International Journal of
Disabilities Sports and Health Sciences
e-ISSN: 2645-9094

RESEARCH ARTICLE

Investigation of the Effect of Eight-Week Aqua Fitness Exercises on Some Strength Parameters and Body Composition with Autism Spectrum Disorder

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Abstract
The aim of this study is to examine the effect of eight-week aqua fitness (AF) exercises on some strength parameters and body composition of individuals with Autism Spectrum Disorder (ASD). Twenty children with ASD, aged 5 to 9 years, who participated in basic physical activity training (BMT) for at least three months were enrolled in the study. Participants were randomly divided into two groups: AF exercise group (AFG) and basic movement training group (BMTG). The AFG group was trained for 8 weeks (2 days per week) using AF, while the BMTG group completed basic movement training (BMT) exercises for 8 weeks (2 days per week). Before and after the training programs, the medicine ball throw, flexibility test, vertical jump, standing long jump, and body fat percentage of the participants were determined. The Wilcoxon test was used for statistical analysis of the study. The study measured a significant difference before and after the AF training program medicine ball throw (p=.005), sit and reach test (p=.005), vertical jump (p=.005), standing long jump (p=.005) and body fat percentage in AFG, before and after training. medicine ball throw (p=.564), vertical jump (p=.461), and standing long jump (p=.674) did not change in the BMTG group before and after training. Sit and reach (p=.039) and body fat percentage (p=.032) changed significantly in BMTG. AF exercises had a positive effect on some strength parameters and body composition in individuals with ASD. AF Exercises showed more effective results than BMT exercises in individuals with ASD

Keywords
Aqua Fitness, Strenght, Body Composition, Autism Spectrum Disorder

INTRODUCTION

Autism spectrum disorder (ASD) is a type of disability characterized by impairments in social interaction and communication skills, as well as limited mobility and repetitive behavior patterns (Wang et al., 2018; Ulu et al., 2022). Specifically, individuals with ASD avoid eye contact (Chawarska et al., 2009), are hypersensitive to certain objects (Pierce et al., 2016), and prefer to be alone (Mattys et al., 2018). If precautions are not taken, these negative behaviors begin in childhood (Jones and Klin, 2013) and continue to increase through adulthood, leading to the emergence of new problems (Totsika et al., 2011). Physical activity is an important phenomenon to prevent these problems (Liang et al., 2022).

Individuals with ASD are at higher risk for many clinical and psychiatric conditions, including obesity, compared to the general population

Received: 22 February.2023 ; **Accepted:** 09 May 2023; **Online Published:** 25 October 2023
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How to cite this article: Kurtoğlu, A., Çar, B., Konar, N., Uzgur, K. and Baltacı, O. (2023). Investigation of the Effect of Eight-Week Aqua Fitness Exercises on Some Strength Parameters and Body Composition with Autism Spectrum Disorder**.** *Int J Disabil Sports Health Sci*;2023;6(3):279-286.https://doi.org/10.33438/ijdshs.1254879

(McCoy et al., 2016). Phillips et al. reported that individuals with ASD had higher rates of obesity compared to their healthy peers (Phillips et al., 2014). It was also found that individuals with ASD had lower physical fitness compared to their healthy peers (Pan et al., 2016). In this case, it is inevitable that motor skills will be negatively affected (Pan, 2014). Studies have shown that the physical activity level of individuals with ASD is lower than that of their healthy peers (Bandini et al., 2013). This is believed to be one of the most important causes of motor disability and obesity in people with ASD.

Although it is important to be physically active, the type of exercise is equally important. The type of physical activity should be determined after analyzing the characteristics of the work group, standard of living, environmental conditions, and financial capabilities (Healy et al., 2017). Aquafitness exercises (AF), which are commonly used in healthy individuals, have been found to eliminate many health problems, increase the level of physical fitness, and increase vascular compliance (Lee, 2014). When the exercises preferred in AF are performed in different locations, they may be insufficient to develop basic skills such as strength, flexibility, endurance, and speed (Parker et al., 1989). On the other hand, it contributes to the development of motor skills (Goncharova et al., 2020) and functions of the respiratory and circulatory systems (Lee et al., 2018), as well as endurance during resistance exercises in water.

It is known that it is difficult to perform anaerobic exercises and various complicated exercise programs in mentally disabled people (Menear et al., 2015). For this reason, exercises for people with mental disabilities should be simple and not complicated. Although the exercises of AF do not consist of complex exercises, they are generally used for rehabilitation purposes in disabled people. The number of studies investigating the effects of AF exercises on the physical fitness of people with intellectual disabilities is limited. Therefore, the aim of our research is: The aim of this study is to investigate the effects of eight-week AF exercises in individuals with ASD on some strength parameters and body composition.

MATERIALS AND METHODS

Participants

The present study followed a within-subjects design, in which two or more measurements were collected from a sample of subjects and groups. The minimum sample size of the our study was calculated using G-power software 3.1.9.7. (University of Dusseldorf, Dusseldorf, Germany). According to this analysis; a priori and F tests were used to calculate power following our study's design; within-factors; α err prob = 0.05; minimum effect size= 0.25, and power (1-β err prob)= 0.95. In a study of 18 participants, there was an actual power of 95.0 % for the current analysis and sample. Therefore, 20 participants with ASD between the ages of 5 and 9 years voluntarily participated in our study. Participants were randomly assigned to an aqua fitness exercise group (AFG=10, 5 males and 5 females) and a basic movement exercise group (BMTG=10, 5 males and 5 females). Participants were selected from individuals with ASD who exercised at least two days per week. Participants with cardiovascular problems, chronic respiratory problems, taking antibiotics, thyroid-like hormone imbalances, water phobia, active infections, open wounds, and an infectious disease in their body were not included in the study. Individuals with ASD who do not participate in the training sessions within the eight-week training period and are unable to perform the specified exercises will be excluded from the study. The families of the participants were informed of the purpose, reason, and possible outcomes of the study. They were informed that participation in the study was on a voluntary basis and that they could leave the study at any point during the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Study Design

In order for participants to have similar physical fitness, all participants were selected from individuals with ASD who had continued BMT for at least 3 months. The AFG group continued the exercises from AF for eight weeks (2 days per week), while the BMTG group continued BMT exercises for eight weeks. Testing was performed before and after the eight-week exercise period. Before BMT exercises, 10 minutes of general warm-up and 5 minutes of stretching were performed. BMT exercises included balance

exercises (walking on a balance board, walking on a moving slide, balancing on one and both feet on a Bosu ball, etc.), jumping exercises (jumping on a trampoline, jumping forward on rings, jumping on a mat above the floor, etc.), and strength and endurance exercises (pulling a rope, pulling a weight ball, legs up to knees, tilting a funnel with a weight ball, crawling on the floor). After the study, 5 minutes of cool down and 5 minutes of stretching were applied.

The AF exercises were performed in a children's pool with a depth of 60 cm. During the exercises, the supervisor in charge was also in the pool. Before the AF exercises, 10 minutes of general warm-up and 5 minutes of stretching were performed. AF Exercises including balance exercises (one-legged balancing in the water, walking on the line under the pool, balancing in manipulatively activated water, etc.), jumping exercises (one-legged and two-legged jumping in the water, jumping to the right and left, etc.), strength and endurance exercises (rope pulling, legs to knees, water resistance exercises, etc.). The study was followed by 5 minutes of cooling down and 5 minutes of stretching. In the study, the ratio of working and resting was applied as 1:1 (1 minute of work and 1 minute of rest).

Data Colection

Before all measurements, participants received a 10-minute general warm-up. This was followed by 5 minutes of stretching movements. Tests were performed according to the warm-up protocol. All tests were performed between 14:00 and 16:00, and participants were asked not to eat or drink anything other than water for at least 3 hours before the tests. The tests were performed and recorded by two different researchers. The similarity between the test results of the two researchers was analyzed as 96.4%. All tests were performed using the show-and-tell technique, and participants were offered a 30-minute familiarization period before testing.

Throwing Medicine Ball

The participant was asked to stop at the starting point determined by the tape. While standing, the athlete was asked to throw the 3 kg medicine ball forward in the throw-in position. The first point where the medicine ball touches the ground is determined. The first point of contact with the starting point was measured and recorded in cm. The participant was given two attempts and the best value was recorded Van den Tillaar and Neumeier, 2015).

Flexibility Test (Sit an Reach):

For the flexibility, the seat and reach test was used. Testing was performed using a Baseline® brand flexibility stand (Cooper Institute/ YMCA, AAHPERD, New York, USA). Participants removed their shoes and placed them on the '0' reference point. During the measurement, participants were not allowed to bend their knees. The participant was asked to push the tape with an outstretched arm, and after waiting 2 seconds, the value in cm was recorded at the longest point they could reach. The participant was asked to do two repetitions and the best value was recorded (Akınoğlu et al., 2021).

Standing Long Jump

Care was taken to ensure that participants spread their legs at shoulder height and that the tops of their feet did not cross the marked line. With the command "Jump", he was asked to jump forward. The distance between the heel of the foot closest to the marked line and the line was measured and recorded in cm. The participant was asked to do two repetitions and the best value was recorded (Almuzaini and Fleck, 2008).

Vertical Jump Test

The Sargent test protocol was used to determine the vertical jump performance of the participants (Ayán-Pérez et al., 2017) . When shooting, the participant waited with both feet in front of a smooth wall. A mark was drawn at the highest point he reached. Then the participant was asked to jump as high as possible and the distance reached was drawn again with chalk in hand. The distance between the two drawings was recorded in cm. The participant had two attempts and the best value was noted (Bui et al., 2014).

Height, Body Weight and Body Fat Percent

In height measurement, the participant's feet were bare, heels were together, and the body and head were measured and recorded. The movable part of the stadiometer was brought to the top of the head, the hair was sufficiently compressed, and the measurement was recorded to the nearest 1 mm. During the measurement, participants were asked to breathe deeply and maintain their upright position. Weight was measured with an electronic scale of SECA brand (Germany) with an accuracy of 0.1 kg, and the participants' feet were bare and they wore shorts and T-shirts during the measurement. Body fat percentage was determined

by Tanita TBF 300 (Japan) brand body analyzer (Padwal et al., 2016).

Statistical Analysis of Data

The data in the research were made with SPSS (Version 25, IBM, USA) package program. The normality analyzes of the data were done using Shapiro-Wilk test because the number of participants was less than 30. In this context, Wilcoxon test, one of the non-parametric tests, was used for statistical analysis. The effect size of the study was determined using Cohen's d formula. In this context, the effect size yielding 0.2 was accepted as small, 0.5 as medium, and 0.8 as large (Cohen, 1988). The significance level of the study was set at 0.05.

RESULTS

Table 1 shows: Age=7.0 ± 2.10 years, height=118.10 ± 22.77 cm, body weight=24.90 ± 12.62 kg, BMI=14.99 ± 5.78 kg/m2 at AFG. Age=6.60 ± 0.96 years, height=103.60 ± 6.61 cm, body weight=18.90 ± 2.02, and BMI=17.62 ± 1.36

Table 1. Descriptive information of participants

Parametes	**AFG (n=10) (5 male, 5 female) x̄±SD**	**BMTG (n=10) (5 male, 5 female) x̄±SD**
Age (year)	7.0 ± 2.10	6.60 ± 0.96
Height (cm)	118.10 ± 22.77	103.60 ± 6.61
Weight (kg)	24.90 ± 12.62	18.90 ± 2.02
BMI (kg/m^2)	14.99 ± 5.78	17.62 ± 1.36
AFG: Aqua Fitness Exercise Group, BMTG: Basic Movement Training Group, BMI: Body Mass Index		

When analyzing Table 2: medicine ball throw before and after AF exercises (pre-study=129.20 ± 40.85 cm, post-study=132.75 ± 41.26 cm, ES =2.82, p=.005), sit and reach test (pre-study=16.70 ± 4.34 cm, post-study=18.57 ± 4.60 cm, ES =2.80, p=.005), standing long jump test (pre-study=54.70 ± 21.57 cm, post-study=59.17 ± 21.68 cm, ES =2.81, p =.005), vertical jump (pre-study=6.23 ± 1.53 cm, post-study=7.56 ± 1.33 cm, ES =2.81, p=.005), body fat percentage (pre-study=17.73 ± 3.04 cm, post-study=16.26 ± 2.72 cm, ES =2.80, p=.005) changed significantly. For BMTG, a significant difference was found between the sit and reach test (pre-study=25.19 ± 1.95 cm, post-study=24.84 ± 2.04 cm, ES =2.06, p=.039) and body fat percentage (pre-study=20.31 ± 3.98 cm, post-study=20.09 ± 4.06 cm, ES =2.14, p=.032).

Table 2. Comparison of test results of AFG and BMTG groups before and after AF exercise

Parameters	Group	Pre-Study x̄ ± SS	Post-Study x̄ ± SS	ES	p
Throwing a Medicine Ball (cm)	AFG	129.20 ± 40.85	132.75 ± 41.26	2.82	.005*
	BMTG	167.80 ± 9.33	167.70 ± 9.63	0.57	.564
Sit and Reach (cm)	AFG	16.70 ± 4.34	18.57 ± 4.60	2.80	.005*
	BMTG	25.19 ± 1.95	24.84 ± 2.04	2.06	.039*
Standing Long Jump (cm)	AFG	54.70 ± 21.57	59.17 ± 21.68	2.81	.005*
	BMTG	82.00 ± 11.44	89.46 ± 35.48	0.73	.461
Vertical Jump (cm)	AFG	6.23 ± 1.53	7.56 ± 1.33	2.81	.005*
	BMTG	7.95 ± 1.36	8.00 ± 1.23	0.42	.674
Body Fat Percent (%)	AFG	17.73 ± 3.04	16.26 ± 2.72	2.80	.005*
	BMTG	20.31 ± 3.98	20.09 ± 4.06	2.14	.032*

Statistical analyzes of the test results of AFG are given in Figure 1. Accordingly, the ratio of medicine ball throw *(p=.005)*, seat and reach test *(p=.005)*, vertical jump *(p=.005)*, standing long jump *(p=.005)* and body fat before and after AF exercise *(p=.005)* there was a significant change. Statistical analyzes of the test results of BMTG are given in Figure 2. Accordingly, there was a significant change in sit and reach *(p=.039)* and

body fat ratio *(p=.032)* before and after AF exercise.

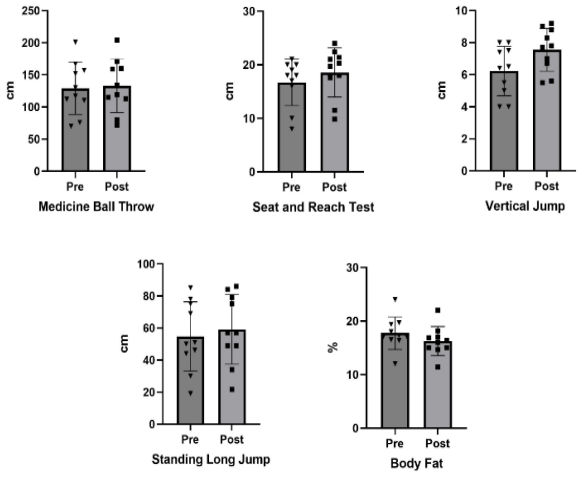

Figure 1. Statistical analyzes of the test results of AFG

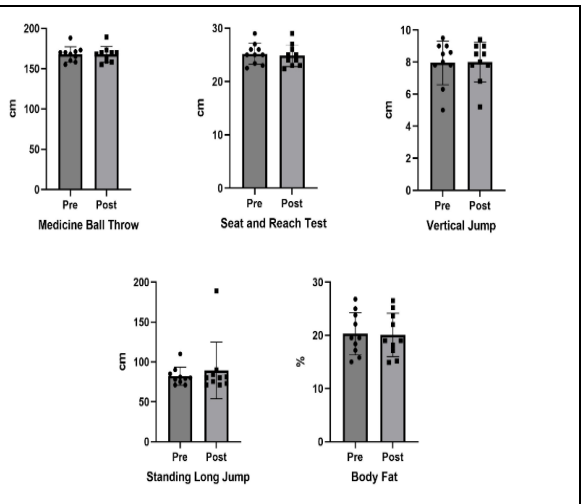

Figure 2. Statistical analyzes of the test results of BMTG

DISCUSSION

In our study, AF and BMT exercises were performed for eight weeks in individuals with ASD. After eight weeks AF, medicine ball throw, flexibility, standing long jump, vertical jump, and body fat percentage changed significantly in AFG. In contrast, flexibility and body fat percentage changed significantly in BMTG, but the significance value was higher in AFG. To our knowledge, this is the first study comparing AF and BMT exercise in individuals with ASD. Thus, our hypothesis that AF exercises have an impact on some strength parameters and body composition in individuals with ASD was confirmed.

The medicine ball throwing test is a method for evaluating trunk strength using a general movement pattern used in many sports (Davis et al., 2008). Although this test provides some information about the subject's general strength, its use to determine anaerobic power is limited (Ikeda et al., 2006). In a study by Costa et al. it was found that performance in throwing medicine balls improved after three days of strength training in wheelchair basketball players (Gomes et al., 2021). In the study by Jorgic et al. it was found that there was a significant relationship between the medicine ball throwing test and the standing long jump test in goalball players, and the medicine ball forging test provided information about overall explosive strength (Jorgić et al., 2019). In a study by Sammoud et al. it was found that jumping performance positively influenced swimming performance (Sammoud et al., 2021). In this context, considering that the medicine ball throw test and the standing long jump test in our study showed a higher significant difference in AFG, it can be concluded that the reaction force formed by the participants against the force applied to the water improved the general strength parameters of the individuals and indirectly positively influenced the explosive power.

While flexibility is not an obvious indicator of performance, it is an important motoric feature that allows for high-level performance. Kirkini et al. concluded that high sit-to-reach flexibility would contribute to improving neuromuscular explosive performance in young elite football players (Kirkini et al., 2019). Jones, on the other hand, argued in his research that a high level of flexibility requires more performance (Jones, 2002). When considered in this context, we think that increasing flexibility in AFG indirectly means an increase in performance level and an increase in explosive force.

High anaerobic endurance means that athletes recover earlier and fatigue occurs in a longer time (Garcia-Depraect et al., 2022). The vertical jump test is also a commonly used test to determine anaerobic capacity (Ostojic et al., 2010). Savoie et al. concluded that muscle endurance and anaerobic power and capacity may decrease as a function of water loss in the body. At the same time, it was argued that vertical jumping ability may increase as a function of body weight loss when water loss is less than 3% (Savoie et al., 2015).

In our study, body fat percentage decreased and vertical jumping performance increased in AFG. At the same time, agility, vertical jump and throwing with medicine ball changed positively at the end of AF exercises. This shows that the decrease in body fat percentage after AF exercises is not due to dehydration, but probably causes an increase in general muscle mass in the body.

As a result, our study found that AF exercises decreased total body fat percentage in individuals with ASD and improved vertical jump, standing long jump, flexibility, and medicine ball throw test scores more than BMT exercises. In this context, the exercises of AF may have positive effects on improving the overall strength endurance, flexibility, and anaerobic performance of individuals with ASD. They may also be recommended for the rehabilitation of chronic diseases such as obesity, cardiovascular disease, and cholesterol that are common in individuals with ASD. AF Exercises can also be used for various disability groups. It is known that water has a rehabilitative effect. The effects of the exercises of AF on the affective characteristics of individuals with ASD can also be studied by conducting some psychological tests after AF exercises in these individuals. By performing long-term follow-up studies after these exercises, the general health status of individuals with ASD, the duration of admission to the hospital and the frequency of getting sick can also be examined.

Conflict of Interest

No conflict of interest is declared by tehe authors. In addition, no financial support was received.

Ethics Committee

The study protocol was approved by the Ethics Committee of the Institute of Health Sciences of Bandırma Onyedi Eylul University (Ethics Committee Approval: 2022/170).

Author Contributions

Study Design, AK, BÇ; Data Collection, AK, OB; Statistical Analysis, AK, NK; Data Interpretation, AK; Manuscript Preparation, AK, BÇ, NK; Literature Search, AK, KU, OB. All authors have read and agreed to the published version of the manuscript.

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