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Professional paper

INVESTIGATION OF THE EFFECTS OF WATER EXERCISES ON BODY

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Abstract

Water exercises provide numerous benefits such as reducing the risk of most chronic diseases, increasing joint range of motion, decreasing body fat, and developing physical fitness and muscular strength. The present study aims to investigate the effects of water exercise programs on body composition, vital signs, and blood glucose levels. In the study, a pretest-posttest comparative analytical model was used. The data were collected through participant forms and measurement instruments. 40 university students aged 20.02±1.09 years participated in the study. The volunteers participating in the study were included in the research program for 10 weeks. The averages of all test values were compared using the independent samples t-test analysis method and the statistical significance level was set as $p<0.05$. Statistically significant differences were observed in the pulse and saturation values of the participants ($p<0.05$), but no significant difference was found between the pretest and posttest glucose values ($p=0.275$). Additionally, statistically significant differences were found in the participants' body weight, muscle mass, fat percentage, waist circumference, trunk and both legs ($p<0.05$). It is thought that the interactions produced by water exercises on body composition and blood glucose values may exhibit significant changes with advancing age due to differences arising from physical activity level, gender, and lifestyle, and that the findings obtained as a result of conducting such studies particularly in homogeneous groups (gender, activity level and age) or in periods when the growth process is evident may yield more decisive findings.

Keywords: Water exercises, body composition, blood glucose level, physical fitness

1. Introduction

Water exercises are among the exercise practice methods that have survived to the present day as a popular tool for healing and a scientific treatment method (Dal, 2018; Guldali, 2017). The main feature of water exercises is that they are an alternative method for the application of physical exertion in exercise practices with a high level of movement difficulty on land (AEA, 2017; Schrepfer, 2007). Water exercises improve the cardiovascular system, physical fitness, movement coordination, muscle strength and aerobic endurance. The buoyancy, viscosity and hydrostatic pressure of water are some of the factors that make water exercises effective and safe (Layne, 2015; Yildirim, 2022). These features enable athletes to maintain and improve their aerobic and muscular endurance by eliminating the risk of micro-trauma to joints and bones against the resistance applied during exercises (Cigerci, 2017; Guldali, 2017; Layne, 2015). Exercises

performed in water are more successful in reducing body fat percentage by providing higher energy consumption compared to exercises performed on land (Baltaci, 2016; Cigerci, 2017; Guldali, 2017; Orus, 2015; Pianna *et al*, 2019; Yildirim, 2022). Moreover, thanks to the thermoregulatory properties of pool water, movement coordination is facilitated by allowing the body and muscle temperatures to be kept at low levels during exercises (Layne, 2015). In addition to being fun and accessible activities that can be applied to all age groups, water exercises also provide numerous benefits such as the treatment of chronic pain, the reduction of cardiovascular disease risks, and the improvement of health and quality of life in diabetic patients (Akgun, 2020; Dal, 2018; Orus, 2015; Schrepfer, 2007).

Regular land and water exercise reduces blood sugar levels and body fat, increases insulin sensitivity and improves cardiovascular functionality (Steppel & Horton, 2008). Regular moderate aerobic activity is recommended in order to reduce and control high blood pressure (AHA, 2022). Regular exercise practices have been shown to reduce the blood pressure of individuals without severe hypertension by an average of 10 mmHg (Guclu *et al*, 2012), while another study found that regular exercise on land and in water reduced systolic/diastolic blood pressure (Arca *et al*, 2014). In this context, the present study aims to investigate the effects of water exercise programs on body composition, vital signs and blood glucose levels in students of the Faculty of Sport Sciences.

2. Methods

Research Model

This study uses a pretest-posttest comparative analytical model.

Study Group (Population-Sample)

A total of 40 healthy, non-smoker students over the age of 18 studying at Lokman Hekim University (LHU) Faculty of Sports Sciences who do not have any chronic disease and do not take regular medication voluntarily participated in the present study. The sample size of the study was calculated using G*Power version 3.1 with a 95% confidence interval based on sample sizes obtained from the literature, and 40 volunteers were included in the assessment. The mean age of the participants was 20.02±1.09 years. Approval was obtained from the LHU Non-Interventional Clinical Research Ethics Board (decision dated 18/04/2022 and numbered 2022051) and the chair of the relevant department for the study. The volunteers participating in the study signed an informed consent form. The present study was conducted in accordance with the Principles of the Declaration of Helsinki.

Data Collection Method and Tools

Participant forms prepared by the researchers were used in the data collection process. These forms include information on the age, gender, body composition, vital signs, and blood glucose levels of the participants. The Tanita MC-780MA instrument was used for body composition, an Erka sphygmomanometer for blood pressure, an Optima device for blood glucose level measurement, and a Braun YK-81CEU Pulse Oximeter for saturation and pulse measurements. The data were collected at LHU laboratories and the TOBB University indoor swimming pool. The volunteers participating in the study were included in the research program for duration of 10 weeks. Before the study, body composition, vital and blood glucose levels of the participants were measured, and the second phase (the planned exercise program) was initiated. Following the completion of the planned exercise program, the same measurements of the participants were checked again. The volunteers participating in the study were included in the research program for duration of 10 weeks. Before the study, body composition, vital and blood glucose levels of the participants were measured, and the second phase (the planned exercise program) was initiated. Following the completion of the planned exercise program, the same measurements of the participants were checked again. The purpose of this study; The aim is to see the long and short-term effects of the exercise program applied on the participants. For this reason, it was desired to evaluate the effectiveness of the program with the participants' pre-exercise values (body composition, vital signs and blood sugar) and post-exercise values (body composition, vital signs and blood sugar).

The necessary information was provided face-to-face to the students who applied to participate in the study voluntarily. The participants were asked to read and sign an Informed Voluntary Consent Form. Two weeks before the start of the study, 40 healthy volunteer students of the Faculty of Sports Sciences who agreed to participate in the study were met and the rules to be followed were explained. Body composition, vital signs (blood pressure, pulse rate, respiratory rate) and blood glucose measurements were taken from the participants (pretest) after 12 hours of fasting. Before starting the program, a student introduction form was applied to the volunteers whose measurements were taken and they were asked to participate in a 1-hour water exercise program 2 days a week. The water exercise programs applied to the participants were conducted by the supervising researchers. The participants were asked to have breakfast at least 2 hours before starting the physical performance tests and not to consume caffeinated and/or alcoholic beverages in the 24 hours prior to the tests. Before each workout; blood pressure (viewed from the left arm), respiratory rate, saturation value (thumb), pulse value (radial pulse) and blood glucose value (viewed from the 4th finger of the hand) were recorded by the researchers. At the end of the study (10 weeks), body composition measurements, vital signs and blood glucose level measurements were taken from the participants again.

Water Exercise Program

The volunteers participated in a 1-hour water exercise program consisting of three phases 2 days a week in an Olympic-sized swimming pool. The water temperature was maintained between 28-30 °C in accordance with the Aquatic Exercise Association guidelines for water-based exercises (AEA, 2017). The implementation principles of the water exercise program are presented below:

Warm-up phase: The warm-up exercises lasted 15 minutes in total, both on land and in water. The warm-up phase on land consisted of 5 minutes of jogging, head, shoulder, and arm movements, while the in-water

warm-up phase consisted of 10 minutes of flutter kicking, arm rotation movements and breathing adaptation exercises.

Main phase: The main phase of the application lasted 40 minutes. In this scope:

1) 3 repetitions of water jogging for 40 seconds, moving the legs similar to a running pattern on land to train the abdominal, gluteus, hamstring, calves and quadriceps muscles,

2) 3 front flutter kicks for 45 seconds while holding the pool wall, keeping the arms at a long distance and the legs parallel to the water to train the deltoids, biceps, triceps, trapezius, pectoralis, abdominal, gluteus, hamstring, calves, and quadriceps muscles,

3) 3 repetitions of high leg swing for 40 seconds in an upright position in the water, with a stance sideways to the wall, grabbing the wall with one arm and extending the arm until the arm is straight, then lifting the far leg with a straight motion to return to the starting position in order to train the deltoid, abdominal, forearm, gluteus, hamstrings, calves and quadriceps,

4) 3 sets and 7 repetitions of the dips movement to train the pectoralis and triceps muscles, the arms placed flat on the wall with the body in the water. The volunteers raised themselves as high as they could and held the position for a few seconds before returning to the starting position,

5) The volunteers were seated at the edge of the pool to train the deltoids, biceps, triceps, trapezius, pectoralis, forearm, and abdominal muscle groups. The hands were held back, and the legs were kept straight in the water. The legs were lifted 45 degrees, straight and adjacent to each other, and held for a few seconds. 3 sets and 7 repetitions of 45-degree leg lifts were performed,

6) The volunteers placed their backs against the edge of the pool with their hips and stretched their arms to the side to train the abdominal, forearm, gluteus, calves, and quadriceps muscle groups. Both knees were pulled up with support from the edge of the pool and 3 sets of the bicycling movement were performed for 40 seconds each,

7) To train the hamstring, quadriceps and gluteus muscle groups, the volunteers spread their hands to the sides and kept their feet hip-width apart. First, with the right foot behind, the left foot was bent forward at the knee and the participants sat in a squat position. The right foot behind was bent up to the point that the knee did not touch the ground and the movement was completed. 3 sets and 15 repetitions of the lunge exercise were performed.

Rest time is 30 seconds between all exercises.

Cool down phase: A cooling down phase is applied for 5 minutes in order to reduce the resting load of the heart and to help the muscles contract during blood circulation to the heart. The cooling down phase consists of low rhythm foot tapping exercises, arm rotation movement and breathing adaptation exercises.

Statistical Analysis

Statistical analysis of the data was performed using SPSS 20.0 (Statistical Package for Social Sciences). Descriptive statistical methods (number, percentage, mean and standard deviation) were used to evaluate the data. The skewness-kurtosis values for the normality test showed that the distribution was normal. As a result of these procedures, the means of all test values were compared using the independent samples t-test analysis method and the statistical significance level was accepted as $p< 0.05$.

3. Results

Table 1 shows the vital and blood glucose measurements of the participants before and after the planned water exercises.

Table 1. Comparison of pre test-post test vital signs and blood glucose values of the students participating in the study

Variable		**X± SS**	**t-test**	**p value**
Pulse	Pre test	85.67±15.17	4.625	p<0.001
	Post test	81.05± 11.83		
Respiratory	Pre test	18.25±0.92	-1.034	p=0.308
	Post test	18.65± 2.32		
Systole Blood Pressure	Pre test	106.12±9.09	2.266	p=0.029
	Post test	103.55±6.96		
Diastole Blood Pressure	Pre test	70.75±6.15	2.020	p=0.050
	Post test	69.25±6.65		
Saturation	Pre test	98.15±1.14	-2.403	p=0.021
	Post test	98.50±.640		
Blood Glucose	Pre test	64.97±7.46	-1.106	p=0.275
	Post test	65.67±5.90		

*p<0.05.

According to Table 1, the initial and final values of the participants' pulse rate, blood pressure, respiration, saturation, and blood glucose levels were recorded. Statistically significant differences were observed in the pulse and saturation values of the participants ($p<0.05$). The mean pulse rate of the participants decreased by 5.39%. However, no significant difference was found between the pretest and posttest glucose values of the participants ($p=0.275$).

Table 2. Comparison of Pretest and Posttest Body Composition Measurements According to Body Parameters

Variable		X±SS	t-test	p value
Body weight (kg)	Pre test	64.72±10.74	8.252	p<0.001
	Post test	63.68±10.22		
Height (cm)	Pre test	172.42±8.96	1.000	p=0.323
	Post test	172.40±8.96		
Muscle Mass	Pre test	50.79±9.87	-7.326	p=0.000
	Post test	51.79±9.87		
Fat Mass	Pre test	11.11±5.53	8.751	p=0.000
	Post test	10.58±5.39		
Liquid Mass	Pre test	35.27±7.17	-0.696	p=0.491
	Post test	35.66±8.08		
Waist	Pre test	76.42±8.33	7.495	p=0.000
	Post test	75.32±7.76		
Right Leg	Pre test	2.25±1.15	11.184	p=0.000
	Post test	2.11±1.11		
Left Leg	Pre test	2.24±1.15	9.062	p=0.000
	Post test	2.12±1.11		
Right arm	Pre test	0.60±0.33	0.764	p=0.449
	Post test	0.59±0.40		
Left arm	Pre test	0.62±0.34	0.746	p=0.460
	Post test	0.60±0.35		
Trunk	Pre test	5.60±2.93	4.995	p=0.000
	Post test	5.42±2.90		

*p<0.05.

Table 2 shows the pretest and posttest body composition measurement values of the participants based on their body parameters.

Statistically significant differences were observed in the study group in terms of body weight, muscle mass, fat percentage, waist circumference, trunk and both legs (p<0.05). After the exercise, it was observed that there was a decrease of 1.60% in the mean body weight and 4.77% in the adipose tissue of the participants while an increase of 1.96% in muscle tissue was observed. At the same time, it was found statistically significant that the body weight of the participants decreased after the exercise and the reason for this was the fat mass (Table 2).

4. Discussion and Conclusion

The present study was conducted with the aim of revealing the effects of planned water exercise practices on body composition, vital signs, and blood glucose levels in students of Sports Sciences. In this scope, in the study results examining the effects of water exercises on cardiovascular fitness level, it was observed that the aerobic endurance capacity values of the study group were statistically higher compared to the

control group, while there were significant decreases in systolic blood pressure and resting heart rate compared to the control group (Piotrowska-Całka, 2010). In another study (12 weeks) in which the effects of water-based and land-based exercises on aerobic capacity and strength were examined, significant improvements in muscle strength development (upper body 20 ± 7.1 %, knee flexion 33 ± 7.9 %, knee extension 32 ± 17.9 %) were recorded. Furthermore, no significant reduction was found in the participants' hip and waist circumference fat percentages (Merdith-Jones *et al*, 2009).

In the study conducted by Medeiros *et al* (2016), examining anthropometric parameters, oxidative profile, and insulin resistance in two programs applied with similar intensity and different severities in water exercises, a moderate aerobic exercise load was applied to the first group for 60 minutes 5 days a week and to the second group for 60 minutes 3 days a week. In the first group, there was increased enzyme activity in anthropometric parameters, lipid peroxidation, catalase, protein oxidation and superoxide dismutase levels, while in the second group, there was a significant decrease in waist circumference fat, sulfhydryl level and glutathione peroxidase activity, but there was no difference in insulin resistance parameters (Medeiros *et al*, 2016).

Similarly, in a previous study analyzing the effects of water exercises on functional capacity and body composition after a 12-week program, a 10% decrease in body fat percentage was recorded, while an improvement of 25% was observed in cardiorespiratory endurance capacity (Pianna *et al*, 2019). On the other hand, Reichert *et al* (2016), examined the effects of water exercises within the framework of blood pressure and functional fitness development (three days a week for 28 weeks) and observed a statistically significant decrease in blood pressure and improvement in functional fitness parameters (Reichert *et al*, 2016).

Wilber *et al* (1996), examined the effects of water exercises and treadmill on cardiorespiratory performance (maximal oxygen consumption (maxVO2), ventilation threshold, running economy) and metabolic responses (blood glucose, blood lactate, plasma norepinephrine), and it was stated that there were significant differences between the tests in terms of ventilation threshold, running economy, maximal blood glucose, blood lactate and plasma norepinephrine concentration after a 6-week program (5 days a week, alternating 30 min 90-100% maxVO2 and 60 min 70-75% maxVO2) while the maxVO2 values recorded during the water exercises displayed statistically significant improvements compared to the treadmill runs (Wilber *et al*, 1996).

Similarly, in the study conducted by Pasetti & Gonçalvesa Padovani (2012), examining the effects of intermittent and continuous water exercises (12 weeks) on general health, it was observed that body composition, cardiorespiratory fitness and the WHOQOL-Brief quality of life scale provided statistically significant improvements in both exercise groups (Pasetti & Gonçalvesa Padovani, 2012). In another supporting study examining the effects of water exercises on pulmonary functions, blood pressure and body composition, it was stated that at the end of an 8-week exercise program, resting heart rate decreased, pulmonary functions such as forced expiratory volume, maximum voluntary ventilation, vital capacity and forced vital capacity increased (Gokhan *et al*, 2011a), while body fat percentage decreased with the stabilization of diastolic blood pressure (Akalin, 2008; Gokhan *et al*, 2011a; Gokhan et al, 2011b).

In contrast with the mentioned studies, in another study conducted by Eyestone *et al* (1993), comparing land running, cycling and water exercises, no significant differences were found between the participants in terms of ventilation threshold, running economy, glucose level, maximum blood lactate level and body composition parameters as a result of an exercise program with similar training intensity, frequency and duration (Eyestone *et al*, 1993). In the present study, it was found that the planned water exercises applied on the students of the Faculty of Sports Sciences were effective on the changes in vital signs and body composition (Table 1), whereas there were no significant changes in blood glucose levels (Table 2).

In addition to revealing the similar effects provided by physical activity applications on land, water exercises allow for the execution of movements that are difficult to perform due to individual differences, facilitate movement coordination, reduce the risk of potential injuries to joints and bones due to strenuous exertion, and increase physical fitness and quality of life by contributing to the protection and development of aerobic and muscular endurance. Within this framework, it is thought that the interactions induced by water exercises on body composition and blood glucose values may exhibit significant changes with advancing age due to differences arising from physical activity level, gender and lifestyle, and that the findings obtained as a result of conducting such studies particularly in homogeneous groups (gender, activity level and age) or in periods when the growth process is evident may yield more decisive findings.

Nomenclature

LHU	Lokman Hekim University
maxVO2	Maximal oxygen consumption

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