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ORIGINAL

HYDROGYMNASTICS TRAINING PROGRAM ON PHYSICAL FITNESS IN ELDERLY WOMEN

PROGRAMA DE ENTRENAMIENTO DE HIDROGIMNASIA SOBRE LAS CAPACIDADES FÍSICAS DE ADULTAS MAYORES

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ABSTRACT

The aim of this study was to evaluate the effect of a hydrogymnastics training program on physical fitness in 26 elderly women (experimental group n=16, control group n=10). The physical fitness was determined by the senior fitness test protocol, the hydrogymnastics consisted in aerobic

exercise at 50%-60% of maximum heart rate, 5 times a week in a period of 12 weeks. ANOVA 2x2 as statistical test was used, indicating statistically significant interaction ($p=0.052$) between groups and measurements on test strength endurance in the legs by squatting on chair in 30 s, agility test 2.4 meters was significant interaction ($p\leq 0.01$) between groups and measures, testing aerobic capacity test step 2 minutes ($p=0.02$) and six minutes walk indicated significant interaction between groups and measurements ($p=0.50$), the results shown that hydrogymnastics in the elderly women participants was effective improving endurance, strength and agility mainly in legs.

KEYWORDS: Elderly, Physical Fitness, Physical Exercise.

RESUMEN

Se evaluó un programa de entrenamiento de hidrogimnasia sobre las capacidades físicas en 26 adultas mayores (grupo experimental $n=16$, grupo control $n=10$), determinadas mediante el protocolo senior fitness test, la hidrogimnasia fue 5 veces por semana por 12 semanas, con ejercicios aeróbicos del 50%-60% de la FC_{máx}. Se utilizó ANOVA 2x2, indicando interacción significativa ($p=0.052$) entre grupos y mediciones en la prueba de resistencia a la fuerza en extremidades inferiores, la prueba de agilidad de 2.4 metros tuvo interacción significativa ($p\leq 0.01$) entre grupos y mediciones, las pruebas de capacidad aeróbica step test de 2 minutos ($p=0.02$) y caminar 6 minutos indicaron interacción significativa entre grupos y mediciones ($p=0.50$); Se infiere que la hidrogimnasia en las adultas mayores participantes es eficaz en la mejora de las capacidades físicas principalmente aeróbicas, de resistencia a la fuerza y agilidad de miembros inferiores.

PALABRAS CLAVE: Adultos Mayores, Capacidades Físicas, Ejercicio Físico.

INTRODUCTION

The increase in senior citizen population has combined with the fertility deficit along with an increase of life expectancy in the population (Gonzalez & Ham-Chande, 2007). According with the National Population Council (CONAPO), life expectancy in Mexico in the year 2000 was of 74 years of age. There is an estimated increase of 80 years of age for the year 2050. In addition to this, the ratio of senior citizens for 2000 was of 7% of the Mexican population. This percentage will increase to 12.5% in 2020 and to 28.0% by 2050 (Barrantes-Monge, Garcia-Mayo, Gutierrez-Robledo, & Miguel-Jaimes, 2007).

The aging process is established as a natural phenomenon showing a decrease in physiological capacities, thus progressively diminishing organs and systems (Fulop et al., 2010). Research also shows that the life stage of a senior citizen pertains to 60+ years of age and it is then where

there is a higher presence of morbidity and mortality due to chronic non-transmissible disease. This is a life stage with a higher need of health attention in comparison to rest of the population, thus directly affecting their quality of life (Thompson, Zack, Krahn, Andresen, & Barile, 2012). A decrease in functions related to aging in senior citizens produces a deficit in conditional and coordinative physical capacities, hindering mobility, showing a higher difficulty in carrying out their daily activities (Serrano-Sanchez, Lera-Navarro, & Espino-Torón, 2013). This also reduces their functional autonomy and their ability to carry out independent motor activities without the help of people and/or devices (Martinho et al., 2013). These motor deficiencies are related to the functional deterioration related to the presence of a motor disability affecting 56% of males and 62% of females 60+ years of age (Barrantes-Monge et al., 2007).

The progressive loss of muscle and skeletal mass has been associated to physical capacity dysfunctions (Rolland et al., 2009), causing precarious motor skills making them more fragile (Barrantes-Monge et al., 2007; Fulop et al., 2010). A sedentary lifestyle in senior citizens makes them more prone to a lower functional autonomy in activities such as: walking, going up a flight of stairs, getting up from a chair successfully without the aid of a person or device, helping them to continue with their social relations and maintaining their cognitive functions (de Noronha Ribeiro Daniel et al., 2011).

The aging process can vary from person to person, depending on multiple factors such as: genetic or environmental or a lifestyle involving physical activity (Moreno González, 2005). It has been proven that a senior citizen who systematically exercises will have a better health and will increase his life expectancy and quality of life as opposed to those sedentary senior citizens (Aparicio García-Molina, Carbonell Baeza, A. & Delgado Fernández, 2010).

Physical activity improves physical fitness in senior citizens providing them a better motor performance with less effort. This allows them to be more self-sufficient in order to be able to carry out everyday activities (Moreno González, 2005). This has been widely recommended since experimental studies have shown the benefits of exercising since it improves physical capacities such as strength (Carrasco Poyatos, Martínez González-Moro, & Vaquero Abellán, 2013), aerobic resistance (Fraga, Cader, Ferreira, Giani, & Dantas, 2011), balance and coordination (Borges et al., 2012).

For these reasons, aging in the population will imply that public health systems will have to efficiently adapt to prevent, diagnose, and treat all those diseases related to a sedentary lifestyle (Barrantes-Monge et al., 2007) since senior citizens show higher rates of morbidity and health care needs in comparison to other stages of life (Gonzalez & Ham-Chande, 2007). That is why it is so important to plan and recommend adequate physical activity for the senior citizen in order to reduce health issues (American College of Sports et al., 2009). It is for all of the aforementioned reasons that we conducted this research by posing the following question:

Can practicing hydrogymnastics improve physical fitness in female senior citizens?

Hydrogymnastics are a type of exercise that is carried out through gymnastical-rhythmical activities that take place in the water with the purpose of counteracting the effects of gravity and improving physical skills. They are especially appropriate to promote health for those people with limited exercising abilities in land (Kamioka et al., 2010). It has become more popular and is being practiced more by senior citizens since it provides the opportunity to take advantage of the aquatic environment by taking advantage of movement and a lower risk of injuries related to impact (Kamioka et al., 2011).

This research identified physical exercise in the form of hydrogymnastics as an independent variable and physical capacities as dependent variables. The main purpose was to assess the effects of a hydrogymnastics training program over physical fitness in female senior citizens. We established two hypotheses: a substantive and a statistical one. The substantive hypothesis establishes that there will be differences in the levels of physical capacities in female senior citizens participating in a hydrogymnastics training program. The statistical hypothesis is presented in a null and alternative manner, with a level of acceptance or relation criteria being $p < 0,05$.

METHODS AND MATERIALS

A quasi-experimental approach was taken for this study, where the independent variable was manipulated in order to measure its effects over the dependent variable, with the purpose of determining the degree of change produced by the treatment; thus establishing a cause-effect relationship with a non-probability sample selected by convenience (Thomas, 2001) composed by senior citizens defined as women in the ages of 60 or more years, according to the World Health Organization (Gonzalez & Ham-Chande, 2007). The female senior citizens were volunteers living in the municipality of Mexicali, Baja California, México.

The inclusion criteria for this research were the following: to be a woman, be 60 years or older, to voluntarily participate in this research, to not have participated in a systematic fitness program in the last 3 months and to be able to carry out everyday activities without the help of others. The exclusion criteria were: to suffer any type of acute or chronic condition that will prevent them to carry out hydrogymnastics activities such as diabetes, heart conditions, hypertension, non-controlled asthma, muscle-skeletal conditions which could affect practicing any type of exercise such as osteoarthritis, joint injuries, recent fractures, psychological or neurological conditions.

According to the inclusion and exclusion criteria for the intervention program, at the beginning of the program we had 31 individuals that were

randomly divided by means of a simple sorting, in two control and experimental groups. However, there were some losses along the research in both groups due to personal and health reasons. These losses were mainly in the control group. There were 26 female senior citizen individuals by the end of the research.

The final control group was composed of 10 female senior citizens who did not practice hydrogymnastics. This group maintained their normal everyday activities without practicing any type of physical activity systematically throughout 12 weeks. The experimental group was composed of 16 female senior citizens who practiced hydrogymnastics.

This present research considered the ethical principles regarding human experimentation contained in the Helsinki Declaration (Puri, Suresh, Gogtay, & Thatte, 2009). The Aquatic Complex of the Faculty of Sports of the Autonomous University of Baja California was place where this research took place and where the application and assessment of the program with the control and experimental groups were carried out. All of the participants signed an Authorization Letter to willingly participate in this research. This document authorized for us to inform the subject about the purpose of the project, the assessment procedures, the possible risks, benefits and consequences, the emergency procedures and their authorization to participate voluntarily.

For the pre and post assessment of the dependent variable, we used a series of senior fitness tests (Rikli, Senior Fitness Test Manual, 2001), which include testing lower body strength with the Chair Stand Test, testing upper body strength with the Arm Curl Test, testing upper body flexibility with the Back Scratch Test, testing lower body flexibility with the Chair Sit and Reach Test, testing aerobic fitness with the Walk Test (6 minutes), and testing aerobic fitness with the Step in Place Test (2 minutes), testing agility with the 8-Foot Up and Go Test.

The Chair Stand Test: in order to measure lower body strength and resistance (legs) we used a chair with a straight back rest, a 43 cm high seat, and a chronometer. The procedure indicated that the individual had to sit half-ways on the chair with her feet flat on the ground and her arms crossed in front of her chest. After receiving the signal of “ready....stand up” the participant had to stand up completely in order to sit down completely on the chair afterwards. They were allowed a first attempt to warm-up as to establish the correct way to carry out the movements, and then the test began. We counted the number of times that the individual was able to completely stand up in 30 seconds.

The Arm Curl Test: The instrument used to measure upper body strength (arms) was a chair with a straight back rest and no armrests or a stool, a chronometer, and a 5lbs weight. The participant had to sit on the chair, leaning slightly towards the predominant side, with both feet flat on the floor, holding the weight up on one side of the body, perpendicular to the floor. After receiving the signal of “ready....start” the participant had to lift the weight flexing the elbow with a wide range of movement, then the palm

had to rotate during the weight lifting stage, and had to rotate once the weight went back to the original position. The upper arm had to remain close to the rest of the body. Two attempts without any weight were allowed which helped to check the technique as well as to warm-up. We counted the number of times the weight was lifted in 30 seconds.

2-minutes Step Test: The instruments used in order to assess aerobic fitness were a metronome, a chronometer, a measuring tape, and adhesive tape. The procedure included placing the subject with her back against the wall and locating the middle of the distance between the mid-section of the knee and the iliac crest bone in the front; adhesive tape was placed on the wall exactly where the mid-section of the thigh. After receiving the signal of “ready....go” the participant had to start marching in her place, raising the knee all the way to where the strip of tape was. We counted the number of complete steps in 2 minutes. Execution time counted every time the right knee reached the indicated height.

The Chair Sit and Reach Test: This test was used to measure the lower body flexibility, especially in the hamstrings. The instruments used were a chair with a 43cm high seat that would not move forward, and a 30 cm ruler. The procedure included placing the participant sitting on the edge of the chair with the predominant leg extended to the front with the heel on the floor and the ankle flexed at a 90 degree angle. The other leg had to have the knee bent, with the shoe stepping flat on the floor, hands one on top of the other. While in this position, the participant had to touch her feet as far as possible. After practicing twice, the test was administered two times. We recorded the results from measuring the distance left between the tip of the toes and the fingertips with the ruler.

The Back Scratch Test: With this test we attempted to measure upper body flexibility. The instrument used was a 30 cm ruler. The procedure consisted in indicating to the participant that she had to try to reach one hand with the other from the back side of the body. After that we made two attempts for practice. We used the ruler to determine the value of the distance between the fingertips of both hands.

The 8-Foot Up and Go Test: In order to establish agility and dynamic balance, we used a straight backed chair, a chronometer, measuring tape, and a cone as a marker. The procedure included placing the subject sitting in the middle of the chair with her hands on her thighs and feet on the floor, one slightly forward than the other. After receiving the signal of “ready....go” the participant had to stand up from the chair, walking as quickly as possible around the cone placed 8 feet away from the chair and then come back to sit down. The chronometer was started as soon as the subject stood up and was turned off exactly when the person sat down again.

The 6 minute Walk Test: To be able to measure aerobic fitness, we used a long measuring tape, two chronometers, four cones, and adhesive tape. The procedure was to make a 45.7 meter rectangle and was divided in

4.57 meter segments (4.57 m x 18.28 m). The subject was asked to walk around the rectangle as quickly as possible, trying to cover the highest amount of yards in 6 minutes. We used the chronometer to record time and the result was the number of times she walked, multiplied by 50 meters.

The Intervention Protocol: A physical activity program of moderate intensity was applied to the participants (in the form of hydrogymnastics) considering the general norms established by the American College of Sports Medicine (American College of Sports et al., 2009) and the American Heart Association (Nelson et al., 2007) which lasted 60 sessions and took place 5 times per week. The 50 minute sessions were divided as follows: a 10 minute warm-up, 30 minutes of core phase with an increasing and progressive intensity of 50% of the maximum heart rate (FC max) for the first 6 weeks and 60% for the last 6 weeks by means of the following formula: $FC_{max} = 208 - 0.7 \times \text{age}$ (Tanaka, Monahan, & Seals, 2001) through alternate movements of arms and legs monitored by telemetrics (a Polar FT7® Finland heart rate monitor) and a 10 minute cool down.

The proposed statistical procedures for a proper analysis in this research were to characterize the sample and assess the hypothesis with the following approach:

By using descriptive statistical techniques we attempted to characterize the sample using localization and dispersion measures within the first ones which were by means of the application of descriptive statistics techniques, we attempted to characterize the sample. We used localization and dispersion measures within the first ones with the first ones. The median was the central trend measure which identifies and locates the core of the set of data. The dispersion measures estimated the existing variables in the data. For this reason, we calculated the standard deviation which was the used to verify the symmetry of the sample (Thomas, 2001). The refined statistical data was processed in the form of tables and graphs processed with the Windows Excel and SPSS 17 software. Inferential statistics were used to assess the normality of the groups as well as the homogeneity of the data variables in the sample by means of the Shapiro-Wilk Test.

With the purpose of obtaining the total of comparison possibilities between and among the groups, we conducted mixed variable analysis tests (ANOVA) 2 x 2 groups (groups x measurements) for the fitness ability variable, with the purpose of maintaining scientific validity for this research. In this present study, the significance level was $p < 0,05$, that is, 95% of certainty possibility per case, or a negative with a 5% probability per case. For the Type I error (α 5%) and for the Type II error, the study will admit the power of the experiment between 80 and 90% (β between 10% and 20%).

We also calculated change percentages ($\Delta\%$) for each study group according to the procedures established by Vincent, WJ (1999): $[(\text{Mediapost} - \text{Mediapre})/\text{Mediapre}] \times 100$.

RESULTS

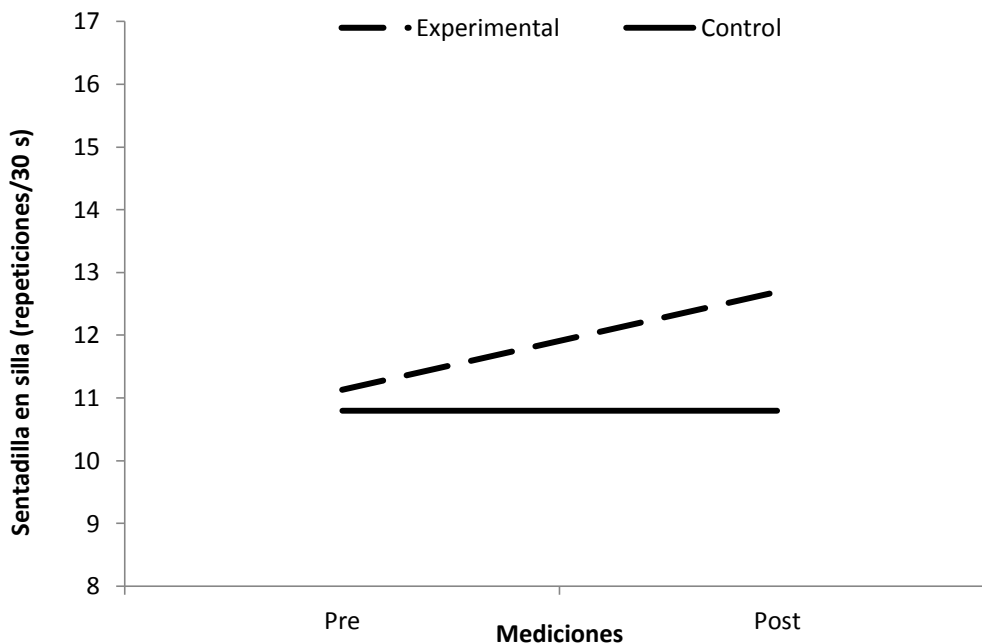
Participants in the present study were 26 elderly women divided randomly into an experimental group (EG, $n = 16$ with an age range of 67.5 ± 5.4 years) who participated in the hydrogymnastics training program and a control group (CG, $n = 10$, with an age range of 67.4 ± 4.7 years) who had no intervention in training. Table 1 shows the general characteristics of the sample.

Table 1 Descriptive statistics ($M \pm SD$) of women participating in the study ($n = 26$).

Variables	Experimental (n=16)		Control (n=10)	
	Pre	Post	Pre	Post
Weight (Kg)	74.09±10.7 4	73.27±10.81	76.26±15.17	76.29±15.70
Height (cm)	155.95±5.7 8	155.90±5.72	153.20±5.86	152.41±6.19
BMI (Kg/m ²)	30.53±.91	30.16±4.55	32.60±6.91	32.97±7.19
Chair Stand Test (repetitions in 30 s)	11.13±2.02	12.69±1.53	10.80±2.70	10.80±2.82
Arm Curl Test (repetitions in 30 s)	12.88±3.36	15.13±3.13	13.10±3.07	13.30±2.90
8-Foot Up and Go Test m (s)	7.62±1.54	6.51±.89	7.38±1.78	7.39±1.57
2-minutes Step Test (repetitions)	76.38±15.7 0	86.56±17.58	73.50±33.50	73.40±32.71
Back Scratch Test (cm)	-2.84±11.06	-4.31±8.46	-4.80±11.76	-4.20±10.44
Chair Sit and Reach Test (cm)	2.84±7.50 468.86±70.	5.91±6.96	-6.30±11.68	-5.50±10.53
6 minute Walk Test (m)	6	493.6±64.58	420.9±88.55	424.92±84.06

Variable analysis (ANOVA) tests were carried out in mixed 2 x 2 (group x measurements) for the physical fitness (strength endurance, aerobic capacity, flexibility, agility and dynamic balance). The level of significance was set a priori to $0.05 \alpha \leq$. Regarding physical capabilities, the 2x2 ANOVA for repeated measures indicated a statistically significant interaction ($p=0.052$) between groups and measurements of the chair squat in 30 s (Figure 1). No statistically significant changes between the groups ($p=0.182$) were found, although there were differences between measurements ($p=0.052$).

Graphic 1: Changes in the number of repetitions of the Chair Stand Test in 30 s in the study participants (n=26).



With regards to physical fitness, 2x2 repeated ANOVA measurements indicated no statistically significant interaction ($p=0.075$) between groups and measurements on the number of repetitions of arm curl test. Also, no statistically significant changes between the groups ($p=0.493$) or between measurements ($p=0.036$) as shown in Table 2. Still, the repeated measures of ANOVA 2x2 indicated no statistically significant interaction ($p = \text{found } 0.550$) between groups and measurements on back scratch test, no statistically significant changes between the groups ($p=0.811$) or between measurements ($p=0.801$) were found either. Although it can be seen in Table 2 that the 2x2 repeated measures of ANOVA indicated no statistically significant interaction ($p=0.437$) between groups and measurements on chair sit and reach test. Statistically significant changes between the groups ($p=0.005$) were found but there were no differences between measurements ($p=0.190$).

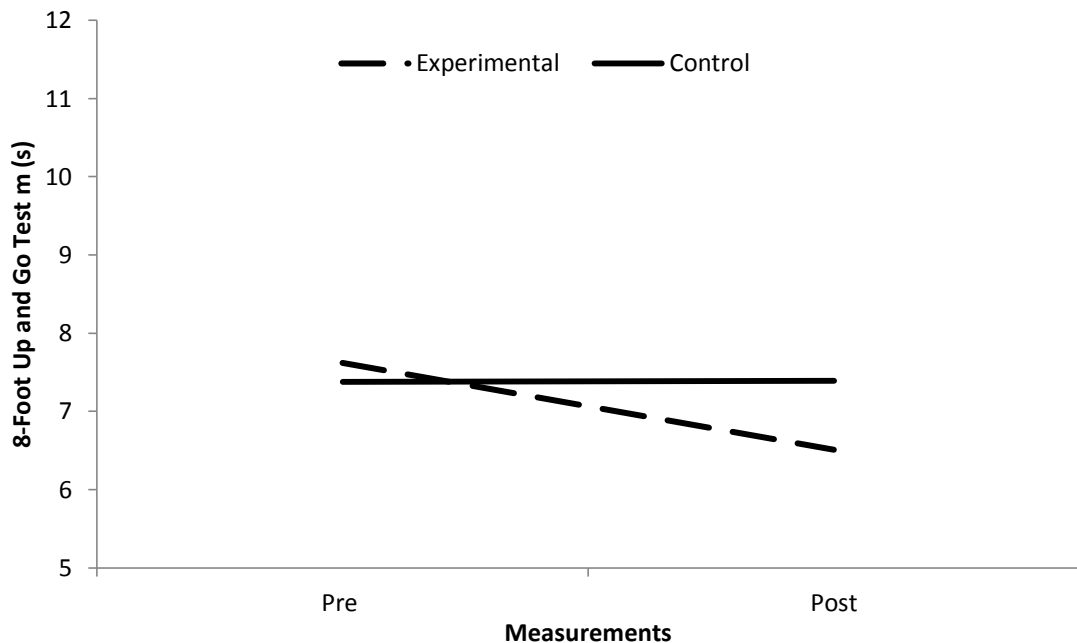
Table 2: Summary of variable analysis tests (ANOVA) mixed 2 x 2 (group x measurements) for the variables of the women participating in the study (n= 26).

Variables	Significance (p) level was $p < 0,05$.		
	Group (A)	Measurements (B)	Interaction (AxB)
Chair Stand Test (repetitions in 30 s)	.182	.052	.052
Arm Curl Test (repetitions in 30 s)	.493	.036	.075
8-Foot Up and Go Test m (s)	.578	.000	.000
2-minutes Step Test (repetitions)	.413	.003	.002
Back Scratch Test (cm)	.811	.801	.550
Chair Sit and Reach Test (cm)	.005	.190	.437
6 minute Walk Test (m)	.063	.009	.050

Regarding physical fitness, Graphic 2 shows that the 2x2 repeated measures of ANOVA indicated that there is a statistically significant

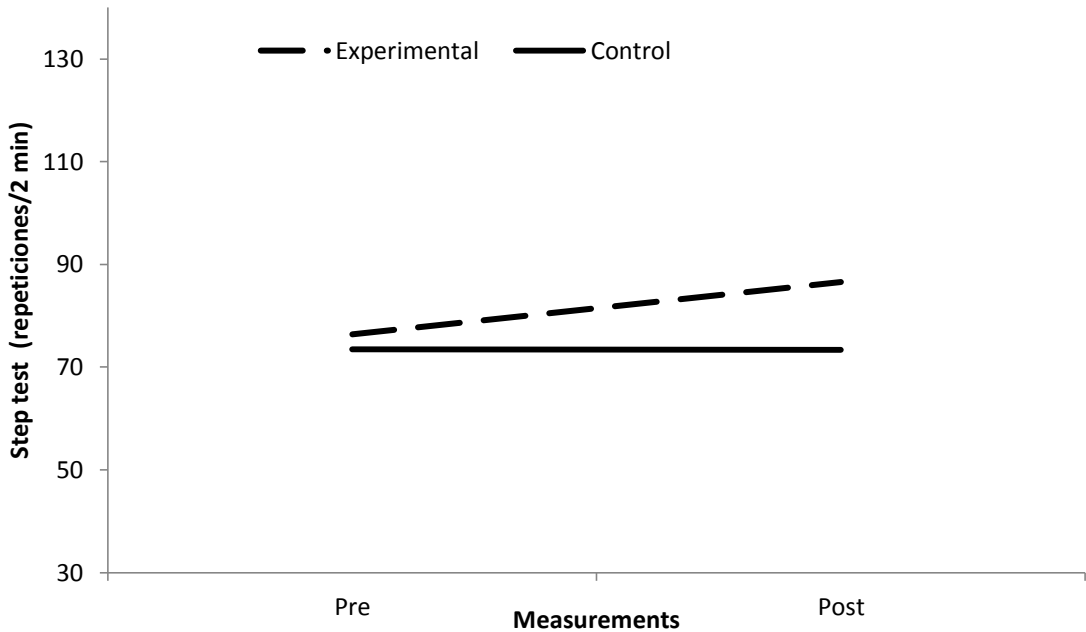
interaction ($p \leq 0.01$) between groups and measurements in the 2.4 m agility test (8 ft). No statistically significant changes between the groups ($p = 0.578$) were found, although there were differences in measurements ($p \leq 0.001$).

Graphic 2: Changes over time in the 8-Foot Up and Go Test in the study participants (n=26).



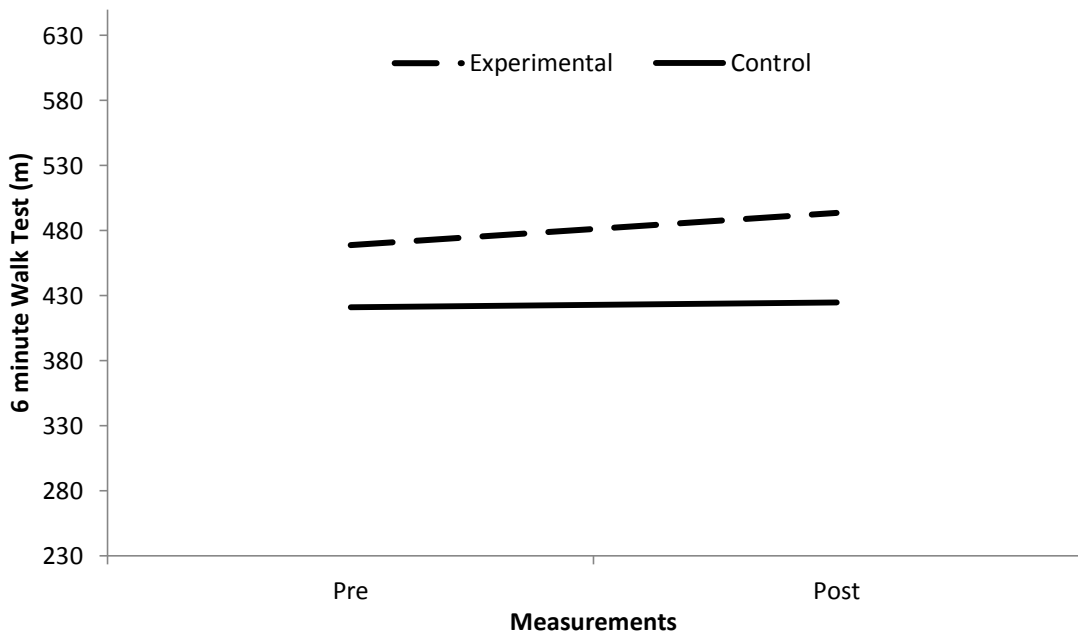
Regarding physical fitness, Graphic 3 shows that the ANOVA 2x2 repeated measures indicated that there is a statistically significant interaction ($p = 0.02$) between groups and Measurements on the 2-minutes Step Test. No statistically significant changes between groups ($p = 0.413$) were found even if there were differences in the measurements ($p = 0.003$).

Graphic 3: Changes in the number of repetitions of 2-minutes Step Test in the study participants (n=26).



Regarding physical fitness in Graphic 4, the 2x2 repeated measures of ANOVA indicated that there is a statistically significant interaction ($p=0.50$) between groups and measurements in the 6-minute walk. No statistically significant changes between groups ($p=0.063$) were found even if there were differences in the measurements ($p=0.009$).

Graphic 4: Changes in distance walked in the 6 minute Walk Test in study participants (n=26).



In this part of the study, we calculated the percentages of change ($\Delta\%$) for each study group according to the procedure established by Vincent: $[(\text{Mediapost} - \text{Mediapre}) / \text{Mediapre}] \times 100$, in the physical fitness variables

(strength, aerobic endurance, flexibility, agility and dynamic balance), which are presented below in Table 3.

Table 3 Percentages of change from the initial measurement in each study group (n=26).

Variables	Experimental (n=16)	Control (n=10)
Chair Stand Test (repetitions in 30 s)	14.0	0.0
Arm Curl Test (repetitions in 30 s)	17.5	1.5
8-Foot Up and Go Test m (s)	-14.6	0.1
2-minutes Step Test (repetitions)	13.3	-0.1
Back Scratch Test (cm)	51.8	-12.5
Chair Sit and Reach Test (cm)	108.1	-12.7
6 minute Walk Test (m)	5.3	1.0

DISCUSSION

The present study assessed the physical fitness of strength, aerobic endurance, flexibility, agility and dynamic balance, finding a percentage of positive change for the experimental group participating in the hydrogymnastics training program with regards to the control group (which did not have any intervention training, remaining inactive). These results indicate the importance of practicing water aerobics in the maintenance and improvement of physical abilities in older adults who practice this exercise. Regarding the assessment of physical abilities are several assessment measures for the elderly. In the present investigation we chose to conduct the assessment with the Senior Fitness Test (Rikli & Jones, 2001) since it is replicable, valid; complete when measuring the conditional physical abilities and practical due to its low cost and the fact that it can be easily applied.

When assessing the physical tests for The 6-minute Walk and The Step Tests measuring aerobic endurance, they showed repeated measures indicating a statistically significant interaction ($p=0.50$) between groups and measurements in the 6-Minute Walk; then the 2 Minute Step Test indicated a statistically significant interaction ($p=0.02$) between groups and measurements, which once we reviewed the literature; we were able to identify several hydrogymnastics research studies following similar methodology to assess physical abilities (Rikli & Jones 2001). We also found similar results for aerobic ability, after verifying the results (Colado et al, 2012;. Devereux, Robertson, & Briffa, 2005).

When assessing the Chair Stand Test, it indicated that there was a statistically significant interaction ($p=0.052$) between groups and measurements of the 30 second Chair Stand resulting similar to other research conducted with the same methodology (Tsourlou, Benik, Dipla, Zafeiridis, & Kellis, 2006) or by measuring the force in other ways such as isometrically (Carrasco Poyatos, Martínez González-Moro, & Vaquero Abellán, 2013). Also, the results in the 2.4 meter agility test indicated that there is a statistically significant interaction ($p\leq 0.01$) between groups and measurements; thus having similar results to other exercises of the same kind that were assessing functional autonomy (Pernambuco et al., 2013).

CONCLUSION

Based on the stated assumptions, it is concluded that a 3-month hydrogymnastics training for elderly women will improve aerobic physical fitness, strength, aerobic endurance, agility and dynamic balance in the lower body. This information will be useful as future reference for planning, executing and assessing interventions aimed to prevent, decrease and / or completely eliminate general physical health problems in older adults, thus allowing researchers and professionals working with this age group to better understand hydrogymnastics and to have more elements that will allow an improvement in their care.

Despite the aforementioned, we recommend that for future research, to increase the "n" sample which consequently will give better power in inferential statistics when it comes to analyzing the results of the experiment and consequently the possibility of comparing the results obtained subjects with similar characteristics, better control of variables to consider such as lifestyle, diet, physical activity, and avoiding a possible alteration of the results. At the same time, we recommend to study the effects of a longer intervention period, with a longer exercise cycle and their application in both: males and females, as well as stratifying age ranges by age group.

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