exercise in healthy people. *Archives of Physical Medicine and Rehabilitation*, *92*(12), 2071–2081. https://doi.org/10.1016/J.APMR.2011.06.018

Çetinkaya, G., & İmamoğlu, G. (2018). Plates-aerobik egzersizlerinin obez kadinlarda vücut kompozisyonu ve vücut imaji üzerine etkisinin incelenmesi. *Journal of International Social Research*, 11(59).

Eyigor, S., Karapolat, H., Yesil, H., Uslu, R., & Durmaz, B. (2010). Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. *Eur J Phys Rehabil Med.*, *46(4)*.

Katayıfçı, N., Düger, T., & Ünal, E. (2014). Sağlıklı bireylerde klinik pilates egzersizlerinin fiziksel uygunluk üzerine etkisi. *Journal of Exercise Therapy and Rehabilitation*, 1(1), 17–25.

Kurtul, R. (2020). *Akuatik Terapinin Serebral Palsili Çocuklarda Denge Üzerine Etkisi* (Master's thesis, İstanbul Gelişim Üniversitesi Sağlık Bilimleri Enstitüsü).

Lange, C., Unnithan, V. B., Larkam, E., & Latta, P. M. (2000). Maximizing the benefits of Pilates-inspired exercise for learning functional motor skills. *Journal of Bodywork and Movement Therapies*, *4*(2), 99–108. https://doi.org/10.1054/JBMT.1999.0161

Lindle, J. (2006). *A resource Manual For Aquatic Fitness Professionals*. FL: Human Kinetics.

Miller, M. G., Berry, D. C., Ma, A. ;, Gilders, R., & Bullard, S. (2001). Recommendations for Implementing an Aquatic Plyometric Program. *Strength & Conditioning Association*, *23*(6), 28–35.

Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C., & Michael, T. J. (2006). The effects of a 6-week plyometric training program on agility. *Journal of Sports Science and Medicine*, *5*, 459–465.

Patti, A., Bianco, A., Paoli, A., Messina, G., Montalto, M. A., Bellafiore, M., Battaglia, G., Iovane, A., & Palma, A. (2016). Pain perception and stabilometric parameters in people with chronic low back pain after a pilates exercise program: A randomized controlled trial. *Medicine (United States)*, *95*(2).

Pérez De La Cruz, S. (2017). Effectiveness of aquatic therapy for the control of pain and increased functionality in people with Parkinson's disease: a randomized clinical trial. *European Journal of Physical and Rehabilitation Medicine*, *53*(6), 825–832. https://doi.org/10.23736/S1973-9087.17.04647-0

Rivas Neira, S., Pasqual Marques, A., Pegito Pérez, I., Fernández Cervantes, R., & Vivas Costa, J. (2017). Effectiveness of aquatic therapy vs land-based therapy for balance and pain in women with fibromyalgia: a study protocol for a randomised controlled trial. *BMC Musculoskeletal Disorders*, 18(1). https://doi.org/10.1186/S12891-016-1364-5

Robinson, L. E., Devor, S. T., Merrick, M. A., & Buckworth, J. (2004). The effects of land vs. aquatic plyometrics on power, torque, velocity, and muscle soreness in women. *Journal of Strength and Conditioning Research*, *18*(1), 84–91. https://doi.org/10.1519/00124278-200402000-00012

Şahin F, Yilmaz F, Ozmaden A, et al (2008). Reliability and validity of the Turkish version of the Berg Balance Scale. J Geriatr Phys Ther. 31: 32-7.)

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: the evidence review. *CMAJ*, *174*(6), 801. https://doi.org/10.1503/cmaj.051351

Wells, C., Kolt, G. S., & Bialocerkowski, A. (2012). Defining Pilates exercise: a systematic review. *Complementary Therapies in Medicine*, *20*(4), 253–262. https://doi.org/10.1016/J.CTIM.2012.02.005

Yılmaz Yelvar, G. D., Baltacı, G., Tunay Bayrakcı, V., & Atay, A. Ö. (2015). The effect of postural stabilization exercises on pain and function in females with patellofemoral pain syndrome. *Acta Orthopaedica et Traumatologica Turcica*, *49*(2), 166–174.

Yolgösteren, E. (2006). *Postoperatif Bel Ağrılı Hastalarda Su içi ve Su Dışı Egzersiz Etkinliği* (Doctoral dissertation, Bursa Uludag University).