AQUA-PILATES EXERCISES IMPROVES SOME PHYSICAL FITNESS PARAMETERS OF HEALTHY YOUNG WOMEN

Rabia Özcan[1]
Gönül Babayiğit İREZ[1]
Özcan SAYGIN[1]
Halil İbrahim CEYLAN[1]

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ABSTRACT

The aim of this study was to investigate the effects of twelve weeks aqua-pilates exercises applied to healthy young women on body weight (kg), body mass index (BMI), body fat percent (%), flexibility, dynamic balance, muscle strength, vital and forced capacity value (FVC-VC). Sixty young women who were students at Faculty of Sports Sciences participated to this study as voluntarily. Participants were divided randomly as exercise group (N=30) and control group (N=30). Modified aqua-pilates exercise programme was applied to exercise group 60 minutes, 2 times a week for 12 weeks. The women in the control group were not subject to any exercise program. As a result of statistical analysis, It was detected that there was a statistically significant difference between pre-test and post-test mean values of body weight (t = 4.39, p =. 00), body mass index (t = 5.49, p = 0.00), body fat percentage (t = 7.38, p =.00), biceps (t = 8.21, p=.00), triceps (t = 4.70, p=.00), supra-iliac (t = 9.72, p=.00), supscapula (t = 7.19 p =.00), flexibility (t = -5.27 p =.00), dynamic balance (t = -7.57 p =. 00), right hand-grip strenght (t = -4.72 p =, 00), left hand-grip strenght (t= -3.47 p=.00), back strenght (t=-4,33 p=,00), leg strenght (t= -5,82 p=,00), vital capacity (t=-2.58, p=.01) and forced vital capacity (t=-3.87, p=.00) in exercise group. While the effect size of the aqua-pilates exercises in exercise group for body weight, body mass index, skinfold thickness measurements (triceps), flexibility, hand-grip strenght (right and left), back strenght, leg strenght and forced vital capacity was small, There was a moderate effect size in body fat (%), skinfold thickness measurements (biceps, supra-iliac, subscapula), dynamic balance. It was reported that the effect size of aqua-piates exercises was unimportant for vital capacity. In conclusion, It was observed that aqua-pilates exercises positively affect the body composition, flexibility, dynamic balance, muscle strength, respiratory functions and balance characteristics of young women. These exercises are recommended to be performed by different age groups due to their easily applicability and low risk of sport injuries.

Key Words: Pilates, Aqua Pilates, Deep Water Exercises, Physical Fitness

AQUA-PİLATES EGZERSİZLERİ SAĞLIKLI GENÇ KADINLARIN BAZI FİZİKSEL UYGUNLUK ÖZELLİKLERİNİ GELİŞTİRİR

ÖZ

Bu çalışmanın amacı, sağlıklı genç kadınlara uygulanan 12 haftalık aqua-pilates egzersizlerinin vücut ağırlığı, beden kütle indeksi, vücut yağ yüzdesi, esneklik, dinamik denge, kas kuvveti, vital ve zorlu vital kapasite değeri üzerine etkisini araştırmaktır. Çalışmaya, Spor Bilimleri Fakültesinde okuyan 60 genç kadın gönüllü olarak katılmıştır. Katılımcılar egzersiz (Sayı=30) ve kontrol (Sayı=30) olmak üzere rastgele iki gruba ayrılmıştır. Egzersiz grubuna 12 hafta boyunca haftada 2 gün 60 dakika modifiye edilmiş aqua-pilates egzersiz programı uygulanmıştır. Kontrol grubu herhangi bir egzersiz programına tabi tutulmamıştır. İstatiksel analiz sonucunda; egzersiz grubunun vücut ağırlığı (t = 4.39, p =. 00), beden kütle indeksi (t = 5.49, p = 0.00), vücut yağ yüzdesi (t = 7.38, p =.00), biceps (t = 8.21, p=.00), triceps (t = 4.70, p=.00), suprailiyak (t = 9.72, p=.00), subscapula (t = 7.19 p =.00), esneklik (t = -5.27 p =.00), dinamik denge (t = -7.57 p =. 00), sağ el kavrama kuvveti (t = -4.72 p =, 00), sol el kavrama kuvveti (t= -3.47 p=.00), sırt kuvveti (t=-4,33 p=,00), bacak kuvveti (t=-4,33 p=,00), vital kapasite (t=-2.58, p=.01) ve zorlu vital kapasite (t=-3.87, p=.00) ön ve son test değerleri arasında istatiksel olarak anlamlı fark saptanmıştır. Aqua-pilates egzersizlerinin, egzersiz grubunun vücut ağırlığı, beden kütle indeksi, deri altı kıvrım kalınlığı (triceps), esneklik, el kavrama kuvveti (sağ ve sol el), sırt kuvveti, bacak kuvveti ve zorlu vital kapasite değeri üzerine etki büyüklüğü küçük olarak saptanırken, vücut yağ yüzdesi, deri altı kıvrım kalınlığı (biceps, suprailiyak, subscapula), dinamik denge değeri üzerine etki büyüklüğü ise orta olarak bulunmuştur. Aqua-pilates egzersizlerin vital kapasite değeri üzerine etki büyüklüğü ise önemsiz olarak rapor edilmiştir. Sonuç olarak; aqua-piates egzersizlerinin genç kadınların beden kompozisyonu, esneklik, dinamik denge, kas kuvveti, solunum fonksiyonları ve denge özelliklerini olumlu yönde etkilediği gözlemlenmiştir. Bu egzersizlerin, kolayca yapılabilirliği ve sportif yaralanma riskinin az olmasından dolayı farklı yaş grupları tarafından yapılması önerilmektedir.

Anahtar Kelimeler: Pilates, Aqua-Pilates, Derin Su Egzersizleri, Fiziksel Uygunluk

1. Mugla Sitki Kocman University, Faculty of Sport Sciences, Mugla, Turkey

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INTRODUCTION

Since Ancient times, water has always encouraged healing and, so it has been widely used in the treatment of medical disorders[8]. In addition to the benefits of general exercise, aquatic exercises have many physical and physiological benefits. The biological impact of immersion in water which are associated with the basic elements of hydrodynamics may be useful in certain training. The effects of physical features of water such as buoyancy, density, and hydrostatic pressure are very profitable when used as a balance against gravity, resistance, compressor and thermal conductor[72]. The effects of buoyancy and hydrostatic pressure minimize the load and impact on the muscle-skeletal system and encourage freedom of the movement[18]. The pressure from the water around body helps blood to move from legs to your heart. This can decrease swelling in the joints and joint sensitivity. The resistance to water increases strength and balance. It can also increase body's awareness, so you know where your joint is in space[3]. An advantage of aquatic exercise is that it can involve the upper and lower extremities with optimal ranges of movement while reducing joint stress[34]. It is also helpul for weight loss as well as working up the quality of life[31]. In recent years, many different types of exercise programme have been suggested to maintain physical and mental health of individuals[69.]or improve physical functions including strength training, aerobics, walking, pilates, aqua-pilates[78]. Pilates, Aqua Pilates[52], Deep Water Exercise[4] and Aquatic exercises are a popular exercise method to enhance physical fitness for large populations including adults[48], older people [65,78], healthy individuals[7], older women[12,16, 66.]

Pilates is a peerless form of therapeutic exercise that highlights improving strength, coordination, proprioception, muscle endurance, mobility, flexibility, balance and control.

The Pilates method is a functional type of exercise, because it compounds multiple planes of movement[17]. Aqua-Pilates is a form of creative training that uses the principles and exercises of the Pilates method in the aquatic environment[52]. It is called as vertical training in shallow or deep water to focus different aspects of fitness in a reduced impact or nonimpact, suspended environment[60.] Aqua-Pilates is a different physical conditioning method, because it is a very reflective activity that works with flotation, aquatic balance, breathing, strength, flexibility, concentration, body and postural awareness. All the movements of Aqua Pilates are performed with an activated center of force, starting the movement always from "inside to outside", in a slow, fluid and harmonic execution[52].

In the literature, It is clear that people with low physical fitness levels prefer aquatic exercises rather than land. Aquatic exercises are suitable for all age groups and fitness levels. Especially in specific groups, it is easier to perform the exercises due to the buoyancy of water[31]. It is seen that these exercises are mostly used for therapeutic purposes in elderly individuals[70], obese people[38,40], women with post-menopausal hypertension[5, 54], parkinson patients[62], accelerating the rehabilitation process[35], hypertension patients[25] and musculoskeletal diseases[76, 79]. It has been also used successfully in orthopedic, neurological and cardiopulmonary rehabilitation patients[8, 20, 37.] These studies are focused on treatment and therapy. There are limited studies investigating the effects of aquatic exercises on cardiovascular fitness[46, 55], flexibility[70, 73], body composition, muscle strength, dynamic balance[10, 73] and vital capacity[43, 75]. As a result of the literature review, it has been found that studies on determining the effect of aqua-pilates

exercises applied to healthy individuals in deep water on some physical fitness elements are also limited[7]. This study was conducted to investigate the effect of aquatic exercise programme performed in deep water on selected physical fitness parameters of young women. The second aim is to increase the awareness of the health benefits of water exercises by enabling young female university students to participate in aqua-pilates exercises.

METHOD

Participants

The research was experimental design with pretest-post-test control group. Sixty volunteers women aged 18-25 who were healthy, did not have any risk factors for exercising and swimming, and were studying at Muğla Sıtkı Koçman University Faculty of Sports Sciences, participated in this study. Prior to the study, permission was obtained from the Ethics Committee of Social Sciences and Humanities in Muğla Sıtkı Koçman University. In addition, volunteers who agreed to participate in the study signed an Informed Consent Form. The participants were randomly divided into two groups as exercise group (N = 30) control group (N = 30). Modified aqua-pilates exercise programme was applied to exercise group 60 minutes, 2 times a week for 12 weeks. The women in the control group were not subject to any exercise program. The measurements of height-body weight, skinfold (biceps, triceps, subscapula, suprailiac), flexibility, dynamic balance, strenght (right, left hand-grip, back and leg), vital and forced vital capacity of the participants in both exercise and control group were carried out in the physiology laboratory at the Faculty of Sport Sciences before and after 12 weeks aquatic exercise programme.

One day before the measurements, the participants were asked to come to laboratory with 6-8 hours of sleep. They were warned not to take alcohol, caffeine and avoid exercising and overfeeding 3 hours before the measurement time. Before starting to collect data and during the training period, the volunteers were informed that they should maintain their normal eating habits and avoid excessive fat intake, additional vitamin and antioxidant nutritional supplements. Participants who could not attend the measurement day were given another appointment for performance tests. Before measurements, the features of measurement tools were explained to participants and they had a one trial for each measurements and then they warmed up for 15 minutes. After warming up, the performance tests were applied to them. They had a rest between tests.

Research Application Place

Aqua-exercise program was implemented to the exercise group in Mugla Sitki Kocman University Indoor Swimming Pool. The semi-olympic standard (12.5m x 25m) outdoor pool is 1.80 meters deep. During exercises, temperature of the pool water was between 26-28°C and the outdoor pool temperature was around 30°C.

Aqua-Pilates Exercise Programme

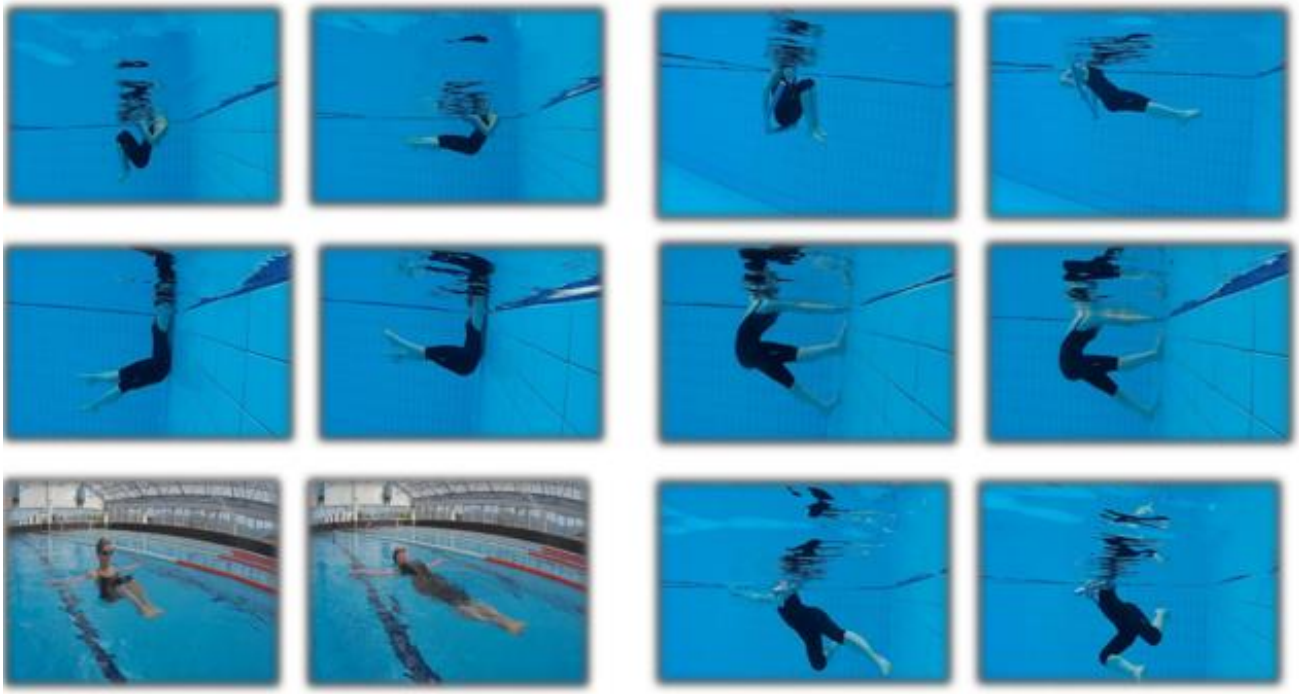
The movements with water (noddle) equipment to keep the body above the water and movements without equipment were included in the exercise program. One exercise session consisted of a total of 60 minutes including warm-up exercises (10 minutes), aqua-pilates exercises (40 minutes), cooling exercises (10 minutes). The exercise programme was performed by 2 instructors (1 instructor in the pool, the other instructor was outside the pool). Aqua-pilates exercises were started with deep water runs and water games were also included in warming up section. In this section, participants' shoulders were in the water and they performed sideways and

backwards movements in which the arms and legs of the muscles worked together for 5 minutes. The Aqua-pilates exercise program, which was applied to the exercise group in deep water for 12 weeks, was modified by the researcher[44] (Table 1). To increase muscle strength, 2-4 sets, 8-12 repetitions are recommended in most adults according to ACSM (2018)[1], therefore the exercise program in this study was applied in 2 sets of 12 repetitions[1,2]. The Rating of Perceived Exertion (RPE) scale was developed to allow the exerciser to subjectively rate his or her physical strain during exercise[13]. During exercise testing, the RPE can be used as an indication of impending fatigue. The original Borg or category scale, which rates exercise intensity from 6 to 20 was used in this study to determine the exercise intensity. The Borg scale was shown to the participants who had reached the recommended number of repetitions while they were applying each movement. They were asked to express their degree of difficulty as a number. The degree of strain was determined according to the Borg scale, between 9-13 (very light-somewhat hard) for aquatic exercises performed in deep water. Participants had a 30 second rest between sets, while the rest period for the next exercise was set as 1 minute[74]. In each exercise session, the participants performed an average of 8 to 10 movements, which did not exceed the duration of the exercise. In addition, the first 4 weeks were preferred for easy movements. In the following weeks, more difficult movements were included in the program (Table 1).

Figure 1. Aqua-Pilates Exercise Programme

Warm-up Exercises (10min.)	Aqua Pilates Exercises (40min.)	Cool- Down Exercises (10min.)
1.Breathing 2.Running 3.Scapular stabilization - elevation and depression 4.Scapular protraction and retraction 5.Spinal rotation 6.Spinal articulation from prone 7.Spinal articulation from supine	1.Pull up knee 2.Twist 3.Triceps dips 4.Jumping jack (4 min) 5.One leg push back 6.Single noodle step 7.Noodle step with both legs 8.One leg adduction and abduction 9.Rotation by pedalling on its own axis 10.Straight-legs-raise-together 11.High leg adduction and abduction with pool noodle 12.Double leg exercises underneath the noodle 13.Hands on the wall, pedaling lying on back 14.Hands on the wall, straight step lying on back 15.Lower Leg Lift 16.Back in the wall, lifting and lowering of feet by double leg point flex. 17.Leg tucks and sway 18.Legs criss cross exercise 19.Push the noddle down with hands and lift it up 20.Hands on the wall in prone position, double legs straight back, pulling forward knee. 21.Holding the wall with hands, touching ground with the feet and pulling up. 22.Side leg lifts (1 min.) 23.The arms are open, the noodle is under the arm while the scissors movement on the leg (2 min.)	1.Stretching the neck, triceps, deltoid 2.Chest expansion back stretch 3.One leg, double leg and upper leg stretching 4.Mermaid 5.Relaxation

Figure 2. Examples of Aqua-pilates exercises in Deep Water in this study



Data Collection Tools

Body weight and height: The body weight and height measurements were determined by Seca brand measurement tool with a degree of sensitivity 0.01 kg. and 0.01 cm[23].

Skinfold measurements: Holtain brand skinfold caliper which apply 10 g/sq mm pressure at each angle, was used to ascertain the percentage of body fat. The measurements were taken from the right side while the participants were standing upright[83]. In this study, the values obtained from 4 regions (biceps, triceps, subscapula and suprailiac) to find the body fat percentage of the participants were calculated based on the Durnin-Womersley (1974) formula[19].

Flexibility: Sit and React Test was used for flexibility measurement. Participants warmed up before the measurement. They then sat on the mat and extended their feet to the test bench. They tilted the trunk forward without bending the knees, pushing the ruler on the table slowly with the fingertips to the extreme point and remained there for 1-2 seconds. The test was repeated three times successively and the best value was recorded[1].

Hand grip strength measurement: Right hand and left hand grip strength measurements of the participants were measured by hand dynamometer 3 times (Takei equipment Industrial T.K.K.5401 grip strength). The hand-held size of dynamometer was set in the position that the participants could feel comfortable. The participants were standing upright and their arms in the side position, and the dynamometer was held parallel to the body. The dynamometer was strongly squeezed without the arm being moved[36, 49, 68].

Back strength measurement: Takei brand digital strenght dynamometer was used to detect back strenght after the participant warmed up, the participant placed his feet on the dynamometer stand with his knees stretched, his head upright and his back straight. The participants pulled the chain upwards with the support of the back muscles without bending the trunk backwards. Measurements were recorded at that point where they reached the maximum. Two measurements were taken from each participant with 1 minute interval. The average of measurements were recorded in[67, 81].

Leg strength measurement: The measurement was performed by Takei brand digital back and lift dynamometer[70]. After warming up, the participant placed his feet on the dynamometer with his back straight, by bending his knees at 130-140 degrees. The participants pulled the chain upwards without using the back muscles to the maximum force. The measurement was recorded at that point where they stretched their knees slowly but strongly. The mean of the 3 measurements was used for analysis[51].

Dynamic Balance: Dynamic balance measurements of the participants were obtained using Stability Platform Lafayette. The participants attempted to maintain their equilibrium position on the platform for 30 seconds. The average of the three measurements were recorded as a test point in seconds[82].

Vital and Forced Vital Capacity: The vital and forced capacity of the participants (lung volume and capacities) was determined by spirometer instrument (M.E.C. PFT Systems Pocket-Spiro RD.302). (http://mecrd.eu/products/lung-functions/pft-systems-pocket-spiro/).The measurement method was explained to the subjects one by one and shown as practical. The information of the participants was recorded prior to measurement. The nose latch was inserted to prevent participants from breathing through the nose. They were asked to take the spirometer fully into their mouths. When the measurement of each subject was completed, the spirometer nozzle was replaced for a new measurement. A only one measurement was taken from each participants and recorded for analysis.

Data Analysis

The data obtained from the study were analyzed with SPSS 16 statistical program. The pre-test comparison of the exercise and control groups was evaluated by Independent t test. The pre-test and post-test mean values of the exercise and control groups were compared with the Paired t test. In determining the effect size of the aqua-pilates training program, Cohen d values were used for sedentary individuals developed by Rhea (2004) (<0.50 unimportant, 0.50-1.25 small, 1.25-1.90 medium,> 2.0 large)[57]. Significance level was determined as 0.05.

RESULTS

Table 1. The arithmetic mean (M) ± standard deviation values (SD) and Independent t-test results of body composition pre-test measurements of exercise and control group

	Exercise Group Pre-test (N=30)	Control Group Pre-test (N=30)		
Variables	**M.±S.D.**	**M.±S.D.**	**t**	**p**
Body weight (kg)	56.54± 5.84	59.29±6.59	-1.70	.93
BMI kg/m^2)	21.51 ±2.40	21.92±2.46	-.65	.51
Body Fat (%)	24.08± 2.00	23.95±2.08	.25	.79
Biceps (mm)	8.43± 2.06	8.50±1.94	-.12	.89
Triceps (mm)	10.80± 2.09	10.80±1.76	.00	1.00
Supra-iliac (mm)	11.52±2.13	11.68±1.87	-.31	.75
Supscapula (mm)	11.56± 2.46	11.60±2.79	-.05	.95

In Table 1, Independent t-test was performed to determine whether there was a significant difference in pre-tests values of body composition parameters of exercise and control groups. There was no statistically significant difference in body weight (t = -1.70, p = .93), body mass index (t = -.65, p = .51), body fat percentage (t = .25, p = .79) other skinfold thickness measurements (biceps, triceps, subscpaula, supra-iliac).

Table 2. The Arithmetic mean (M) ± standard deviation (SD) and Independent t-test results of flexibility, dynamic balance, strenght, vital and forced vital capacity pretest measurements of exercise and control group

	Exercise Group Pre-test (N=30)	Control Group Pre-test (N=30)		
Variable	**M.±S.D.**	**M.±S.D.**	**t**	**p**
Flexibiliy (cm)	34.58± 6.73	32.94±6.78	.93	.35
Dynamic balance (sn)	12.41± 4.80	10.37±3.63	1.85	.68
Right hand-grip strenght(kg)	26.55± 3.62	27.77±4.09	-1.22	.22
Left hand-grip strenght (kg)	25.42± 3.78	25.70±3.59	-.29	.77
Back strenght (kg)	65.92±13.76	66.90±13.56	-.28	.78
Leg strenght (kg)	61.24±12.65	59.93±15.80	.35	.72
Vital capacity (VC)	3.25 ± .31	3.30±.40	-.55	.58
Forced vital capacity (FVC)	3.60± .39	3.72±.51	-1.01	.31

In Table 2, Independent t-test was applied to determine whether there was a significant difference between flexibility, dynamic balance, right-hand grip strenght, left-hand grip strenght, back strenght, leg strenght pre-test mean values of exercise and control group. No statistically significant difference was found in flexibility (t = .93 p = 0.35), dynamic balance (t = 1.85 p = .68), the right-hand grip strength (t = -1.22 p = .22), the left-hand grip strength (t = -.29 p = .77), back strength (t = -.28 p = .78), leg strength (t = .35 p = .72), vital capacity (t= -.55 p=.58), and forced vital capacity (t = -1.01, p =.31) values.

Tablo 3. Comparison of pre-test and post-test values of exercise group for body composition measurements

	Exercise Group (N=30)				
Variable	**Pre-test (M.±S.D.)**	**Post-test (M.±S.D.)**	**t**	**p**	**Cohen d**
Body weight (kg)	56.54±5.84	55.24±4.95	4.39	.00*	0.80
BMI (kg/m^2)	21.51±2.40	20.83±1.94	5.49	.00*	1.05
Body fat (%)	24.08±2.00	21.92±1.92	7.38	.00*	1.34
Skinfold thickness measurements					
Biceps (mm)	8.43±2.06	6.78±1.67	8.21	.00*	1.49
Triceps (mm)	10.80±2.09	9.50±1.63	4.70	.00*	0.85
Supra-iliac (mm)	11.52 ±2.13	10.00±1.92	9.72	.00*	1.77
Subscapula (mm)	11.56 ±2.46	9.75±1.79	7.19	.00*	1.31

*p<0.05

As shown in Table 3, the body composition post-test scores of the exercise group after 12 weeks of aqua-pilates training differed significantly from pre-test scores. There was a statistically significant difference in body weight (t = 4.39, p = .00), body mass index (t = 5.49, p = .00), body fat percentage (t = 7.38, p =.00), biceps (t = 8.21, p=.00), triceps (t = 4.70, p=.00), supra-iliac (t = 9.72, p=.00), supscapula (t = 7.19 p =.00).

The effect size of the aqua-pilates exercises in exercise group for body weight, body mass index, skinfold thickness measurements (triceps) was small. There was a moderate effect size in body fat (%), skinfold thickness measurements (biceps, supra-iliac, subscapula) after 12 weeks aqua-pilates programme.

Table 4. Comparison of pre-test and post-test values of exercise group for flexibility, dynamic balance, strenght, vital and forced vital capacity

Exercise Group (N=30)					
Variable	**Pre-test (M.±S.D.)**	**Post-test (M.±S.D.)**	**t**	**p**	**Cohen d**
Flexibiliy (cm)	34.58±6.73	36.15±6.67	-5.27	.00*	0.96
Dynamic balance (sn)	12.41±4.80	15.82±5.21	-7.57	.00*	1.38
Right hand-grip strenght(kg)	26.55±3.62	27.82±3.49	-4.72	.00*	0.86
Left hand-grip strenght (kg)	25.42±3.78	26.49±3.97	-3.47	.00*	0.63
Back strenght (kg)	65.92±13.76	70.23±11.65	-4.33	.00*	0.79
Leg strenght (kg)	61.24±12.65	64.77±12.52	-5.82	.00*	1.06
Vital capacity (VC)	3.25±.31	3.35±.23	-2.58	.01*	0.47
Forced vital capacity (FVC)	3.60±.39	3.81±.31	-3.87	.00*	0.65

*p<0,05

As shown in Table 4, It was detected that there was a statistically significant difference between pre-test and post-test mean values of flexibility (t = -5.27 p =.00), dynamic balance (t = -7.57 p =.00), right-hand grip strenght (t = -4.72 p =.00), left-hand-grip strenght (t= -3.47 p=.00), back strenght (t=-4.33 p=.00), leg strenght (t= -5.82 p=.00), vital capacity (t=-2.58, p=.01) and forced vital capacity (t=-3.87, p=.00) of exercise group. The effect size of 12 weeks aqua-pilates exercise on flexibility, right hand-grip strenght, left hand-grip strenght, back strenght, leg strenght and forced vital capacity was small. Moderate effect size was found in dynamic balance performance after training. The effect size was unimportant for vital capacity after training.

Table 5. Comparison of pre-test and post-test values of control group for body composition measurements

Control group (N=30)				
Variable	**Pre-test (M.±S.D.)**	**Post-test (M.±S.D.)**	**t**	**p**
Body weight (kg)	59.29± 6.59	59.33± 6.53	-.27	.78
BMI (kg/m^2)	21.92±2.46	21.87±2.43	.88	.38
Body fat (%)	23.95±2.08	23.89±2.22	.41	.68
Skinfold thickness measurements				
Biceps (mm)	8.50±1.94	8.70±2.13	-.97	.33
Triceps (mm)	10.80±1.76	10.70±1.76	.64	.52
Supra-iliac (mm)	11.68 ± 1.87	11.43±2.06	1.10	.27
Subscapula (mm)	11.60 ±2.79	11.50±2.84	.64	.52

In Table 5, When the pre-test and post-test values of body composition measurements of control group compared, no statistically significant difference was found in all variables.

Tablo 6. Comparison of pre-test and post-test values of control group for flexibility, dynamic balance, strenght, vital and forced vital capacity

Control Group (N=30)				
Variable	**Pre-test (M.±S.D.)**	**Post-test (M.±S.D.)**	**t**	**p**
Flexibiliy (cm)	33.32±6.73	32.91±6.82	2.78	.01*
Dynamic balance (sn)	10.37±3.63	10.39±3.69	-.20	.84
Right hand-grip strenght(kg)	27.77±4.09	27.91±4.29	-.80	.43
Left hand-grip strenght (kg)	25.70±3.59	25.67±3.70	.33	.73
Back strenght (kg)	66.90±13.56	67.02±13.62	-.41	.68
Leg strenght (kg)	59.93±15.80	60.24±16.12	-.86	.39
Vital capacity (VC)	3.30±0.40	3.29±0.40	1.19	.24
Forced vital capacity (FVC)	3.60±0.40	3.62±0.43	-.84	.40

*p<0.05

In Table 6, there was a statistically significant difference in flexibility only. It was observed that the flexibility performance of the participants in control group was decreased after 12 weeks.

Table 7. The results of the studies related to aquatic exercises in literature

First Author	Training Type	Population	Age	Frequency (Weeks)	Significant Improvement
Colado et al.[15]	Aquatic exercises	Postmenopausal women	54.71	10 weeks, 2 sessions per week	Body composition (Fat Mass, Fat Free Mass)
Gappmaier et al.[22]	Aerobic exercise in water	Obese women	Middle-aged	13 weeks (4 Times a week, %70 of age predicted maxhr	Body weight, percent body fat, skinfold measurements
Piotrowska-Całka[55]	Deep water aerobic training	19 women	49.2±8.7	24 weeks (twice a week for 45 minutes)	Aerobic capacity, systolic blood pressure and resting heart rate
Ide et al.[26]	Aquatic respiratory exercise	Women patients with fibromyalgia	20-60	4 weeks, four times a week (45min.)	Quality of life, functional capacity, anxiety and quality of sleep
Fragala-Pinkham et al.[21]	Aquatic exercise programme	Children with cerebral palsy	6–15	Twice per week for 14 weeks	Gross motor skills and walking endurance
Oh et al.[50]	Aquatic exercise programme	Elderly people with history of falling	74.71 ± 2.9	10-week (perceived exertion at 4 of a 10-point scale)	Time up and go test, quality of life, flexibility, strength
Kantyka et al.[30]	Aqua aerobics at approximately 128–137 bpm	Middle-aged sedentary females	56.20 ± 2.57	Three times a week for three months, at approximately 128–137 bpm	Body weight, total body water, fat-free mass, and skeletal muscle mass
Raffaelli et al.[56]	Water based exercises	Active young adult women	26.4 ± 3.8	Two times a week for 9 weeks, Borg Scale	Cardiorespiratory fitness, muscular endurance, strength, balance, and body composition
Costa et al.[16]	Water based aerobic training	Elderly women	60- 75	Two times per week for 10 weeks (45min.), 80-100% MHR	Maximal oxygen consumption (13.8%), oxygen consumption at the second ventilatory threshold (16.4%), maximal dynamic strength of knee flexion and extension 10.6%
Yusof et al.[80]	Aqua zumba	Obese middle age women	40-59	12 weeks 3 times per week, 60 minutes per session, with the intensity of 50-75% of MHR	Body mass index, body fat (%), upper body strength, lower body strength, cardiorespiratory fitness, flexibility
Takeshima et al.[70]	Well-rounded exercise program performed in water (baseline peak vo2, and the hr corresponding to lt, one set of 10–15 repetitions)	Older women	60–75	12 week, 70 min. (10 min of warm-up and stretching exercise, 10 min of resistance exercise, 30 min of endurance-type exercise), 3 day a week	Peak V_{O2} (12%), V_{O2} at lactate threshold (20%), muscular strength, skin-fold thickness (-8%), trunk extension (flexibility) (11%), LDL cholesterol (17%), total cholesterol (11%) $FEV_{1.0}$ (7%)
Lee and Oh[38]	Aquatic exercise	20 obese elementary students	11.45	60 minutes a day, 3 times a week for 12 weeks with an exercise intensity of 50-70% HRmax	Body composition, both body fat percentage and fat-free mass, muscular endurance, flexibility, and cardiopulmonary endurance

Table 8. The results of the studies related to aquatic exercises in literature

First Author	Training Type	Population	Age	Frequency (Weeks)	Significant Improvement
Shari et al.[64]	Aqua zumba fitness	Sedentary obese women	20-59	12 weeks 3 times per week, 60 minutes per session, with the intensity of 50-75% of HRmax	Body fat (%), waist circumference
Lim et al.[39]	Aquatic exercise	Female elderly with knee osteoar-Thritis	66	Three times a week, 60 minutes per session for 12 weeks.	Muscular function of isokinetic strength of leg muscle in flexion and extension of knee joint, static balance, waist circumference, body mass index and body weight.
Ryzkova et al.[59]	Aqua fitness shallow program with high intensity interval training	Female college students	21.1± 3.2	10-week with a frequency of 50-minute sessions twice per week	Waist circumference, body fat percentage, waist to hip ratio, static balance, flexibility of the hamstrings and lumbar spine and dynamic balance
Babaeipour et al.[6]	Aquatic exercise	36 male with chronic ischemic stroke patients	40-70	6 weeks (3 sessions of exercises per week)	Balance
Johnson et al.[27]	Aquatic exercise	Older adults with type 2 diabetes mellitus arthritis	≥55	60-min, twice/week, 40% to 65% of heart rate reserve for a total of 12 weeks.	6-min walking distance, sit-to-stand repetitions, and body mass index
Mandaric et al.[42]	Water training programme	154 female adolescents	13.05±0.45	The three-times-a-week lasting for eight weeks, Music Tempo between 122-132 bpm	Body composition, cardiorespiratory endurance, muscular force, muscular endurance and mobility
Sahebozamani et al.[63]	Deep aquatic exercise program	Thirty elderly men	Over 65	60-minute sessions three times a week for 8 week	Muscle strength and static balance.
Neiva et al.[48]	Water aerobics	Adults and older adults	58.80±14.32	45 min of twice a week for 12 week, recording heart rates between 101 and 126 bpm	Explosive strength in upper limbs, body composition, body fat, and blood pressure
Boguszewski et al.[12]	Aqua fitness Exercises	Elderly Women	55 to 76	Once a week, 1.5 hours each	Strength of upper limbs and the strength and endurance of lower limbs
Bocalini et al.[11]	Water-based exercise	Fifty healthy sedentary women	62–65	12 weeks at 70% of the age-predicted MHR, 1 set 10-15 reps.	HR at rest, VO_{2max}, lower body strength, upper and lower body flexibility
Kaneda et al.[28]	Deep-water-running exercise	Thirty healthy elderly	60.7 ± 4.1	Twice-weekly for 12 week.	Dynamic balance ability
Maniu et al.[43]	Aquatic therapy programme	24 children with cerebral palsy	12.5±2.7	6 months, 2 weekly sessions, 45 minutes	Vital capacity 56.7%, quality of life

Table 9. The results of the studies related to aquatic exercises in literature

First Author	Training Type	Population	Age	Frequency (Weeks)	Significant Improvement
Hashemi Javaheri et al.[24]	Water exercise programme	15 elderly people	63.2 ± 4.2	(3 times per week for 6 weeks	Static and dynamic balance
Roth et al.[58]	Aquatic exercise	24 healthy subjects	21.18 ± 1.24	3 days per week for 4 weeks	Balance, strength, flexibility
Kang et al.[29]	Aquatic exercise	16 elderly women	72.63	3 days per week for 12 weeks, 50 min.	Foot pressure balance and body posture stability
Meredith-Jones et al.[45]	Aquatic circuit training in deep water	Overweight obese sedentary Female	59 ± 9	60 min, 3/week, 70—75% mode specific max HR	V_{O2} peak 13%, wait circumference 4.9%, upper body strength 20% and lower body strength 32-33%
Saavedra et al.[61]	Aqua aerobic programme (Shallow water)	20 Healthy sedentary Female	43.1 ± 9.7	8 months, 2 days/week 60 min, RPE 13-14	Total body mass, body fat percentage, cardiorespiratory function (aerobic capacity)
Lord et al.[41]	Shallow water exercise	85 older men and women	71.8 ± 8.8)	1 day per week 60 min., 20 week	Balance and shoulder range of motion (flexibility)
Broman et al.[14]	High intensity deep water training	Twenty-nine healthy women	69 ± 4	48 min, two times a week for 8 weeks, 75% MHR on cycle ergometer	Heart rate 3% less, maximal oxygen uptake was raised by 10%, maximal ventilation was increased 14%
Penaforte et al.[53]	Continuous water exercise	Twenty-seven sedentary female volunteers	42.8±7.4	Two months with 3 weekly sessions of 60min, 70-85% of maximum HR	Weight (-0.6 kg), BMI (-0.3 $kg.m^{-2}$), fat mass (-0.6 kg), arm circumference (-1.8cm) and hip circumference (-4.0cm)
Vedana et al.[75]	Shallow water-based exercise	34 adults and older	50-80	16 weeks, 50 min., 2 sessions/week	BMI, body adiposity, endomorphism and resting heart rate, pulmonary function (spirometry) and flexibility
Kasprzak et al.[32]	Aqua aerobics training program	32 women with abdominal obesity	41–72	3 months, twice a week, and each class lasted 60 min, 65–75% hr_{max}	Body mass, BMI, waist circumference, hip circumference and the Waist-hip ratio
Katsura et al.[33]	Aquatic exercise training using the new equipment	12 healthy elderly individuals	68.5 ± 4.2	90 min, three times per week for 8 weeks, “moderately strong” RPE	Balance and walking ability (5-m maximum walking speed and 10-m obstacle walking), muscle strength in plantar flexion, the timed up and go test
Volaklis et al.[77]	Combined resistance and aerobic training in water	12 patients with coronary artery disease	53 ± 4	4 months, 4 sessions per week (2 aerobic sessions (at 50%-70% of MHR, 2 sessions of resistance training (60%-80% 1MR), 60min,	Body weight, sum of skinfolds and muscular strength +12.8%
Bento et al.[9]	Water-based training	20 older women	65.5 ± 3.9	3 days/week for 12 weeks, 60min., rpe; 12–16 and heart rate (progressing from 40% to 60% of the heart-rate reserve	8.0% dynamic balance

DISCUSSION

The aim of this study was to investigate the effects of 12 weeks aqua-pilates exercises in deep water on some physical fitness parameters of young female university students. In the literature, the effect of aquatic exercises applied to different age groups in different intensities on various physical fitness characteristics were shown in Table 7, 8, 9.

Deep water exercise is traditionally defined as exercises performed by the participant in a vertical manner (suspended) without touching the bottom of the pool in deep water. In deep water exercises, participants perform movements in three different planes. These exercises include all body work out, enhancing the core muscles and strength, without creating any load on the joints[2].

Aqua therapies are useful in the treatment of musculoskeletal problems, neurological problems, cardiopulmonary pathology and other diseases[8]. When the literature was examined, it was seen that water exercises accelerate the rehabilitation process[35], increase physical function in the elderly[78], decrease the risk factors caused by the disease in individuals with various diseases[25,47], improve cognitive function in the elderly[65], and use for therapeutic purposes in individuals with obese and knee injuries[31]. Studies investigating the effect of aqua-pilates exercises on selected physical fitness parameters in deep water are limited. This reveals the importance of the study in terms of literature.

According to the results of this study; there was a statistically significant difference in body weight (t = 4.39, p =.00), body mass index (t = 5.49, p = .00), body fat percentage (t = 7.38, p =.00), biceps (t = 8.21, p=.00), triceps (t = 4.70, p=.00), supra-iliac (t = 9.72, p=.00), subscapula (t = 7.19 p =.00). The effect size of the aqua-pilates exercises in exercise group for body weight, body mass index, skinfold thickness measurements (triceps) was small.

There was a moderate effect size in body fat (%), skinfold thickness measurements (biceps, supra-iliac, subscapula). It was detected that there was a statistically significant difference between pre-test and post-test mean values of flexibility (t = -5.27 p =.00), dynamic balance (t = -7.57 p =.00), right-hand grip strenght (t = -4.72 p =.00), left-hand grip strenght (t= -3.47, p=.00), back strenght (t=-4.33 p=.00), leg strenght (t= -5.82 p=.00), vital capacity (t=-2.58, p=.01) and forced vital capacity (t=-3.87, p=.00) of exercise group. The effect size of 12 weeks aqua-pilates exercise on flexibility, right-hand grip strenght, left-hand grip strenght, back strenght, leg strenght and forced vital capacity was small in the exercise group. There was a moderate effect size in dynamic balance after 12 weeks aqua-pilates programme in the exercise group. (Table 3 and Table 4). There was no statistically significant difference in the comparison of the pre-test and post-test results of the control group except for flexibility (p> 0.05) (Table 5 and Table 6).

The studies were summarized in Table 7, 8, 9 that aquatic exercises applied to different sampling groups (women, children, adults, elderly, patients, obese, sedentary, healthy individuals) at different durations and exercise intensity positively improved physical fitness characteristics. Some of these studies are therapeutic and, while the aim of the othes were to improve physical fitness characteristics. The studies summarized in Table 7, 8, 9 support the findings of this study results.

Meredith-Jones et al. (2011) reported that regular deep or shallow water exercises led to beneficial effects on cardiorespiratory fitness, strength and body fat distribution according to the limited literature related to the aquatic exercises[46]. Water-based exercises were found to be more effective in improving the strength due to the viscosity, turbulence and resistance of water as compared to land-based exercises[50]. When immersed in water, the body may have a weight less than 90% on land. This weight loss

removes the load on the joints and spine and helps to increase the range of motion according to normal conditions. In addition, there is a significant increase in energy expenditure (with or without water equipment) to overcome water resistance[30]. Compared with land-based exercises, energy consumption is higher in aquatic exercises. According to Aquatic Exercise Association (2010), during deep-water exercise, caloric expenditure changes between 8.8 (lower intensity) and 18.9 (higher intensity) kilocalories per minute, or 528 to 1,134 kilocalories per hour, for most cardiorespiratory class formats as compared with land-based exercise[2]. In this study, significant improvements was detected in body mass, body fat percentage and skinfold measurements. Recently, aquatic exercises using the properties of water viscosity, buoyancy and water resistance have been widely applied to the elderly. It was observed that water exercises prevented falls in people who had poor balance beacuse of the water's viscosity and buoyancy[33].

CONCLUSION

It was found that the twelve weeks of deep water aqua-pilates exercises which performed at a low and moderate intensity according to the Rating of Perceived Exertion Scale, improved the body weight, body fat percentage, flexibility, dynamic balance, strenght (hand grip, back and leg), vital and forced vital capacity of sedentary young women. The effect size of aqua-pilates training in deep water was moderate for body fat (%), skinfold thickness measurements (biceps, supra-iliac, subscapula) and dynamic balance. Small effect size effect was found in other parameters after training. These developments in physical fitness parameters could be attributed to the application of the exercises in horizontal and vertical positions in deep water (using equipment in some movements). In these positions, it is important for participants to maintain their equilibrium condition so that the movements can perform smoothly in the determined repetition. The arm and leg muscles work together to ensure balance against water resistance.

In this study, some movements were performed at certain angles and might affect the flexibility performance. Significant improvements in strenght performance could also be attributed to the resistance and buoyancy created by water. Participants breathed against the resistance of water viscosity as well as the intensity of exercise. This was thought to affect the vital and forced vital capacity positively.

In this study, the intensity of aqua-pilates exercises in deep water were determined according to Rating of Perceived Exertion Scale (9-13) as very light-somewhat hard. Although the number of repetitions in movements were constant for 12 weeks, the degree of difficulty of the movements was gradually increased. As a result, to achieve maximum efficiency within a short time, aqua-pilates exercises can be used by all age groups and also used for the development of physical fitness parameters that are necessary in daily life other than the purpose of therapy. In future studies, increasing exercise intensity, frequency and applying the exercise program for a longer time period may improve much more physical fitness capacities of individuals.

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