Middle-East Journal of Scientific Research 9 (5): 661-666, 2011
ISSN 1990-9233

Effect of Aquatic Balance Training and Detraining on Neuromuscular Performance, Balance and Walking Ability in Healthy Older Men

[1]Seied Sajad Hosseini, [2]Bahman mirzaei, [1]Mehriyeh Panahi and [1]Hossein Rostamkhany

[1]Department of Physical Education and Sport Sciences,
Faculty of Humanities, Abhar Branch, Islamic Azad University, Abhar, Iran
[2]Department of Physical Education and Sport Sciences,
University of Guilan, Guilan (Rasht), Iran

Abstract: Since disorders in neuromuscular performance and imbalance are the main cause of falling among the elderly, their aspects including rehabilitation of balance are the main concern the researchers attend to. The aim of this study was to determine the effects of eight weeks aquatic balance training (ABT) and detraining on neuromuscular performance and balance in healthy older male. Thirty adult male subjects were randomized into two groups of ABT and control (n=15 per groups). Berg balance scale, Timed Up & Go and 5-Chair stand tests, as they are indicators of balance and neuromuscular performance in older subjects, were taken as pretest and posttest and after four, six and eight weeks of detraining as well. The ABT consisted sessions that lasted one hour, three times a week, for eight weeks. Results of Repeated-measure ANOVA and one-way ANOVA showed that neuromuscular performance and balance improved significantly in ABT group ($P \leq 0.05$) and there were not any significant differences in these parameters between post-test and four, six and eight weeks of detraining periods in this group. It was concluded that ABT can affect neuromuscular performance and balance in healthy older male and reduce the probability of falling among them. Moreover, the effects of these training are persistent after detraining periods. Hence, ABT can be recommended as an effective neuromuscular and balance training in healthy older male.

Key words: Elderly · Aquatic balance training · Detraining · Neuromuscular performance · Balance

INTRODUCTION

Falling is among the most common and serious problems whose potential of occurrence increased with ageing. It usually has physical (pelvic fracture, disability, loss of physical ability and death), psychological (loss of confidence and self esteem and life expectancy reduction) and financial consequences [1, 2]. Just from financial aspects, in the United States, $10 billion are annually imposed on families and society for the treatment of hip fractures among elder persons who fall [3]. It has been documented that the causes of falling among elderly subjects could be attributed to internal factors (including lower limb muscle weakness, loss of balance, reduced mental ability, loss of sensory information and slow motor responses) and external factors (factors that are induced by environmental conditions, including psychotropic drugs, environmental conditions such as dim light in passageways, uneven surfaces, moving the base of support and gliding, cumbersome furniture in passageways) [4].

It has been also documented that balance deficit is one of the main risk factors that affect falling among adults [3-5]; therefore, its aspects including rehabilitation of balance is the main concern the researchers and physiotherapist attend to. Balance is a component of basic needs for daily activities and it plays an important role in static and dynamic activities. Postural control or balance system is a complicated mechanism that coordination in three balance systems include visual, vestibular and proprioceptive systems have the basic role in it [6, 7]. It is well proven that the conventional training programs, which had been used to improve balance, significantly affected balance, gait, strength and aerobic

Corresponding Author: Seied Sajad Hosseini, Department of Physical Education and Sport Sciences, Faculty of Humanities, Abhar Branch, Islamic Azad University, Abhar, Iran. Mob: +989123420801.

endurance; while in some occasion, they led to reduce incidence of falling among adults [7-10]. Though the conventional exercises perform on the ground have benefits for many adults, however, there are certain medical conditions among adult subjects (i.e. osteoporosis, arthritis, stroke and obesity) which, because of pain and/or decrease in joint mobility, decrease their ability to participate or prevent them from doing training programs [11].

The water environment, due to its unique nature, such as buoyancy, viscosity and hydrostatic pressure, also makes it unique to develop confidence and reduces the effect of weight bearing from the Earth's gravity and allows adults to be interested in doing exercise and physical activity without Pain [1, 11]. Recent studies have reported multiple gains from exercise in water for the adults, which they include postural oscillations reduction [12], blood lipids diminish, increased maximal oxygen uptake, strength, muscular endurance and flexibility enhancement [13], increase in the reaching distance [14], as well as greater independence in daily tasks [15]. Many studies have investigated the effects of ABT on balance and mobility in the elderly that mainly their results confirm the positive effects of ABT on their balance [1, 11, 14, 16-18], however, to the best of our knowledge there is no study that examine the effect of detraining after ABT on elderly balance.

Detraining is a time period after exercise intervention that does not do any exercises. Regarding that the purpose of any exercise training is to maintaining of that's effects on body and also that the effects of detraining after ABT is unknown on elder population, the purpose of this study was to examine the effect of ABT and detraining on neuromuscular performance, balance and walking ability in healthy older men.

MATERIALS AND METHODS

Study Participants: Current study was a Quasi-experimental one with pretest - posttest design on an experimental group and one control group. Thirty healthy male adults (age: 70 ± 9.6 years, height: 168 ± 6.9 cm, mass: 70 ± 10.5 kg) voluntarily participated in this study; they were randomly assigned in to two groups of ABT and control group (CG) (15 subjects per group). All participants signed an informed consent document approved by the Institution human subjects review board. Participants were asked to fully explain the history of possible dislocation of joints and falling. Participants who had a history of falling or suffered from any kind of displacement or dislocation of joint in the past 12 months, or had chronic arthritis or dizziness were excluded.

Study Protocol and Intervention: This study was approved by the university institutional review board. Initially, subjects performed Berg Balance Scale (BBS), 5-Chair Stand (5CS) and Timed Get Up & Go (TUG) tests which are criteria for neuromuscular performance and balance in adults [19-23].

The ABT group performed exercises in water with the aim of increasing the neuromuscular performance and walking ability for eight weeks and three 60-minute sessions per week in accordance with previous studies done in this regard [1, 14, 16, 24]. All exercises were conducted in water with subjects' chest high depth. Each exercise session in water was divided into three stages: adaptation with water environment, stretching exercises and static and dynamic ones for balance. ABT was designed to improve the control of center of gravity and ability to combine sensory information, compensatory postural control and walking. All eight-week activities were progressively consolidated due to manipulated and switching hands position (i.e. cross arms to be placed on the breasts) or an increase in the difficulty of performed activities (i.e. to move with closed eyes, walking in different directions or use the insoles). Duration of each exercise session was approximately 60 minutes, each session were started with a 10-minute warm-up including walking in water, aerobic activity in water, resistance training and flexibility activities; the exercise were ended with 10-minute cool-down one, including static flexibility. The remaining time of each session (about 40 minutes) was allocated to balance and walking exercises in water.

Post-tests were performed on three groups after training. After the post-test, to assess and compare persistence of exercises in groups, tests were taken after four, six and eight weeks on all three groups.

Statistical Analysis: Subjects' distribution in groups was normal according to Kolmogorov-Smirnov test. Descriptive statistics, repeated measure ANOVA and one-way ANOVA were applied to examine and compare the effects of WBVT and ABT on neuromuscular performance and walking ability of subjects. To examine the performance changes in TUG and 5CS tests, a repeated-measure ANOVA with a within-subjects factor (time, including pre-test, post-test, persistence test after four, six and eight weeks) and a between-subjects factor (three groups) were used. One-way ANOVA with Bonferroni test as Post Hoc was used on each varying levels of within-subjects factor; for further analysis repeated-measure ANOVA was used to examine changes in each group over the five tests (within group) at the significant level of $P \leq 0.05$.

RESULTS

Descriptive data of subjects including age, height and mass is given in Table 1.

Repeated-measure ANOVA results on 5CS test showed significant interaction between time (five tests) and groups (2 experimental groups) ($F_{4, 112} = 108.25$, $P = 0.000$). Furthermore, the main effect of time ($F_{4, 112} = 722.27$, $P = 0.000$) and experimental intervention ($F_{1, 28} = 2.56$, $P = 0.04$) were significant. The results of repeated-measure ANOVA (within groups) separately for each groups in 5CS test showed that the effect of time in the ABT group ($F_{4, 56} = 307.25$, $P = 0.000$) was significant, but this effect in the CG was not significant ($F_{4, 56} = 1.61$, $P = 0.18$). The result of one-way ANOVA (between groups) for this test showed that the two groups did not have any significant difference in the pre-test, but the performance during the post-test ($F_{1, 29} = 12.08$, $P = 0.002$), after four weeks of detraining, six weeks of detraining ($F_{1, 29} = 8.39$, $P = 0.016$) and eight weeks of detraining ($F_{1, 29} = 6.99$, $P = 0.03$) had significant differences in two groups. Mean and standard deviation in each group during pre-test, post-test and detraining periods as well as the Post Hoc test results can be seen in Table 2.

Repeated-measure ANOVA results on TUG test showed significant interaction between time (five tests) and groups (2 experimental groups) ($F_{4, 112} = 35.97$, $P = 0.000$). Moreover, the main effect of time ($F_{4, 112} = 38.37$, $P = 0.000$) and experimental intervention ($F_{1, 28} = 24.54$, $P = 0.000$) were significant. The results of repeated-measure ANOVA (within groups) separately for each of the experimental groups in TUG test showed that the effect of time in the ABT group ($F_{4, 56} = 178.93$, $P = 0.000$ was significant, but this effect in the control group was not significant. The result of one-way ANOVA (between groups) for this test showed that the two groups did not have any significant difference in the pre-test, but the

Table 1: Descriptive characteristics of participants

Group*	Age (yr)	Height (cm)	Mass (kg)
ABT	71 ± (7.4)	168 ± (6.5)	69 ± (11.5)
CG	70 ± (8.8)	167 ± (7.9)	70 ± (10.3)

*subjects' distribution in groups are normal

Table 2: Mean and standard deviation for training groups in pre-test, post-test and after four, six and eight weeks of detraining and post hoc test results for the 5-Chair Stand Test

	Pretest	Posttest	4 weeks detraining	6 week detraining	8 week detraining
ABT	14.30 ± 1.16	12.27 ± 1.31[ab]	12.39 ± 1.31[a]	12.52 ± 1.33[a]	12.82 ± 1.21[a]
CG	13.97 ± 1.20	13.84 ± 1.16	13.94 ± 1.20	13.87 ± 1.22	13.96 ± 1.14

Significant difference between (a: ABT and CG, b: pre-test and post-test), all at the $p \leq 0.05$

Table 3: Mean and standard deviation for training groups in pretest, post-test and after four, six and eight weeks of detraining and post hoc test results for the Timed Up & Go Test

	Pretest	Posttest	4 weeks detraining	6 week detraining	8 week detraining
ABT	7.88 ± 0.23	6.75 ± 0.38[ab]	6.79 ± 0.43[a]	6.87 ± 0.40[a]	6.97 ± 0.36[a]
CG	7.66 ± 0.28	7.59 ± 0.52	7.59 ± 0.53	7.73 ± 0.32	7.75 ± 0.25

Significant difference between (a: ABT and CG, b: pre-test and post-test), all at the $p \leq 0.05$

Table 4: Mean and standard deviation for training groups in pretest, post-test and after four, six and eight weeks of detraining and post hoc test results for the Berg Balance Scale

	Pretest	Posttest	4 weeks detraining	6 week detraining	8 week detraining
ABT	48.66 ± 1.91	52.13 ± 1.76[ab]	52.53 ± 1.80[a]	52.60 ± 1.76[a]	52.00 ± 1.55[a]
CG	48.93 ± 1.75	49.13 ± 1.92	48.80 ± 1.42	48.86 ± 1.72	49.20 ± 1.70

Significant difference between (a: ABT and CG, b: pre-test and post-test), all at the $p \leq 0.05$

performance during post-test ($F_{1, 29}$ = 24.82, P = 0.000), after four weeks of detraining ($F_{1, 29}$ = 20.23, P = 0.000), after six weeks of detraining ($F_{1, 29}$ = 40.70, P = 0.000) and after eight weeks of detraining ($F_{1, 29}$ = 45.57, P = 0.000) had significant differences in two groups. Mean and standard deviation in each group during pre-test, post-test and detraining periods and also the Post Hoc test results can be seen in Table 3.

Repeated-measure ANOVA results on BBS test showed significant interaction between time (five tests) and groups (2 experimental groups) ($F_{4, 112}$ = 48.85, P = 0.000). Moreover, the main effect of time ($F_{4, 112}$ = 49.31, P = 0.000) and experimental intervention ($F_{1, 28}$ = 18.85, P = 0.000) were significant. The results of repeated-measure ANOVA (within groups) separately for each of the experimental groups in BBS test showed that the effect of time in the ABT group ($F_{4, 56}$ = 178.93, P = 0.000) was significant, but this effect in the control group was not significant. The result of one-way ANOVA (between groups) for this test showed that the two groups did not have any significant difference in the pre-test, but the performance during post-test ($F_{1, 29}$ = 19.80, P = 0.000), after four weeks of detraining ($F_{1, 29}$ = 39.48, P = 0.000), after six weeks of detraining ($F_{1, 29}$ = 34.30, P = 0.000) and after eight weeks of detraining ($F_{1, 29}$ = 22.13, P = 0.000) had significant differences in two groups. Mean and standard deviation in each group during pre-test, post-test and detraining periods and also the Post Hoc test results can be seen in Table 4.

DISCUSSION

The aim of this study was to determine the effects of eight weeks ABT and detraining on neuromuscular performance and balance in healthy older male. The main hypothesis was that adults who participate in ABT for eight weeks would significantly improve neuromuscular performance and balance compared against the control group, which will be preserved after four, six and eight weeks of detraining. The results of this study confirm the effect of this training program on aforementioned factors on the adult samples.

The time of 5CS and TUG tests for post-test in comparison with the pretest declined 10 / 14.13 percent in ABT group respectively. BBS score also increased 7.3 percent in ABT after training program. Reduce in time of TUG and 5CS tests and increase in BBS score represent improvement in neuromuscular performance and balance in training group [20-22]. It shows that neuromuscular performance and balance in the posttest compared against pretest significantly improved for ABT groups.

The improvement of neuromuscular and balance is similar to the results in former studies that examined effect of hydrotherapy among elderly subjects [1, 11, 12, 14, 16, 18, 25]. However, functional tests and intervention programs in these studies were different and a little find it difficult to compare the results. Our findings indicate that resistive nature of water may have increased lower limb muscle strength and it has improved neuromuscular performance and balance in adult groups [26, 27]. On the other hand, water has viscous property that slows down the movement and delays falls in adult subjects; during failure in balance, it provides more time to restore balance [1, 25]. Floating property of water also acts as a supporting factor, which increases self confidence and reduces fear of falling. Using this exercise, we enable the adult subjects to exercise beyond their limit of support without fear of falling [18]. These physiological properties of water have probably improved neuromuscular performance and walking ability in adult subjects. Our findings, however, challenge the results of Chu and colleagues [28]. They reported that eight-week training in water had no significant effect on balance in patients with heart attack, while significant improvements in cardiovascular preparation, walking speed and lower extremity strength were observed. However, in their study, balance system was not considered and researchers were of the opinion that the buoyancy of water and use of flotation devices have not challenged balance systems effectively [28].

Detraining is a period after the training intervention when no training is performed. As shown in tables, in ABT group, there were not any significant differences in amounts of post-test with four, six and eight weeks of detraining. The findings imply that neuromuscular performance and balance remained to their high levels after discontinuation of the training in ABT. Since the goal of athletic training programs is to maintain their effects on the body, it is likely to say that the effect of ABT is enduring on neuromuscular performance and balance in adult subjects.

CONCLOSION

The results of this study showed that ABT with an emphasis on several senses involved can improve balance. Multi-sensory trainings, which manipulate senses involved in balance, both in stable and unstable levels, may also be an effective tool to improve balance and walking ability in adults. Meanwhile, the use of ABT, due to low-risk nature, providing challenging conditions for balance systems can be an effective way to improve balance and prevent subsequent falls among adults. According to the findings of this study, exercise in water can be recommended as a training method to improve neuromuscular performance and balance for male adults with no history of regular exercise.

ACKNOWLEDGMENTS

The authors also acknowledge the formal consent and willingness of the adult subjects participated in this study.

REFERENCES

1. Resende, S.M. and C.M. Rassi, 2008. Effects of hydrotherapy in balance and prevention of falls among elderly women, Revista Brasileira de Fisioterapia, 12: 57-63.
2. Lopes, K., D. Costa., L. Santos, D. Castroand A. Bastone, 2009. Prevalence of fear of falling among a population of older adults and its correlation with mobility, dynamic balance, risk and history of falls, Revista Brasileira De Fisioterapia, 13: 223-9.
3. Carter, N., P. Kannus and K. Khan, 2001. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. J. Sports Medicine, 31(6): 427-38.
4. Shumway-Cook, A., W. Gruber, M. Baldwin and S. Liao, 1997. The effect of multidimensional exercises on balance, mobility and fall risk in community-dwelling older adults, Physical Therapy, 77(1): 46-57.
5. Hobeika, C.P., 1999. Equilibrium and balance in the elderly. Ear Nose and Throat J., 78: 558-67.
6. Bernier, J.N. and D.H. Perrin, 0000. Effect of coordination training on proprioception of the functionally unstable ankle, The Journal of Orthopaedic and Sports Physical Therapy, 27(4): 264-75.
7. Frändin, K., U. Sonn, U. Svantesson and G. Grimby, 1995. Functional balance tests in 76-year-olds in relation to performance, activities of daily living and platform tests. Scandinavian J. Rehabilitation Medicine, 27(4): 231-41.
8. Lord, S., S. Castell, J. Corcoran, J. Dayhew, B. Matters, A. Shan, *et al.*, 2003. The effect of group exercise on physical functioning and falls in frail older people living in retirement villages: a randomized, controlled trial. J. the American Geriatrics Society, 51(12): 1685-92.
9. Campbell, A., M. Robertson, M. Gardner, R. Norton, M. Tilyard and D. Buchner, 1997. Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. British Medical J., 315(7115): 1065-77.
10. Lord, S., J. Ward, P. Williams and M. Strudwick, 1995. The effect of a 12-month exercise trial on balance, strength and falls in older women: a randomized controlled trial. Journal of the American Geriatrics Society, 43(11): 1198-206.
11. Booth, C.E., 2004. Water Exercise and Its Effect on Balance and Gait to Reduce the Risk of Falling in Older Adults. Activities, Adaptation and Aging, 28(4): 45-57.
12. Lord, S., D. Mitchell and P. Williams, 1993. Effect of water exercise on balance and related factors in older people. Australian J. Physiotherapy, 39: 217-24.
13. Jones, C.J. and D.J. Rose, 2005. Physical activity instruction of older adults: Human Kinetics.
14. Simmons, V. and P.D. Hansen, 1996. Effectiveness of water exercise on postural mobility in the well elderly: an experimental study on balance enhancement. Journals of Gerontology Series A: Biological and Medical Sci., 51(5): 233-8.
15. Rissel, C., 1987. Water exercises for the frail elderly: a pilot programme. The Australian J. Physiotherapy, 33(4): 226-32.
16. Douris, P., V. Southard, C. Varga, W. Schauss, C. Gennaro and A. Reiss, 2003. The effect of land and aquatic exercise on balance scores in older adults. J. Geriatric Physical Therapy, 26: 3-6.
17. Suomi, R. and D.M. Koceja, 2000. Postural sway characteristics in women with lower extremity arthritis before and after an aquatic exercise intervention. Archives of Physical Medicine and Rehabilitation, 81(6): 780-5.
18. Avelar, N.C.P., AC. Bastone, M.A. Alcântara and W.F. Gomes, 2010. Effectiveness of aquatic and non-aquatic lower limb muscle endurance training in the static and dynamic balance of elderly people. Revista Brasileira De Fisioterapia, 14(3): 229-36.
19. Van Nes, I., A. Geurts, H. Hendricks and J. Duysens, 2004. Short-term effects of whole-body vibration on postural control in unilateral chronic stroke patients: preliminary evidence. American J. Physical Medicine and Rehabilitation, 83(11): 867-73.
20. Duncan, P., D. Weiner, J. Chandler and S. Studenski, 1990. Functional reach: a new clinical measure of balance. The J. Gerontol., 45(6): 192-7.

21. Podsiadlo, D. and S. Richardson, 1991. The timed Up and Go: a test of basic functional mobility for frail elderly persons. J. the American Geriatrics Society, 39(2): 142-8.
22. Moreland, J., J. Richardson, C. Goldsmith and C. Clase, 2004. Muscle Weakness and Falls in Older Adults: A Systematic Review and Meta Analysis. J. the American Geriatrics Society, 52(7): 1121-9.
23. Conradsson, M., L. Lundin-Olsson, N. Lindelöf and H. Littbrand, 2007. Berg balance scale: intrarater test-retest reliability among older people dependent in activities of daily living and living in residential care facilities. Physical Therapy, 87(9): 1155.
24. Lord, S., B. Matters, R. George, M. Thomas, J. Bindon and D. Chan, 2006. The effects of water exercise on physical functioning in older people. Australasian Journal on Ageing, 25(1): 36-41.
25. Devereux, K., D. Robertson and N. Briffa, 2005. Effects of a water-based program on women 65 years and over: a randomised controlled trial. Australian J. Physiotherapy, 51(2): 102-8.
26. Booth, C., 2004. Water exercise and its effect on balance and gait to reduce the risk of falling in older adults. Activities, Adaptation and Aging, 28(4): 45-57.
27. Lord, S., D. Mitchell and P. Williams, 1993. Effect of water exercise on balance and related factors in older people. Australian J. Physiotherapy, 39: 217-22.
28. Chu, K.S., J.J. Eng, A.S. Dawson, J.E. Harris, A. Ozkaplan and S. Gylfadóttir, 2004. Water-based exercise for cardiovascular fitness in people with chronic stroke: a randomized controlled trial. Archives of Physical Medicine and Rehabilitation, 85(6): 870-4.