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THE INFLUENCE OF EIGHT WEEKS OF SHALLOW AND DEEP WATER EXERCISES ON THE STATIC AND DYNAMIC BALANCE OF SENIORS ORIGINAL SCIENTIFIC PAPER WATER EXERCISES AND THE STATIC AND DYNAMIC BALANCE

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Abstract
Background and aim: Physiological changes, such as muscular weakening and a rise in physical ailments, psychological and social challenges, and other difficulties become more common beyond age 60, making old age a particularly vulnerable time in a person's life. By studying the effects of various hydrotherapy techniques on the static and dynamic balance of the elderly, this study hopes to shed light on this question.
Methods: The present study employs a semi-experimental approach of applied research. 45 women and 45 men, all aged 60 and above, were randomly chosen for the research, and their results were compared to those of 30 controls of similar age and gender. After the completion of the pre-examination tests, all qualified people who were pre-tested were randomly divided into three groups, 15 each groups of water therapy exercises in the deep part of water (therapy exercises at a depth of 20.2 meters up to 50.2 meters). The second group of water therapy exercises is in the shallow part (therapy exercises in water at a depth of 1 meter to 130 meters). Finally, the third group was the control group.
Results: The results showed that after doing exercise therapy interventions in water, static and dynamic balance improved significantly in the two treatment groups compared to the control group. ($P<0.05$). Balance, both static and dynamic, did not vary significantly between the two workout modalities, either in deep or shallow water.($P>0.05$). Moreover, static and dynamic balance improvement in the older women were similar across the two groups.
Conclusion: The findings suggest that water-based exercise treatment may be an option for enhancing the static and dynamic balance of the elderly.
Keywords: Therapeutic Exercise in Water; Elderly; Static and Dynamic Balance

1. Introduction

One of the most vulnerable times in a person's life is old age, which begins around the age of 60 and is marked by physiological changes including muscular weakening and a rise in physical ailments, psychological and social disorders. In the beginning, the person's adaptability was hampered by the inability to balance and respond quickly to changing environmental circumstances [1]. Eventually, the person's skeletal framework and internal organs were affected. Maintaining stability requires a steady grasp on the ground or other support mechanism. To put it another way, in the stable zone of the body, balance is a multi-sensory activity that requires the integration of information from a number of different senses, muscles, and the skeleton [2].

The ability of the body to detect a shift in its centre of gravity and respond with swift muscular correction diminishes with age because of a decrease in the activity of the key sensory systems involved in balance [3]. As these systems deteriorate, the elderly has difficulties with their equilibrium and mobility. Furthermore, the aged in this scenario are vulnerable to major injuries due to falls, which may result in fractures, a fear of falling, and a decrease in activity independence [4]. Postural fluctuations determine postural stability, which means small deviations of the body from the vertical position, and leads to instability and increasing the possibility of falling [5]. The control of postural fluctuations requires the integration of responses related to the systems involved in balance, and this process is faced with a significant drop in the elderly [6]; however, research has shown that people with frequent positioning are less sensitive to the movements of the support level and show responses with a smaller range [7]. Therefore, repeated exposure to a task leads to refinement of features and optimization of response efficiency. Consequently, exercise and different physical activities can affect the way of organizing a person's stability when the balance is disturbed [8]. Although physical exercises have been accepted as a suitable intervention method in maintaining and restoring balance and preventing falls in the elderly, the benefits of different types of exercise on the systems involved in balance are still questioned [9].

One of the appropriate exercises that are recommended today to improve balance and prevent falls in the elderly is therapeutic exercise in water [10]. The hydrostatic pressure of water increases the resistance to the muscle groups involved in the activity and creates stronger stability. The contributing factors of hydrostatic pressure and buoyancy allow training in the aquatic environment to have several advantages over the outdoor environment [11]. First, the buoyancy force acts against gravity, which can act as an auxiliary force, a resistance force, and a support force. It also provides a suitable environment for easy and comfortable movement for some people who have difficulty moving on the ground. Secondly, hydrostatic pressure exerts equal resistance on all active muscle groups during immersion in water. Therefore, it creates a kind of resistance training conditions and also provides a strong sense of stability. This problem may help the individual practicing in water to build strength, flexibility, and, most significantly, improve balance [12], given that there is no stable state of rest in the water, and the muscles are continually recruited to stabilize the body postures.

According to literature, although many researches have been done on the positive role of therapeutic exercise in water on balance, and most of them have confirmed this issue [13], however, in relation to whether exercise in shallow and deep parts can leave different effects, there is little research and these little researches have reported this issue so far. Therefore, the purpose of the current study is to determine whether or not there is a correlation between the kind of hydrotherapy a person receives and their static and dynamic balance.

2. Methods

2.1. Study design and setting: The present study employs a semi- experimental approach of applied research. 45 women and 45 men, all aged 60 and above, were randomly chosen for the research, and their results were compared to those of 30 controls of similar age and gender. The dependent variables are measured before and after the study is conducted to glean the necessary information. In order to collect information after a public call from healthy elderly people referring to the swimming pool in district 1 of Baghdad with the age range of 60 to 85 years, 180 people (90 women and 90 men) declared their readiness and entered the research were selected to enter the present research.

2.2. Inclusion and exclusion criteria: Among the conditions for entering the current research include not taking drugs that have a psychoactive aspect, not having inner ear problems, not having dementia, not having corrected vision, not having bone fractures, not having a history of suffering from diseases such as Parkinson and Alzheimer, having a healthy sense of hearing, and not needing devices. Help was like canes and walkers.

2.3. Protocol: After identifying the people participating in the research, they were evaluated in the pre-test, i.e., static balance, stork balance, and dynamic balance, balance test [14]. After the completion of the pre- examination tests, all qualified people who were pre-tested were randomly divided into three groups, 15 each groups of water therapy exercises in the deep part of water (therapy exercises at a depth of 20.2 meters up to 50.2 meters). The second group of water therapy exercises is in the shallow part (therapy exercises in water at a depth of 1 meter to 130 meters). Finally, the third group was the control group. After the groups were determined, the researcher started training each sample about how to perform exercise movements. The two experimental groups performed the relevant interventions for 8 weeks of three sessions a week, and after completing the interventions, static balance and dynamic balance were again performed for all three groups. The post-test was measured again like the pre-test. It's important to note that the pre- and post-test static and dynamic balancing assessments were administered by someone who was blind to the individuals and the groups to which they belonged.

Among the activities of the intervention protocol of present research, the following can be mentioned: standing on one leg with eyes open and closed, walking in different directions with eyes open and closed, closing hands and feet simultaneously, moving arms and legs in a pendulum position, assuming a square and walking on the sides of the square, lifting the right and left leg forward, inward and backward, jumping the vertical pair, bringing the elbow to the knee of the opposite leg while standing, bringing the elbow to the knee of the opposite leg, etc. The content of the intervention protocol exercises for both experimental groups was the same. With the difference that the shallow group used this protocol at a depth of 1 meter to 130, and the deep group performed these exercises at a depth of 20.2 meters to 50.2 meters. The control group was not subjected to any intervention during the implementation of research.

2.4. Measurement tools: In this study, the individual examination is one of the instruments. The individual is required to stand in one place, barefoot on a level surface. His hands are placed on his hips. Then, he positions his non-weight-bearing leg such that its knee is adjacent to the knee of his supporting leg. After some practice, the subject lifts his or her heel off the ground and attempts to balance on his or her fingers; at this point, the timer begins counting, and it stops as soon as a mistake is made. To fail this test, the supporting leg must be moved away from the thigh in any direction, the non-supporting leg must be moved away from the knee, and the supporting leg's heel must contact the ground [15]. Dynamic balances were tested using the 2-La method. For this evaluation, a 135-degree angle is made between the two sets of anterior, posterior, exterior, and posterior internal directions. To execute the test and thermalize the actual drum data, we measured the subject's length from the top of their anterior cruciate ligament to the inside of their ankle while they were flat on their back and then again when they were arched over. Every topic is given six opportunities to practice the exam in order to master it. The individual stood on one of his legs in the middle of the testing area, reached as far as possible in the direction selected by the examiner, and then returned to the starting position correctly. To counteract the subjects' ability to remember the instructions, we had them practice each code six times, separated by 15 second of break each time. The examinee will take a five-minute break before beginning the examination in either direction around Munger. The tester uses a centimeter scale to determine the precise location of the touch. Each participant took the exam three times, and the average score was calculated by dividing their three best scores. Then, that number was increased by 100 to get the reaching length as a proportion of the length; if there was a mistake in the subject's center foot's movement or if their balance was off, the test would have to be redone (14).

2.5. Statistical analysis: SPSS version 21.0 software was used to describe the data. After calculating descriptive statistics, we used the Shapiro-Wilk test to ensure that our dependent variables were normally distributed. In the following, in order to check the research hypotheses and determine the intra-group and inter-group differences, paired t- tests and covariance analysis were used, respectively. In order to determine the differences more precisely, Bonferroni post hoc test was used. P-values < 0.05 were judged to be statistically significant.

3. Results

In general, 60 subjects (30 women and 30 men) with a mean age of 66.01 (SD ±3.392) were enrolled and compared to 30 age and sex-matched controls with a mean age of 66.78 (SD ±3.322). Other basic demographics and characteristics of included subjects can be seen in Table 1.

Table 1: Basic demographics and characteristics of included subjects

Variables	Experimental groups (n = 90)			Control (n = 30)
	Deep group	Shallow group	Total	
Age (year)	65.87 ± 3.495	66.02 ± 3.416	66.01 ± 3.392	66.78 ± 3.322
Height (cm)	166.27 ± 5.125	169.38 ± 6.143	168.85 ± 5.512	169.12 ± 6.413
Weight (kg)	69.724 ± 8.774	70.232 ± 7.530	70.165 ± 7.475	71.120 ± 8.136
body mass index (BMI)	25.210 ± 2.412	24.498 ± 3.353	24.601 ± 2.502	24.982 ± 3.463

Next, we used a paired test to compare the groups, and we found that, on average, the static and dynamic balancing factors had changed significantly between the pre-and post-test phases (P<0.05; Table 2). When comparing the means of the dynamic and static balancing variables before and after the experiments, there is an improvement of statistical significance in the present experimental groups. Furthermore, there is no indication that the control group's before and post-test results changed.

Table 2: Descriptive statistics of dependent variables in study groups at different stages of the research

Group	Stage	Number (persons)			Mean ± SD			P-values		
		W	M	T	W	M	T	W	M	T
Deep group	Pre-test static equilibrium	15	15	30	2.26 ± 1.28	1.98 ± 0.96	2.21 ± 1.19	0.1039	0.0004	0.0002
	Post-test static equilibrium	15	15	30	3.24 ± 1.86	3.97 ± 1.65	3.5 ± 1.34			
	Post-test between women and men comparison P-value				0.2651		----	-----		
	Pre-test dynamic equilibrium	15	15	30	248.69 ± 50.28	315 ± 49.23	295 ± 50.02			

	Post-test dynamic equilibrium	15	15	30	312.87 ± 47.64	401.02 ± 52.25	361.51 ± 49.28	0.0013	0.0002	<0.0001
	Post-test between women and men comparison P-value				<0.0001		----	-----		
Shallow group	Pre-test static equilibrium	15	15	30	0.82 ± 0.28	1.27 ± 0.86	1.01 ± 0.99	0.0087	0.0254	<0.0001
	Post-test static equilibrium	15	15	30	1.57 ± 0.99	2.21 ± 1.28	2.11 ± 0.89			
	Post-test between women and men comparison P-value				0.1368		----	-----		
	Pre-test dynamic equilibrium	15	15	30	244.81 ± 48.28	295.61 ± 56.10	283.01 ± 50.87	0.0420	0.0308	0.0086
	Post-test dynamic equilibrium	15	15	30	285.16 ± 55.19	351.12 ± 76.11	328.02 ± 75.07			
	Post-test between women and men comparison P-value				0.0112		----	----		
Control comparison group	Pre-test static equilibrium	15	15	30	1.25 ± 0.89	2.29 ± 1.08	2.20 ± 0.99	0.7066	0.8348	0.3644
	Post-test static equilibrium	15	15	30	1.12 ± 0.98	2.21 ± 1.00	1.98 ± 0.87			
	Post-test between women and men comparison P-value				0.0054		----	----		
	Pre-test dynamic equilibrium	15	15	30	261.29 ± 49.41	265.18 ± 48.19	263.35 ± 48.89	0.8084	0.8913	0.8306
	Post-test dynamic equilibrium	15	15	30	265.56 ± 46.05	267.53 ± 45.11	265.98 ± 45.88			
	Post-test between women and men P-value				0.9066		----	----		

Post-test averages of static and dynamic balancing measures showed a difference in statistical significance among the three groups studied (Table 3). The results showed that the two experimental groups obtained significantly better results than the control group in static and dynamic balance. Also, the results showed that there was no significant difference in static and dynamic balance between the two experimental groups (exercise at low depth and exercise at high depth).

Table 3: Analysis of covariance to compare the mean of static and dynamic balance variables among research groups

Variable	source	Sum of squares	Degrees of freedom	Mean square	F statistics	sig
Static balance	Pre-test	45.91	14	47.29	84.12	<0.001
	group	8.93	29	4.67	8.48	<0.001
	Error	23.67	44			
Dynamic balance	Pre-test	61621.09	14	59987.09	62.54	<0.001
	group	19003.18	29	6496.53	9.78	<0.001
	Error	39809.76	44			

4. Discussion

The goal of this study was to see how physical therapy in water affected the static and dynamic balance of older women. This study found that static and dynamic balance improved after 8 weeks of therapeutic training in water at varying depths. Consistent with the impact of therapeutic workouts in water on static and dynamic balance in various persons [16-19], the current study's findings are in line with those of Esmailiyan et al. (2023), Peng et al. (2022), Ali et al. (2021), and Fail et al. (2022).

Imbalance is one of the most common and serious problems of the elderly, which causes many physical consequences, such as footfalls. It has been shown that exercise improves the quality of life for individuals of all ages, including the elderly, and is, therefore, one of the ways used to postpone the onset of aging- related diseases. Finally, they improve the neural control of muscles, which increases the speed of mechanical and physiological responses, and also leads to the activity of alpha and gamma motor neurons, which ultimately leads to the facilitation of muscle contraction [20], the first sensorimotor integration to control reflex balance. Myotonic contractions are carried out by muscle spindles, and it is likely that enhanced sensitivity of the muscle spindles and enhanced neuro- muscular control contribute to enhanced balance after exercise; hence, participating in sports and activities in a variety of settings.

By various tools, significant effects can be achieved in correcting posture and subsequently improving balance. Balance control requires participation in three areas: information received from sensory balance (visual, vestibular, and somatic), their central integration in the brain, and motor response to them. Any impairment in controlling posture due to various factors can be a reason for reducing individuals' balance. Studies have demonstrated that any type of physical activity is beneficial for improving both postural control and balance, while idleness just makes the problem worse. Chan *et al*. (2017) also studied the effect of water-based exercises on balance of stroke patients [21]. This researchconfirmed previous findings that integrating aquatic and land-based activities is beneficial for enhancing equilibrium. The benefits of water-based activities for stroke survivors were also confirmed. Exercises performed in water have been shown to improve postural control due to the fact that, on the one hand, the environment (water) allows for a greater variety of motions to be performed with no boosting the possibility of falling or injury, and on the contrary, the cushioning of water alone allows for the maintenance of a straight and smooth posture.
Improving static and dynamic balance in elderly women in water can be achieved by:

Water's turbulent forces provide a conducive setting for motor activity and present a unique challenge to the systems responsible for maintaining equilibrium [22]. Furthermore, owing to the slower movements in water and the greater response time, such workouts are appropriate for those with balance deficits [23]. Studies have shown that water viscosity increases resistance and helps strengthen muscles [24-26]. On the other hand, regarding the effect of exercises in water on improving balance in elderly individuals, it can probably be attributed to neural-muscular adaptation, especially in the lower limbs [27]. Neural-muscular adaptation can increase the ability to control perturbations, as the neural-muscular function of the lower limbs and the ability to quickly restore balance through the rapid activation of motor control strategies play a fundamental role in balance control [28].

The current research also shown that the depth at which therapeutic exercises were done had no effect on the rate at which older women's balance improved. In other words, exercises performed at both shallow and deep depths have the same effect. The equilibrium was helped by the water therapy exercises. That is to say, therapeutic activities performed in water had the same impact on both open and closed chain static and dynamic balance. These results are consistent with the findings of Bento *et al*. [29] and Labata-Lezaun *et al*. [30], and Bula *et al*. [31], six weeks of aquatic treatment at two depths affected the static equilibrium, and concluded that despite greater improvement in static balance and pain in deep water, there was no difference in the amount of improvement in static balance and pain in the two aquatic therapy groups. However, Zamanian et al.

[32] found that those who trained in shallow water improved much more than the other group after comparing the effects of water aerobics at two different depths.

One reason for the similar effects of water therapy at different depths could be the duration of the protocol of 8 weeks. It is possible that exercises over a longer period of time could demonstrate a clearer difference between the two depths. Improvement in static balance in deep water may be due to the water pressure during movement and the unstable environment caused by the lack of contact between the foot and the pool floor, while improvement in shallow water may be due to the creation of a closed chain movement and activation of the lower extremity joints.

Conclusion

Although in the aquatic therapy protocol in the shallow part, where the feet are in contact with the pool floor, the lower muscles are more involved, in aquatic therapy exercises in the deep part where the legs are floating, and the upper limb muscles are more involved, there may be a chance that due to the difference in the performance of elderly women at two different depths, different results may be obtained in their balance performance. However, as mentioned, the results of the study did not show any difference in static and dynamic balance. Another reason for this lack of difference may be that if the difference between these two depths was greater or less, a difference would have been observed, which requires further investigation in future studies.

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Conflict of Interest

The authors declare they have no potential conflicts of interest.

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