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Effects of hydrotherapy in balance and prevention of falls among elderly women

Efeitos da hidroterapia na recuperação do equilíbrio e prevenção de quedas em idosas

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Abstract

Background: Hydrotherapy is used to treat rheumatic, orthopedic and neurological disorders. It has been the subject of investigations regarding balance recovery in elderly people. **Objective:** To evaluate the effect of a hydrotherapy program for balance, in relation to the risk of falls in elderly women. **Methods:** This was a quasi-experimental before/after study without a control group. Twenty-five elderly women were evaluated using two scales: the Berg Balance Scale and Timed Up & Go. The subjects underwent, subsequently, a low to moderate intensity hydrotherapy program for balance, which consisted of three phases: a phase of adaptation to the aquatic environment, a stretching phase and a phase of static and dynamic balance exercises. The program was applied for 12 weeks, with two sessions per week, each session lasting 40 minutes. The elderly women were reassessed after the sixth and twelfth weeks of the hydrotherapy program. The data were analyzed statistically by means of Student's *t* test for paired samples and the Wilcoxon test. **Results:** Hydrotherapy promoted significant increases in the elderly women's balance, as assessed using the Berg Balance Scale ($p < 0.001$) and the Timed Up & Go test ($p < 0.001$). There was also a reduction of the scores in a scale of risk of falls ($p < 0.001$), according to the model of Shumway-Cook et al. **Conclusions:** It can be suggested that this hydrotherapy program for balance gave rise to an increase in balance and a possible reduction in the risk of falls among these aged women.

Key words: hydrotherapy; physical therapy; musculoskeletal equilibrium; accidental falls; aged person.

Resumo

Contexto: A hidroterapia é utilizada para tratar doenças reumáticas, ortopédicas e neurológicas. Na atualidade, é alvo de investigações na recuperação do equilíbrio em idosos. **Objetivo:** Avaliar o efeito de um programa de hidroterapia no equilíbrio e no risco de quedas em idosas. **Métodos:** Trata-se de um estudo quase-experimental antes/depois sem grupo controle. Foram avaliadas 25 idosas por meio de duas escalas, a Escala de Equilíbrio de Berg e *Timed Up & Go*. Posteriormente, foram submetidas a um programa de hidroterapia para equilíbrio, de baixa a moderada intensidade, que consistiu de três fases: fase de adaptação ao meio aquático, fase de alongamento e fase de exercícios estáticos e dinâmicos para equilíbrio. O programa foi aplicado durante 12 semanas, sendo duas sessões semanais com 40 minutos de duração cada sessão. As idosas foram reavaliadas após a sexta e a 12ª semanas do programa de hidroterapia. Os dados foram analisados estatisticamente pelo teste *t*, para amostras pareadas, e pelo teste de Wilcoxon. **Resultados:** A hidroterapia promoveu aumento significativo do equilíbrio das idosas, avaliado por meio da Escala de Equilíbrio de Berg ($p < 0,001$) e teste *Timed Up & Go* ($p < 0,001$), e ainda, redução do risco de quedas ($p < 0,001$), de acordo com o modelo de Shumway-Cook et al. **Conclusões:** Pode-se sugerir que este programa de hidroterapia para equilíbrio aumentou o equilíbrio e reduziu o risco de quedas nas idosas.

Palavras-chave: hidroterapia; fisioterapia; equilíbrio musculoesquelético; acidentes por quedas; idoso.

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Introduction

Nowadays, falls are one of the largest public health problems among elderly people due to the high morbidity, mortality and costs for the family and society[1]. The main risk factors for falls in this population are related to functional limitations, history of falls, increasing age[1-4], muscle weakness, use of psychotropic drugs, environmental risks[1,3,4], the female gender[2,5,6] and visual deficits[2]. Researchers have reported that elderly women have a higher propensity for falls because of less lean body mass and muscle strength, a higher prevalence of chronic-degenerative diseases and exposure to domestic activities[2,5,6].

Every year, in Brazil[2] and the United States[7], 30% of non-institutionalized elderly people suffer falls. Approximately 5% of these cause fractures, especially in the hips[2]. In the United States, the annual cost of treating hip fractures among elderly people caused by falls is 10 billion dollars[8]. On the other hand, despite the high rate of fractures in Brazil, R$ 12 million is spent every year[9].

To prevent falls, it is necessary to improve the reception conditions for sensory information from the vestibular, visual and somatosensory systems, so that the antigravity muscles are activated and balance is stimulated[10]. One of the means applied for promoting the stimulation mentioned above is the practice of physical activities[11,12].

Thus, it is recognized in the literature that physical activity practiced throughout life can diminish bone and muscle loss, and reduce the risk of fractures by up to 60%[1,3]. In addition, physical activity promotes increased muscle strength, aerobic conditioning, flexibility and balance, and reduces the risk of falls and improves quality of life[3,13].

Since long ago, hydrotherapy has been used as a resource for treating rheumatic, orthopedic and neurological diseases; however, it has only recently become the target of scientific studies. The physical proprieties of water, together with the exercises, can fulfill most of the physical objectives that are proposed in a rehabilitation program. The aquatic environment is considered safe and efficient for the rehabilitation of elderly people, because water acts simultaneously on musculoskeletal disorders and balance improvements[14,15].

The multiplicity of symptoms such as pain, muscle weakness, balance deficits, obesity, arthritic diseases and gait disorders, among others, make it difficult for elderly people to perform exercises on the ground. The situation is different with exercises in an aquatic environment, where there is a reduction in joint overload and less risk of falls and lesions. In addition, floating allows individuals to perform exercises and movements that cannot be done on the ground[10,14,16].

Although few studies have reported the effects of hydrotherapy on balance and the reduction of falls, all of them have shown benefits, for example, of reduced postural oscillations[17], increased functional reach[16] and greater independence in activities of daily living (ADLs)[18]. Given the relevance of this subject, the objective of the present study was to evaluate the effects of a hydrotherapy program on balance and risk of falls among elderly women.

Methods

This was a quasi-experimental pre/post study without a control group, carried out at the Elderly People's Association of Brazil, in Goiânia, State of Goiás. It was carried out following the ethical principles for research involving human beings, in accordance with Resolution 196/96 from the National Health Council. The study was approved by the Research Ethics Committee of the Universidade Católica de Goiás, under procedure number 0065.0.168.000-05.

Individuals

To develop the study, 50 elderly people (49 women and one man) were selected. The volunteers were recruited by means of posters in the association itself and subsequently selected in accordance with the inclusion and exclusion criteria.

The inclusion criteria were: over 60 years of age, independence in walking, independence in activities of daily living, the absence of medical contraindications for exercise, cardiological and dermatological medical certificate, 80% participation in the treatment and signature of the free and informed consent statement. The exclusion criteria were: urinary or fecal incontinence, renal insufficiency, open wounds, contagious skin diseases, infectious diseases, catheters, vascular thrombi, cardiac insufficiency, uncontrolled arterial pressure, dyspnea upon minimal effort, use of psychotropic drugs (benzodiazepines) or participation in any other physical activity or physical therapy program.

After the selection, 40 elderly women fit the inclusion criteria. Fifteen of them did not complete the study for reasons such as travel and health problems. Thus, 25 elderly women with a mean age of 72.60 ± 7.11 years composed the sample that was investigated.

Materials

The materials consisted of the following: a questionnaire for interview, the Berg Balance Scale – Brazilian version[19], the Timed Up & Go test[20], a chronometer (Sport Timer®), a 20-centimeter (cm) graduated ruler, two chairs of 45 cm in height (one of them with arms), a measuring

tape, stethoscope and sphygmomanometer of the Becton Dickinson brand, and a rectangular-shaped swimming pool measuring 7.5 by 11.1 meters, with a sloping bottom with the depth going from 0.8 to 1.2 meters, and with a mean temperature of 30ºC.

Procedures

The evaluation started with an interview to collect information such as age, marital status, number of people living in the home, reports of diseases, use of medications and history of falls and fractures. After the interview, the elderly women underwent balance evaluation using the Berg Balance Scale[19] – Brazilian version, and the Timed Up & Go[20] test. In addition, the prognosis for the risk of falls, in relation to the Berg Balance Scale score, was evaluated in accordance with the model of Shumway-Cook et al.[21]. These tests were chosen because they are functional, validated, internationally accepted, easy to apply and low-cost[19,20].

The Berg Balance Scale serves various purposes, such as quantitative description of functional balance ability, determination of risk factors for loss of independence and falls among elderly people, and evaluation of the effectiveness of interventions both in clinical practice and research. The scale evaluates static and dynamic balance based in 14 common items in daily life, such as reaching, turning around, moving away, standing up and getting up. The maximum score that can be attained is 56 points. It was applied in accordance with the procedures described by the authors who translated and adapted it for Brazil[19].

The model for quantitative prediction of the risk of falls among elderly people, which establishes the relationship between the Berg Balance Scale and the risk of falls (10 – 100%), was also used as developed by Shumway-Cook et al.[21]. In this model, the sensitivity of the scale was 91% and the specificity was 82%. The likelihood of falls increases with decreasing scores on the Berg Balance Scale in a nonlinear relationship. For amplitudes from 56 to 54, each point lost is associated with an increase in the risk of falls of 3 to 4%. From 54 to 46, each one-point decrease is associated with an increase of 6 to 8%. Below 36 points, the risk of falls is nearly 100%[21].

The Time Up & Go test provides rapid monitoring to detect balance problems that affect elderly people's ADLs. The shorter the time used to complete the test, the better the balance is. The time it took for the elderly women to get up from a chair, walk a distance of 3 meters, turn around, walk back to the chair and sit down again was measured in seconds[20]. The elderly women did the test once to become familiarized with it and, on the second attempt, the time was recorded.

The scales were applied before the treatment (pre-test) and after six weeks (post-test 6) and 12 weeks (post-test 12) of hydrotherapy. The arterial pressure (AP) was measured before and after the treatment sessions, with the aim of checking the individuals' conditions for performing the aquatic activities, without statistical intentions.

The study lasted 12 weeks, with 40-minute sessions, twice a week (on Mondays and Wednesdays). The hydrotherapy for balance program was carried out with six elderly women per group and included adaptation to the aquatic environment, hydrokinesiotherapy and inclusion of aquatic exercises from other studies[16,22,23] that challenge balance. Each session was divided into three phases: aquatic environment adaptation phase, stretching phase and a phase of static and dynamic exercises for balance. The intensity was low to moderate, with constant intensity, frequency and speed, for 12 weeks. Each series was performed continuously and between each one there was a one-minute rest. The program is described in the following and can be observed in Figures 1, 2 and 3.

Phase I – Aquatic environment adaptation.

Exercise 1: Respiratory control.

- Positioning: Semi-seated position without posterior support, with immersion to the shoulder level. Shoulders at 90º flexion and with extended elbows.
- Activity: Slow and prolonged expiration through the mouth over the water, then with the mouth immersed, and subsequently with both mouth and nose immersed (2').

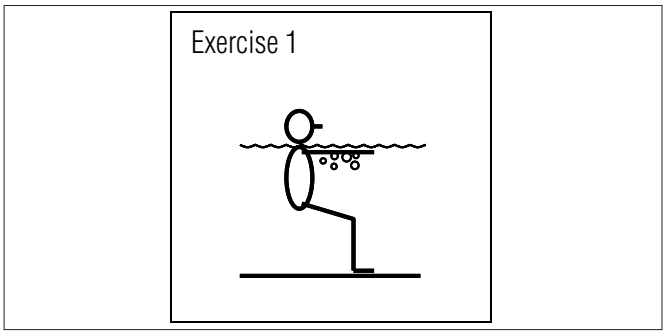

Figure 1. Hydrotherapy program for balance. Phase I – aquatic environment adaptation.

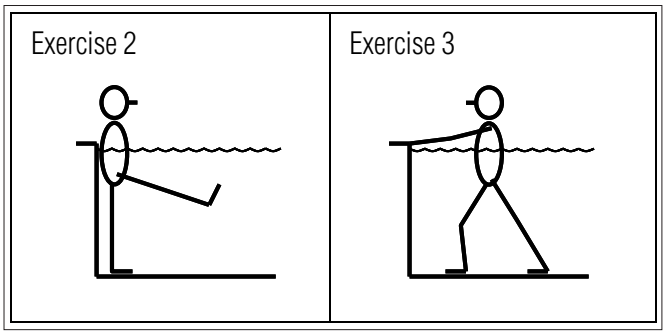

Figure 2. Hydrotherapy program for balance. Phase II – stretching.

Phase II – Stretching. Each stretching exercise was maintained for 30 seconds.

Exercise 2: Stretching of the hamstring muscles

- Positioning: Orthostatic position with back supported against the wall.
- Activity: Elevation of one of the lower limbs, maintaining knee extension and ankle dorsal flexion.

Exercise 3: Stretching of the triceps surae and iliopsoas muscles

- Positioning: Orthostatic position with hands on the edge of the pool.
- Activity: Taking a large step forward, while maintaining the anterior knee in flexion, the posterior knee in extension, and feet in contact with the bottom of the pool.

Phase III – Static and dynamic exercises for balance. The speeds and frequencies indicated were approximate averages.

Exercise 4: Walking in circles hand-in-hand with sporadic changes of direction

- Activity: Walking sideways, facing forwards and backwards, alternating the direction from clockwise to anticlockwise, three times in each kind of walk (once for each kind of walk, speed: 0.40 m/s).

Exercise 5: Walking in line

- Positioning: Hands supported on the waist of the individual in front.
- Activity: Moving in the pool making circles and changes in direction. The activity was conducted by the physical therapist (Three times, speed: 0.40 m/s).

Exercise 6: Walking forward pushing lower members vigorously

- Activity: Walking with higher speed and propulsion (45 meters, speed: 0.50 m/s).

Exercise 7: Walking backwards. (45 meters, speed: 0.50 m/s)

Exercise 8: Lateral walk with large steps. (45 meters, speed: 0.55 m/s)

Exercise 9: Walking with one foot in front of the other

- Activity: Walking supporting one foot immediately in front of the other, and so on successively (45 meters, speed: 0.20 m/s).

Exercise 10: Walking with trunk rotation

- Activity: Walking forwards taking hand to opposite knee in flexion, alternately (45 meters, speed: 0.30 m/s).

Exercise 11: Walking with one-leg support pauses

- Activity: Walking and, at the physical therapist's command, maintaining one-leg support with the opposite knee in flexion for 10 seconds (12 pauses in 45 meters, speed: 0.50 m/s).

Exercise 12: Bilateral shoulder flexion-extension

- Positioning: Semi-seated position.
- Activity: Performing shoulder flexion and extension, while keeping the elbows in extension. Starting with maximum

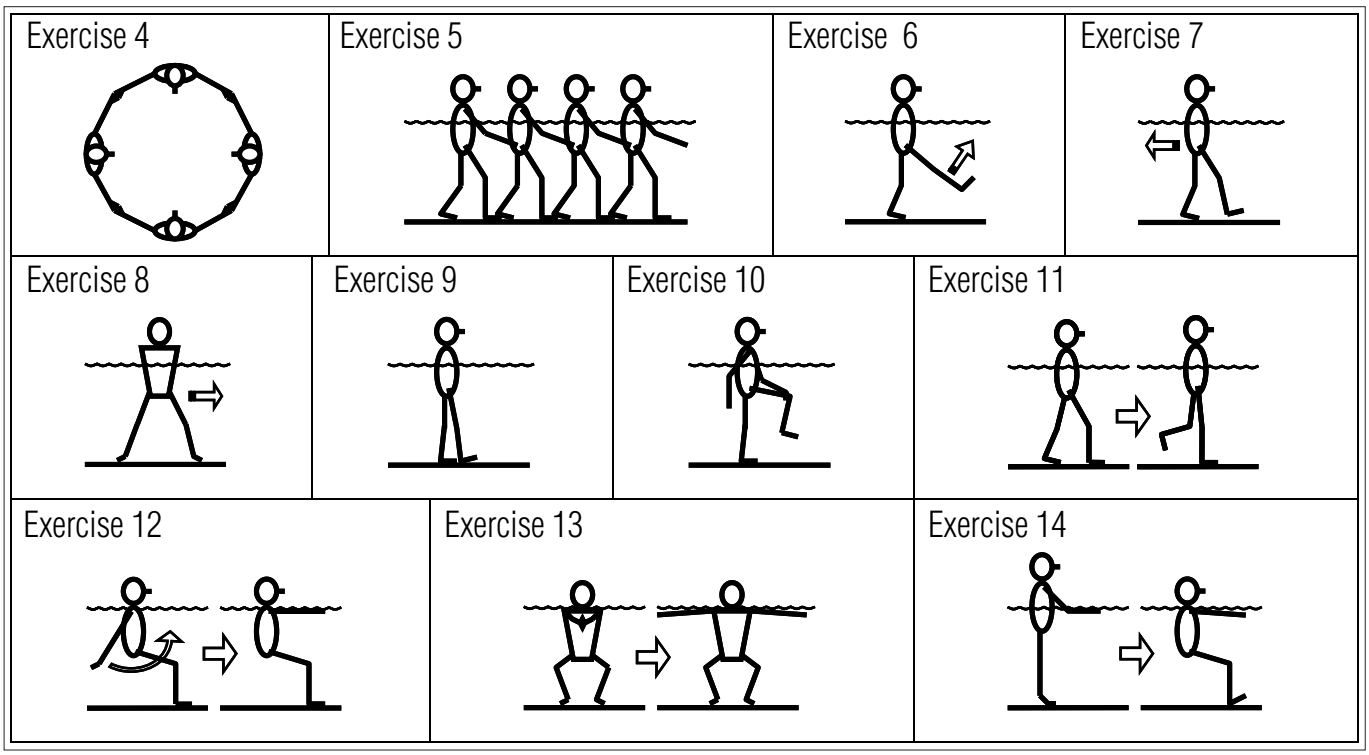

Figure 3. Hydrotherapy program for balance. Phase III – static and dynamic exercises for balance.

shoulder hyperextension and going until 90º flexion (10 repetitions, frequency: 12 repetitions per minute).

Exercise 13: Bilateral horizontal shoulder abduction-adduction

- Positioning: Semi-seated position, shoulders flexed at 90º, extended elbows.
- Activity: Starting in adduction and going until 90º of horizontal abduction (10 repetitions, frequency: 12 repetitions per minute).

Exercise 14: Ankle pumping

- Positioning: Orthostatic position, with immersion up to the xiphoid process level.
- Activity: Extension of the knees associated with plantar flexion, maintaining this position for 5 s, and then knee flexion associated with dorsiflexion, also maintaining this for 5 s (10 repetitions, frequency: 3 repetitions per minute).

Statistical Analyses

For comparisons over the course of time for the measurable variables, the Student t test for paired data and the Wilcoxon test were used, by means of comparing scores or times after the treatment with corresponding results for the same individual from the preceding evaluation. The data have been shown as mean differences and standard deviations of the difference. The analysis was carried out with the aid of the "Minitab" software. The significance level adopted was $\alpha = 0.01$.

Results

According to the initial interviews, the elderly women demonstrated the following characteristics: predominant age group between 70 and 79 years (64%), 28% were married and 28% lived alone. The mean number of diseases reported per individual was 2.2: predominantly controlled arterial hypertension (60%) and osteoporosis (28%). The mean number of regularly used medications was 1.76 per individual. Twenty% of the elderly women had already experienced fractures as a consequence from falls, and 76% had history of falls. Regarding arterial pressure, there were no variations from before to after the sessions.

According to the obtained results, the hydrotherapy program promoted significant increases in the elderly womens' balance, as observed by means of the Berg Balance Scale. The increase occurred after the sixth week ($p < 0.001$), after the twelfth week ($p < 0.001$) and between the sixth and twelfth weeks ($p < 0.001$) (Table 1).

Likewise, the Timed Up & Go test showed that there was a significant decrease in the elderly women's times taken to perform the tests after the hydrotherapy program, after the sixth week ($p < 0.001$), after the twelfth week ($p < 0.001$) and between the sixth and twelfth weeks ($p < 0.001$), which indicated an increase in their balance (Tables 2 and 3).

The results show that the hydrotherapy program promoted a significant reduction in the risk of falls among these elderly women, after the sixth week ($p < 0.001$), after the twelfth week ($p < 0.001$), and between the sixth and twelfth weeks ($p < 0.001$). These results are in agreement with the prediction given by the model of Shumway-Cook et al.21 applied to the Berg Balance Scale scores (Table 4).

Table 1. Mean differences and standard deviations of the differences, in points on the Berg Balance Scale, among elderly women before and after the program of hydrotherapy for balance, for the periods from Pre-test (before treatment) to Post-test6 (after 6 weeks), from Post-test6 to Post-test12 (after 12 weeks) and from Pre-test to Post-test12. *p* values were obtained by means of the Student ***t*** test for paired data.

	Mean difference ± standard deviation	99% confidence interval	*p*-value
Pre-test – Post-test6	6.36 ± 3.49	4.41 to 8.31	<0.001
Post-test6 – Post-test12	1.24 ± 0.97	0.70 to 1.78	<0.001
Pre-test – Post-test12	7.60 ± 3.77	5.49 to 9.71	<0.001

Table 2. Mean differences and standard deviations of the time differences in seconds in the Timed Up & Go test, among elderly women before and after the program of hydrotherapy for balance, for the periods from Pre-test (before treatment) to Post-test6 (after 6 weeks) and from Pre-test to Post-test12 (after 12 weeks). *p* values were obtained by means of the Student ***t*** test for paired data.

	Mean difference ± standard deviation	99% confidence interval	*p*-value
Pre-test – Post-test6	-3.68 ± 2.58s	-5.12 to -2.24s	<0.001
Pre-test – Post-test12	-5.08 ± 2.78s	-6.64 to -3.52s	<0.001

Table 3. Median differences in time taken in seconds in the Timed Up & Go test, among elderly women before and after the program of hydrotherapy for balance, for the period from Post-test6 (after 6 weeks) to Post-test12 (after 12 weeks). The *p* value was obtained by means of the Wilcoxon test.

	Median Difference	*n* for test	99% confidence interval	*p*-value
Post-test6 – Post-test12	-1.50s	20	-2.00 to -1.00s	<0.001

Table 4. Mean differences and standard deviations of the differences, in percentage points, of the risk of falls based on the model by Shumway-Cook et al.[21] applied to the Berg Balance Scale scores, among elderly women before and after the program of hydrotherapy for balance, for the periods from Pre-test (before treatment) to Post-test6 (after 6 weeks), from Post-test6 to Post-test12 (after 12 weeks) and from Pre-test to Post-test12. p values were obtained by means of the Student t test for paired data.

	Mean difference ± standard deviation	99% confidence interval	*p*-value
Pre-test – Post-test6	-35.2 ± 19.4	-46.0 to -24.4	<0.001
Post-test6 – Post-test12	-6.1 ± 5.8	-9.4 to -2.9	<0.001
Pre-test – Post-test12	-41.3 ± 21.0	-53.1 to -29.6	<0.001

Discussion

According to the obtained results, balance increased significantly after conducting the hydrotherapy program, according to the Berg Balance Scale and the Timed Up & Go test. This was similar to the results obtained by many other authors[14,16,17,22-24], in which the application of a hydrotherapy program increased balance among elderly people. However, the functional tests and treatment programs used in these studies were different, making it difficult to make quantitative comparisons.

In the present study, the risk of falls among elderly women, evaluated quantitatively, underwent a significant reduction after the treatment. Studies that have found increased balance after hydrotherapy programs have also suggested that there is a reduction in the risk of falls, since balance has a direct relation with these risks[14,16,22]. These authors did not use a model with scoring that predicted the risk of falls, but was evaluated indirectly. That is, they classified the elderly people as having a low, medium or high risk of falls according to the score obtained in the balance tests. Thus, it can be suggested that subsequent studies should use scales for scoring the risk of falls, in order to directly obtain results.

Other authors are unanimous regarding the indication of aquatic exercises for individuals with fear of falling who are at risk of falls[14,16,22,24]. Water is viscous: it decelerates movement and retards falls, which prolongs the time available for regaining posture when the body gets out of balance. Floating acts as a support, which increases individuals' confidence and reduces the fear of falling. In this way, individuals can be challenged beyond their limits of stability without being afraid of the consequences of falls that would occur on the ground[10,25].

This hydrotherapy program was effective in reducing the risk of falls among elderly women, thus, undesirable effects resulting from falls could be prevented. These can vary from small injuries, mobility restrictions, limitations in ADLs and loss of functional independence, up to social isolation, can create a vicious circle of voluntary restriction of activities and, thus severely compromises the quality of life[2,26].

When analyzing the time intervals between the evaluations according to the scales, it was observed that there was a greater gain in balance during the first stage of the program (up to the sixth week), as was seen by Simmons and Hansen[16]. These results possibly occurred because the responses to physical exercise are more evident during the first weeks of treatment. In the initial phase, neural changes predominate, and in the intermediate phase muscle adaptations predominate. In elderly people, the muscle strength increases are mainly due to neural adaptations, which occur with greater magnitude during the first six to eight weeks of training[27,28].

In the present study, the same program was applied throughout the whole period. It is possible that modifying the program during the treatment, with progressive exercises (increasing intensity, frequency and duration) would allow results of greater magnitude.

Another possible hypothesis which may explain this result relates to the limitations of the scales that were used. This meant that there was no possibility of measuring new abilities in the next period. The Berg Balance Scale has a maximum score of 56 points, and many of the elderly women came very close to this value after the sixth week; and the Timed Up & Go test cannot indefinitely show reducing times. As a reference, 10 s is the time considered normal for healthy and independent elderly people[20]. Furthermore, other functional tests that were used to evaluate balance, such as functional reach, Tinetti gait and balance scale and the dynamic gait index resulted in similar limitations.

The proposal of this hydrotherapy program consisted of stimulating balance reactions, in order to promote increased balance and prevent falls among elderly women. It also sought to create a program that would be easy to replicate, since each exercise and its frequency, intensity and duration were described, differently from most studies on this same theme, in which the descriptions of the programs are simple and general[14,16,17,22-24]. Well defined programs are fundamental for reproducing new research, and for confirmation of the results.

One possible limitation for this study regarding prediction of the risk of falls may come from the low sensitivity of the Berg Balance Scale. Thorbahn and Newton[29] compared elderly people's self-reports of falls with the scale scores and observed that the specificity of the test was high, but the sensitivity was only 53%. Due to the scarcity of tests for quantifying the

risk of falls, it is suggested that the existing ones should be improved and new tests should be created.

Although the sample size was small, and there was no control group, the results indicated that the hydrotherapy exercise program promoted increases in balance and, possibly, a reduction in the risk of falls among elderly women. Thus, hydrotherapy is a possible physical therapeutic resource to be recommended for preventing falls among elderly people.

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