Effects of Water Strength Training on Muscle Fitness and Functional Capacity in Older Adult Women

Efeitos do treinamento de força na água na performance de força e capacidade funcional de mulheres idosas

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ABSTRACT

To describe the effects of water strength training (WST) on muscle fitness and functional capacity in older adult women after detraining. One hundred and eighty-eight women (68±5y) previous trained (hydrogymnastics) had their muscle strength (isometric dynamometer) and functional capacity (Time Up and Go-TUG and 6-minute walk test-6MWT) evaluated before hydrogymnastics interruption (Hydro), after 12 weeks of detraining (Detra) and after 12 weeks of WST. Muscle strength was higher after 12-w of WST compared to Hydro (p<0.001) and Detra (p≤0.001). WST improved functional capacity on 6MWT, and TUG compared with Detra and Hydro period (p≤0.01). WST induces positive changes on muscle fitness and functional in older adult women after detraining previously after a detraining period. Randomized controlled trials are needed to establish the real effects of

KEYWORDS

Aging; Water resistance exercise; Hidrogymnastic; Water exercise.

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RESUMO

Descrever os efeitos do treinamento de força na água (WST) na força muscular e capacidade funcional de idosas após período de destreinamento. Foram recrutadas 188 mulheres (68±5 anos) previamente treinadas (Hidroginástica) e mensurada a força muscular (dinamômetro isométrico) e a capacidade funcional (Time Up and Go-TUG e teste de caminhada de 06 minutos-6MWT) sendo avaliado antes da interrupção do programa de Hidroginástica (Hydro), após 12 semanas de destreinamento (Detra) e após 12 semanas de WST. Os resultados mostraram que a força muscular foi maior após 12 semanas de WST quando comparado Hydro (p<0.001) e Detra (p<0.001). O WST aumentou a capacidade funcional no 6MWT e TUG quando comparado os períodos Hydro e Detra (p<0.001). Concluímos que WST induz a mudanças positivas na performance de força e capacidade funcional de idosas após destreinamento prévio. Ensaios clínicos randomizados são necessários para estabelecer os reais efeitos do WST.

PALAVRAS-CHAVE

Envelhecimento; Treinamento de força na água; Hidroginástica; Exercício na água.
INTRODUCTION

Aging causes changes in physiological and sensory functions (HARADA; LOVE; TRIEBEL, 2013). One of the most common alterations is sarcopenia, characterized by low muscle strength, reduced quantity and quality of muscle mass and decreased physical performance (CRUZ-JENTOFT; BAHAT; BAUER; BOIRIE et al.). Sarcopenia is common in older adults and is associated with adverse muscle changes that accumulate throughout life. Sarcopenia has been increasingly considered a crucial public health problem, due to its close correlation with increased risk of falls and fractures, dependence, decreased quality of life, hospitalization and mortality (LANDI; LIPEROTI; RUSSO; GIOVANNINI et al., 2012) as well as high social and economic costs (PINEDO-VILLANUEVA; WESTBURY; SYDDALL; SANCHEZ-SANTOS et al., 2019).

Physical activity (PA) is one of the main strategies for minimizing the deleterious effects of aging, especially sarcopenia (CHODZKO-ZAJKO; PROCTOR; FIATARONE SINGH; MINSON et al., 2009). Due to morpho-functional benefits of body immersion in water, as well as the psychological and social benefits, aquatic exercises are a very popular activity in older adults (AVEIRO; AVILA; PEREIRA-BALDON; CECCATO OLIVEIRA et al., 2017; BERGAMIN; ERMOLAIO; TOLOMIO; BERTON et al., 2013; BOCALINI; SERRA; MURAD; LEVY, 2008).

The most common type of aquatic exercise used by the older adults is Hydrogymnastics, whose effects on physical function in the elderly are well (BENTO; RODACKI; INTERNATIONAL, 2015; BOER; DE BEER, 2019; GUIARAES; FERNANDES-SILVA; DRAGER; DE BARROS CRUZ et al., 2018; GUIARAEAS; FERNANDES-SILVA; DRAGER; DE BARROS CRUZ et al., 2018). In recent years another type of aquatic exercise called Water Strength Training (WST) has been used. It is performed at maximum velocity with aquatic resistance equipment (highest intensity), has been proposed as a feasible and more efficient exercise modality for older adult people compared to hydrogymnastics (KRUEL; COSTA; LIEDTKE; KANITZ, 2018; PÖYHÖNEN; SIPILÄ; KESKINEN; HAUTALA et al., 2002).

As previously mentioned, the benefits of regular PA for older adults are well documented (KIM; LEE, 2019; SPARLING; HOWARD; DUNSTAN; OWEN, 2015), however training interruption (also called detraining), a common practice in older adult people (voluntary interruption, extended holidays, and hospitalization) (HENWOOD; TAFFE, 2008), may lead to gradual fitness impairment (PSILANDER; EFTESTØL; CUMMING; JUVKAM et al., 2019), as well as reduced motivation for PA (HASSELMANN; OESCH; FERNANDEZ-LUQUE; BACHMANN, 2015). The purpose of this study was to describe the effects of WST on muscle strength and functional capacity in older adult women after a detraining period.

METHODS

Participants

Sixty hundred and fifty-four older adult women enrolled in a hydrogymnastics program and were invited to take part in this study. 350 initial volunteers, 188 were selected due to not practicing any type of exercise, not having orthopedic problems, being at least of age, and able to practice PA, as evidenced by a certificate (68±5 years of age; height 1.56±0.70 cm; body mass 71.71±12.80 kg; BMI 29.37±4.68 kg·m⁻²; average time of practice 6±3 years). This study was carried out in accordance with the Declaration of Helsinki and was approved by the Local Ethical Committee (CAAE: 01953018.2.00005505). Written informed consent was obtained from all participants.

Participants who met the inclusion criteria came to the laboratory, immediately before the interruption of the hydrogymnastic program (Hydro), to perform the physical and anthropometric assessments. After 12 weeks of detraining period (Detra) they were reevaluated and started 12 weeks of WST where they were reevaluated at the end of this period (WST).
PROTOCOL:

Hydrogymnastic program

The hydrogymnastic program performed before detraining period was characterized, predominantly, by aerobic exercises, sets from 45 seconds to 1 min, composed of coordination exercises and movements against the water resistance followed by 5-min of cool down and stretching.

Water strength training (WST)

The WST was conducted according to previously described methods (BERGAMIN; ERMOLAO; TOLOMIO; BERTON et al., 2013; HEYWOOD; MCCLELLAND; MENTIPLAY; GEIGLE et al., 2017; SILVA; ALBERTON; BRAGA; PINTO, 2019). The sessions were composed of 10 min warm up, 30 min of WST and 5 min cool down. The older adult people were verbally encouraged by the instructor, to exercise at the highest intensity possible and with a high range of motion (called “all out”) (Shape, 2001). The WST session comprised of 2 sequences of 30 seconds each, 3 sequences of 20 seconds each, 4 sequences of 15 seconds each and, at the end 2 sequences of 3x10 maximum repetitions with total movement width and maximum execution speed for each exercise, running in place in the intervals, being 40 to 60 seconds between each sequence with intensity between 6 and 13 in the Borg scale. The water in the indoor swimming pool was kept at 30°C, pool depth 1.30m.

Assessments

The assessments were performed by the same trained researcher, using the same equipment and at similar day-hours to reduce circadian variations.

Anthropometric Measurements

Body mass was measured on a Filizola scale (accuracy of 0.1 Kg). The participants were instructed to wear light clothing and no shoes. Height was measured by using a wall-mounted stadiometer (Sanny, Model ES 2030) with an accuracy of 0.5 cm.

Muscular Fitness

A manual dynamometer (Commander Echo MMT System-J. Tech Medica) was used to assess hand-grip strength (Kg/f), according to the proposed by Shiratori and colleagues (SHIRATORI; IOP; BORGES JÚNIOR; DOMENECH et al., 2014). The procedures were repeated 3 times for each arm, and the highest value was recorded, as the highest value of 3 attempts for each side.

Knee extension strength of the lower limbs was evaluated using the same equipment, based on recommendations from Mentiplay et al. (MENTIPLAY; PERRATON; BOWER; ADAIR et al., 2015), with the results given in kilogram/force (Kg/f). The subject remained seated on a stretcher with the leg at 90° from the thigh and with a voice command saying “attention, go”, and then performed the maximum extension force against the dynamometer, being noted as the highest value of 3 attempts for each side.

Functional Capacity

Functional capacity was evaluated through Time Up and Go (TUG) and 6-minute walk test (6MWT). The TUG quantifies functional mobility in seconds through the task of getting up from a standardized chair, walking a three-meter linear path, and returning towards the chair while sitting again. The time taken to perform the test is timed (PODSIADLO; RICHARDSON, 1991). For (6MWT) the individual is instructed to walk along a designated path as far as they can in 6 minutes. (MED, 2002)

Statistical analysis

Data was firstly evaluated to check normality using the Skewness, Kurtosis, and Shapiro–Wilks tests. Non-parametric variables were transformed using the method proposed by Templeton (2011) (TEMPLETON, 2011). After that, General Linear Model (GLM) with repeated measures was used for all comparisons. Post hoc tests were carried out using Bonferroni’s correction. Moreover, the effect size (ES) was calculated using Cohen’s d as follows: 0.20 (small effect), 0.50 (moderate effect), and 0.80 (large effect). A significance level of 5%
was adopted for all analyses. Most statistical analyses were performed using IBM SPSS Statistics v22 (IBM Corp., Armonk, NY, USA). The effect sizes were calculated using the R based software jamovi v1.1.2 (The jamovi project, 2019. Retrieved from https://www.jamovi.org)

RESULTS

From the total of 188 women included in the sample, 170 older adult people (68 ± 6 years old, body mass 71.71 ± 12.80 kg, and BMI 29.37 ± 4.88 kg/m²) completed all the experimental procedures (02 women died and 18 withdrew).

Knee strength was reduced (-14.19% in right leg and -18.41% in left leg ES= 0.50 and d= 0.69, for right and left leg respectively), in Detra compared to Hydro (p=0.001). Improvement on knee extension strength, for both legs, were observed after WST when compared to Detra (right leg: +59.28% with an ES d = 1.59); (left leg: +58.26% with ES d = 1.57) and a Hydro period (right leg: +36.67% with an ES d = 1.05); (left leg +29.04% with an ES d = 0.88) (Figure 1).

Figure 1. Means and standard values for knee extension strength strength.

Retraining with WST showed an increase in hand grip force when compared with a Detra period (right hand +6.67% with ES d = 0.26) and a Hydro period (right hand: +14.51% with ES d = 0.48; left hand: +8.22% with ES d = 0.26). The hand grip force did not show significant change after Detra a period (Figure 2).

Figure 2. Means and standard values for hand grip strength.

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Results for 6MWT showed that retraining with WST leads to an increase in travelled distance (p≤0.001) compared with Detra (+ 5.74% with ES d = 0.50) and a Hydro period (+ 8.39% with an ES d = 0.65). For the TUG test, there was no significant difference with the Detra period. Retraining with WST led to an improvement (p≤0.001) in dynamic balance when compared to Detra (-30.91% with an ES d = 2.33) and a Hydro period (-31.34% with an ES d = 1.92), as showed in Figure 3.

**DISCUSSION**

The main findings of this study were: 1) the detraining has caused a decrease in lower limb strength, however without reducing the functional capacities, and 2) the retraining with strength training in water (WST) increased muscle strength when compared to Hydro and Detra, periods as well as the functional capacities.

Studies related to detraining showed similar results to those found in the present study regarding the decrease in muscle strength. Psilander et al. (PSILANDER; EFTESTØL; CUMMING; JUVKAM *et al.*, 2019) showed a decrease in strength to baseline level after 20 weeks of detraining. On the other hand, Bezerra, *et al.* found a decrease of 15% in strength after 3 months of detraining (DE SOUZA BEZERRA; DIEFENTHAELER; SAKUGAWA; CADORE *et al.*, 2019). In our study, after 12 weeks of detraining, the muscle force in lower limbs was reduced for both legs, however the participants were used to practicing hydro gymnastics, a kind of exercise which does not have the gain of muscle strength as the main purpose. With 12 weeks of retraining, having performed strength training in water, we noticed an increase in the muscle strength with values significantly higher when compared to the detraining period (Detra) and to the baseline (Hydro). This suggests that this kind of training can be as effective as to improve this capacity in older adult people when compared to traditional hydrogymnastics, reinforcing the studies which used similar methodologies and improved the strength in lower limbs. (AMBROSINI; BRENTO; COERTJENS; KRUÉL, 2010; BENTO; PEREIRA; UGRINOWITTSCH; RODACKI* et al.*, 2012; HEYWOOD; MCCLELLAND; MENTIPAY; GEIGLE *et al.*, 2017; PÖYHÖNEN; Sipelä; Keskinen; Hautala *et al.*, 2002; RIBEIRO; AGUIAR; SCHØNENFELD; NUNES *et al.*, 2018). The increase in strength of lower limbs, showed by the practice of strength training in water, might be a way of improving functional capacity in older adult people and enhancing the...
Effects of Water Strength Training on Muscle Fitness and Functional Capacity in Older Adult Women

The execution of domestic chores in everyday life, giving more independence to the individual (BOOTH, 2004; PÖYHÖNEN; SIPIŁÂ; KESKINEN; HAUTALA et al., 2002).

The detraining has altered the functional capacities tested by TUG and 6MWT. The main hypothesis for this finding is that the training modality done in the traditional Hydrogymnastics, which does not use specific intensity nor volume control, might not be enough to provide any benefit. The studies that showed improvement in the functional capacity have the intensity control as the main characteristic (DIONNE; GOULET; LEONE; COMTOIS et al., 2018; INGLE; KARGARFARD; KARGARFARD; SHARIAT et al., 2018; VALE; VOO; BRUMINI; SUDA et al., 2020). Different studies have found similar results and have showed that water-based exercise is not effective to improve functional capacities (BOER; DE BEER, 2019; MEHRHOLZ; KUGLER; POHL, 2011; NASCIMENTO; FLORES; DE MENEZES; TEIXEIRA-SALMELA, 2019). However, when participants were submitted to a retraining using a 12-week protocol of strength training in water, the agility has showed significant improvement reinforcing similar findings in literature (DE ANDRADE BEZERRA; DE OLIVEIRA FARIAS; JÁCOME; CASTRO et al., 2011; REICHERT; DELEVATTI; PRADO; BAGATINI et al., 2018; SILVA; ALBERTON; PORTELLA; NUNES et al., 2018). Katsura and partners showed an increase in the plantar force capacity as well as in the agility test of TUG in participants submitted to training in water with resistance equipment (KATSURA; YOSHIKAWA; UEDA; USUI et al., 2010), what can be related to water environment favoring the strength increase, with hydrostatic pressure 700 times higher than the air making the resistance during the movement 4 times stronger, increasing this relation with the use of resistive equipment (SHAPE, 2001), reinforcing the findings of Fisken et al., who determined the exercise done in water improves the balance as well as the postural capacity in older adults (FISKEN; WATERS; HING; STEELE et al., 2015). This can be related to a larger width of the movement provided by the aquatic environment and its hydrodynamic changes. Despite the significant differences found in manual pressure strength, the effect size was always small in the study.

Decrease in the hand grip force with increase in mortality risk (KOBAYASHI; IMAGAMA; ANDO; TSUSHIMA et al., 2019; RANTANEN; GURALNIK; FOLEY; MASAKI et al., 1999; SMITH; YANG; HAMER; SPORTS, 2019). According to Labott et al (LABOTT; BUCHT; MORAT; MORAT et al., 2019), training many tasks can increase handgrip strength, which may be related to water strength training and the use of dragging materials that favor the execution of movement in different directions. With McGrath et al (MCGRATH; VINCENT; JURIVICH; HACKNEY et al., 2020), they found a relationship between low strength and handgrip asymmetry with lower functional capacity, which in our study can be mitigated by increasing handgrip strength after the period of water strength training, suggesting that this type of exercise might play an important role in health and in the increase of lifespan for older adult people.

The main limitations of the present study are not having a control group and not having a precise control of individual training intensity, despite using the Borg’s perceived exertion scale during the process.

CONCLUSION

Water strength training induces positive adaptations on muscle strength and functional in older adults women previously after a detraining period. RCT are needed to establish the real effects of WST.

Acknowledgements

There was no conflict of interest of the authors of the article.
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Effects of Water Strength Training on Muscle Fitness and Functional Capacity in Older Adult Women


