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The Effects of Strength Training in Hydrogymnastics for Middle-Age Women

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This study analyzed the effects of different strength training protocols carried out in hydrogymnastics workouts on the maximal strength of the shoulder horizontal flexors (SHF), shoulder horizontal extensors (SHE), and hip extensors (HE) muscles. Fifty-two women (ages 50.4 ± 14.15 years) were divided into two groups: hydrogymnastics with strength training without resistive equipment (HS) and hydrogymnastics with strength training using resistive equipment (HSE). The training lasted 12 weeks (2 × per week) and the intensity was controlled using Borg's rating of perceived exertion scale for both groups. After 12 weeks of training, both groups showed an increase in maximal strength of all muscles analyzed for both HS (SHF: 13.68 ± 3.20kg vs. 16.02 ± 2.57kg; SHE: 17.20 ± 6.54kg vs. 21.14 ± 2.44kg; HE: 22.79 ± 6.98kg vs. 32.27 ± 6.57kg) and for HSE (SHF: 13.52 ± 3.53 vs. 16.02 ± 4.13kg; SHE: 18.23 ± 3.43 vs. 20.02 ± 4.32kg; HE: 24.79 ± 6.91 vs. 33.29 ± 5.71). There were no differences between training groups. These results indicated that the hydrodynamic strength training exercises may increase the maximal strength of middle-age women, independent of the type of resistive equipment used.

Health-related physical fitness includes many components, including cardiovascular (or cardiorespiratory) capacity, body composition, muscle strength, muscle endurance, and flexibility. Health-related fitness is defined as the capacity to support moderate to intense physical exercise, without exacerbating muscle fatigue and to maintain one's capacity for everyday life skills (ACSM, 1998).

We now know that in older adults, the achievement in many of these components is reduced, including muscular strength. Maximal muscular strength is achieved during the age range of 20–30 years and remains relatively stable until the beginning of the fifth decade. During older adulthood (defined as older than 65 years), maximal strength decreases rapidly, reaching levels that can impair typical domestic activities. It has become very important to try to maintain higher, healthy levels of muscular strength in the elderly (Fleck & Kraemer, 2006).

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There is a consensus that strength training in young individuals and athletes brings relevant adaptations in performance. For some period of time, these same types of exercise were contraindicated for older people. In contrast, participating in regular endurance exercises was indicated due to the cardiovascular benefits. The myth of strength training in the elderly started to be revealed in the last few years, because several studies showed that older people can be trained in a safe manner with positive results and reversal of increasing physical dependence based on different land-based strength training methodologies (Frontera, 1997; Monteiro, Amorin, Farjalla, & Farinatti 1999).

Some researchers believe that water-based strength training programs may promote significant increases in muscle strength (Kruel et al., 2005; Lindle, 2001; Müller, 2002; Pöyhönen et al., 2002; Takeshima et al., 2002). Müller (2002) studied older women undergoing strength training in hydrogymnastics workouts, utilizing resistive equipment with the upper-limbs and compared the results with traditional hydrogymnastics. The results showed that only strength trained women demonstrated increases in upper-limb strength. It seemed that resistive equipment had no additional influence on strength gains in middle-aged women, compared with strength training in hydrogymnastics without using accessory equipment (Kruel et al., 2005).

Although earlier studies (Kruel et al., 2005; Müller, 2002) support the idea that hydrogymnastics may increase muscle strength, other authors found different results (Di Masi, 1999; Madureira & Lima, 1998). Di Masi (1999) divided eight women experienced in hydrogymnastics into a control group and a strength training group, which trained the lower-limbs (3 sets of 12 repetitions of knee extension in maximal velocity, using "aquafins") over eight weeks. The results showed no increase in muscle strength for either group, suggesting that water's resistance is not enough to develop muscle strength. The authors suggest that resistive equipment is essential to increase the amount of resistance provided in the water and, consequently, to reduce the number of repetitions of each set necessary to provide a strength training effect. It is important to note that due to the very small sample size of only eight participants, this study likely did not have the statistical power to identify changes if they did indeed exist.

Because of this controversy about whether hydrogymnastics increases muscular strength, and about the role of resistive equipment in developing strength, this study aimed to analyze the effect of different types of hydrogymnastics workouts on maximal strength of upper limbs and lower limbs in middle-aged adult women. We hypothesized that the strength training performed in hydrogymnastics would increase the muscle strength independent of the use of resistive equipment.

Method

Participants

Fifty-two middle-aged women participated of this study, recruited during the workouts of the hydrogymnastics program offered by the Aquatic and Landing Research Group of the Federal University of Rio Grande do Sul. They were divided into two experimental groups: hydrogymnastics with only strength training (HS) and hydrogymnastics with strength training and resistive equipment (HSE). The individuals who trained with the resistive equipment used with the lower limbs but used no resistive equipments in upper limbs, and vice-versa. Table 1 shows the descriptive characteristics of the participants. Before participation, all subjects were informed about the procedures, risks, and benefits of the study and signed an informed consent form approved by the Ethics Committee of the Federal University of Rio Grande do Sul.

Procedures

All measurements were conducted by the same evaluator, between 2:00 and 6:00 p.m. at a gymnasium or in the Natatorium Center of the Physical Education School of the Federal University of Rio Grande do Sul.

Anthropometric Data. The weight and height were measured using a calibrated balance scale with a stadiometer (Filizola, Brazil). These data were recorded on a personal entry form, along with other information (i.e., name, address, age, diseases, and medications).

Dynamic Strength (1-RM). All participants performed one repetition maximum (1-RM) tests to evaluate the maximal strength of shoulder horizontal flexors (SHF), shoulder horizontal extensors (SHE), and hip extensors (HE), respectively. Before that, each participant attended three sessions to familiarize themselves with the testing exercises. The initial load in each test was calculated based on a percentage of body mass (Beachle & Groves, 2000). After the first trial, the load was corrected by the coefficients proposed by Lombardi (1989; Table 2) to estimate 1-RM. After each adjustment, a new trial was carried out in a repetitive process until the 1-RM was achieved. Three trials were conducted, with two minutes rest apart. Then, if the 1-RM was not reached, a second test was administered after 48 hr, something that occurred with two participants only during the pretraining test. In performing the 1-RM exercise, each repetition was controlled with a metronome (KM 201, Rebel).

Training. All training sessions were conducted in the swimming pool of the Natatorium Center of the Physical Education School of the Federal University of Rio Grande do Sul—UFRGS. The water temperature was kept between 29 °C and 31 °C. All exercises were performed at approximately the xiphoid process and can be observed at Figure 1. The HSE group performed strength training to

Table 1 Means and Standard Deviations (σ) of Age, Body Mass, Height, and BMI of the Subjects

	Subjects (n = 52)	
	Média	**σ**
Age (years)	50,41	± 14,15
Body mass (kg)	65,72	± 13,06
Height (m)	1,59	± 0,08
BMI (kg/m^2)	25,72	± 4,20

Table 2 1RM Estimation Based on Repetitions Performed

Reps Performed	Factor of Correction
1	1,00
2	1,07
3	1,10
4	1,13
5	1,16
6	1,20
7	1,23
8	1,27
9	1,32
10	1,36

Note. From Lombardi, 1989

Figure 1 — The initial and final positions of the exercises for shoulder horizontal flexors and extensors (A1 and A2), and hip extensors (B1 and B2).

lower and upper limbs by increasing the movement speed and utilizing EVA low-floating resistance equipment, designed and manufactured specially to our study (Figure 2). The HS group performed strength training for lower and upper limbs by increasing the movement speed without resistive equipment. All exercise sessions were performed in groups, supervised by a Physical Education professor and one assistant. Each participant trained twice per week (Mondays and Wednesdays), over a twelve week period, focusing on the three muscle groups of interest: (a) shoulder horizontal flexors (SHF), (b) shoulder horizontal extensors (SHE), and (c) hip extensors (HE).

The strength training intensity was controlled by ratings of perceived exertion (RPE), specifically using the Borg scale (Borg, 2000). The 6–20 point scale was presented visually on a banner fixed close to the pool side (Table 3). The training period was divided in 4 phases, following the linear periodization commonly used in land-based strength exercises (Baker et al., 1994; Buford et al., 2007; Rhea et al., 2002, 2003,). In the first phase, we asked all participants in the HSE and HS groups to maintain intensity between the RPE numbers of 12–15. These indices represent approximately 70% of maximal strength (Tiggemann, 2000). At phases 2, 3, and 4, the subjects reached the intensity equivalent to 16–19 on the Borg scale, corresponding to 90% of the maximal strength (Tiggemann, 2000). The training program can be observed in Table 4.

Statistical Analyses

We calculated descriptive and inferential statistics for all the measures. The normality and homogeneity of the sample was verified by the Shapiro-Wilk and Levene tests, respectively. The within- and between-groups comparisons were performed using a factorial Analysis of Variance, as appropriate for each analysis. The sampled calculation considered a level of significance of 5%, statistical power of 80%, and a correlation coefficient of 0.8 for all the variables. A review of the literature was made to obtain the variability of each dependent variable and the adopted difference was

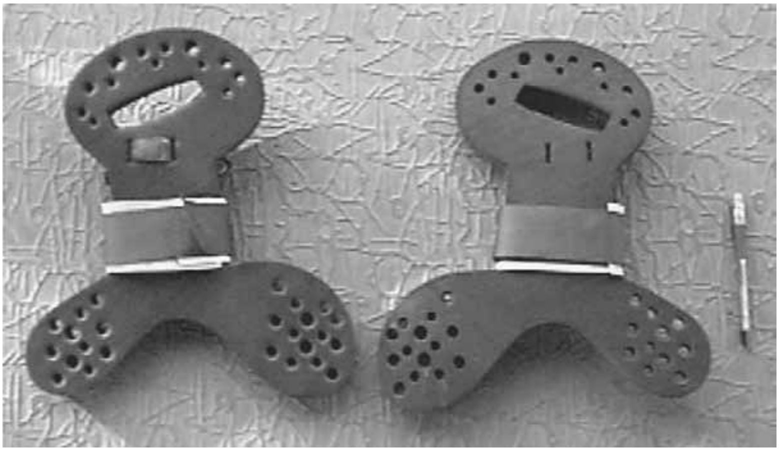

Figure 2 — Low-floating resistive equipment.

Table 3 Borg Scale

Rating	Perceived Exertion
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Table 4 Periodization of Training

Weeks	Phase	Workouts per Phase	Sets	Time of Each Exercise	Set (total time)	Rest	Rest of Muscle Group
1	1	6	2	30 min	1 hr	1 hr	2 hr
2							
3							
4	2	6	3	20 min	1 hr	1 hr 20 min	2 hr
5							
6							
7	3	6	4	15 min	1 hr	1 hr 30 min	2 hr
8							
9							
10	4	6	2 × 3	10 min	1 hr	1 hr 40 min	2 hr
11							
12							

based on values considered physiologically different, in the event that statistically significant differences were found between the protocols. The level of significance of $p \leq .05$ was adopted for all analyses.

Results

After 12 weeks of training, we observed increases in the 1RM of all the muscle groups analyzed in both training groups (Figures 3, 4, & 5); however, there were no differences observed between the two types of training groups. That is, the strength of the trained muscle groups was improved by both water-based exercises, independent of resistive equipments.

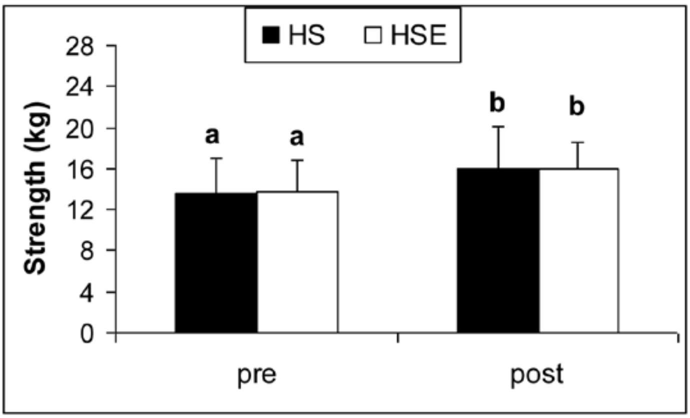

Figure 3 — Means, standard deviations and intra groups comparisons of the shoulder horizontal flexors strength (SHF) variable. b—Different from a ($p < .01$).

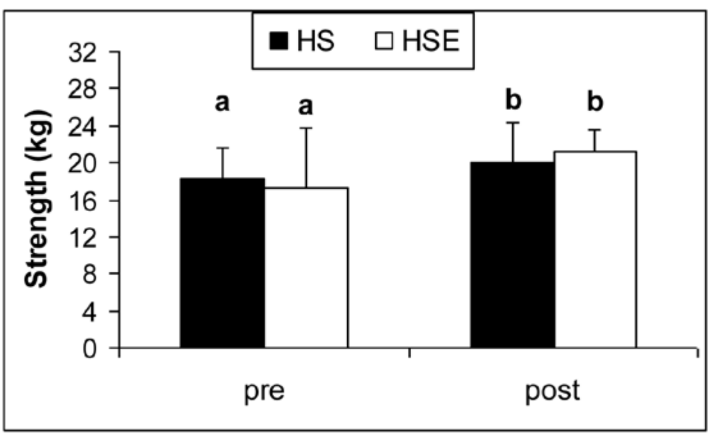

Figure 4 — Means, standard deviations and intra groups comparisons of the shoulder horizontal extensors strength (SHE) variable. b—Different from a ($p < .05$).

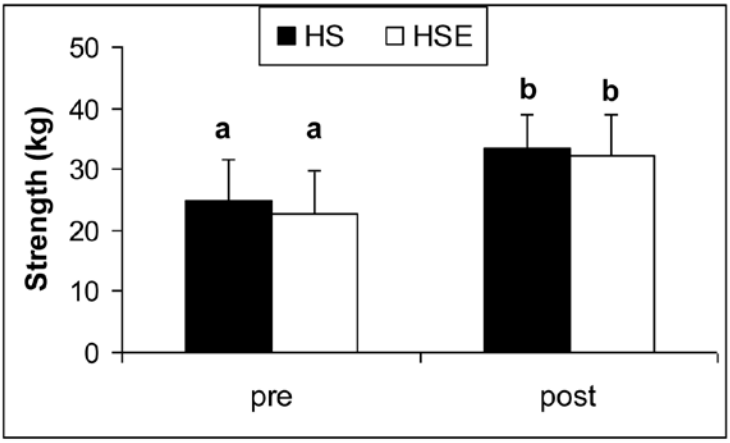

Figure 5 — Means, standard deviations, intra and inter groups comparisons of the hip extensors strength (HE) variable. a—Different from b ($p < .05$).

Discussion

The main finding of our study was that, regardless of the type of hydrogymnastics training (i.e., with or without resistive training equipment), all muscles group analyzed (horizontal shoulder flexors, horizontal shoulder extensors, and hip extensors) increased their strength as a result of 12 weeks of twice-weekly hydrogymnastics training. These results confirmed our hypothesis that independent of using resistive equipment, hydrogymnastics training would result in strength increases. Increases in muscle strength had been found elsewhere (Gehlsen et al., 1984; Kruel et al., 2005; Müller, 2002; Pöyhönen et al., 2002; Takeshima et al., 2002). In contrast, some other researchers had found no increases in strength after a hydrogymnastics program (Di Masi, 1999; Madureira & Lima, 1998; Taunton et al., 1996).

Gehlsen et al. (1984) verified that a program using aquatic exercises promoted an increase in dynamic strength of knee extensors and flexors (12.7% and 24.3%, respectively); however, no increases in isometric strength were observed. These results seem to support the concept of training specificity, whereas given the nature of aquatic exercise, which involves dynamic contractions and no focus on isometric exercises, no increase in isometric strength would be expected.

The studies where strength training was included during hydrogymnastics sessions observed increases of about 11% in the SHF (Müller, 2002). In our study, we observed increases of 17.11% in HSE, which are values considerably higher than found previously. Kruel et al. (2005) had observed increases in muscle strength ranging from 10.73% to 28.76% after strength training included within hydrogymnastics workouts. The strength increases occurred regardless of whether resistive equipment was used, suggesting that focus on strength training is more relevant than on the use of resistive equipment. Our results supported those by Kruel et al. (2005) since we also found no differences between HSE and HS.

Takeshima et al. (2002) verified an increase of 6.7–10.6% in the bench press test, after strength training for 12 weeks included in a hydrogymnastics program. These increases are descriptively lower than those observed in our study (15.77–17.11%), but we did not test the statistical significance. Similar results were found in a chest pull test with results ranging from 7.4% to 10.8% vs. 9.84–22.85%. It should be noted that Takeshima et al. (2002) used hydraulic machines to collect their data, thus making comparisons difficult.

All studies cited before (Kruel et al., 2005; Müller, 2002; Takeshima et al., 2002) justified the increases in muscle strength due to an increase in movement speed when performing each exercise or the increased surface area offered by the resistive equipment. Our results suggested that both "mechanisms" may be relevant to increasing exercise intensity when performed in water and, consequently, perhaps increasing the possibility of promoting changes in muscle strength. Future studies involving cross-sectional area adaptations induced by water-based exercises must be designed. Information about other populations (i.e., elderly persons) is scarce, and the benefits of hydrogymnastics involving muscle strength or neuromuscular responses seem to be relevant in those individuals.

Conclusion

The results of our study demonstrated that strength training included in a hydrogymnastics program can increase the upper and lower limb muscular strength of middle-age adult women. The addition of using resistive equipment did not promote additional strength gains, thus suggesting that strength exercises produced the maximum strength gains and that resistive equipment is not really necessary in hydrogymnastics. Other larger studies are necessary to confirm whether resistive equipment, in fact, does not increase muscular strength beyond those produced by typical muscular strength exercises during hydrogymnastics programs.

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