

Does dance-based training improve balance in adult and young old subjects? A pilot randomized controlled trial

Ario Federici¹, Silvia Bellagamba¹, and Marco B.L. Rocchi²

¹Istituto di Ricerca sull'Attività Motoria, ²Istituto di Biomatematica, Università di Urbino "Carlo Bo", Urbino, Italy

ABSTRACT. Background and aims: Loss of balance is a major risk factor for falls in the elderly, and physical exercise may improve balance in both elderly and middle-aged people. We propose a clinical trial to test the efficacy of an exercise program based on dance in improving balance in adult and young old subjects. **Methods:** We carried out a mono-institutional, randomized, controlled clinical trial. 40 subjects (aged 58 to 68 yr) were randomly allocated in two separate groups: the exercise group (n=20) followed a 3-month exercise program; the control group (n=20) did not engage in physical activities. Differences in balance between the end of the training period and the baseline were assessed using four different balance tests: Tinetti, Romberg, improved Romberg, Sit up and go. **Results:** Results showed a significant improvement in balance in the exercise group at the end of the exercise program, whereas the control group did not show any significant changes. The comparison between exercise and control group variations in balance test scores showed a highly significant difference. 17 out of 20 subjects in the exercise group reported great or moderate satisfaction with the dance activity. **Conclusions:** Results suggest that physical activity based on dance may improve balance and hence be a useful tool in reducing the risk of falling in the elderly. The exercise program also revealed interesting psychosocial benefits.

(*Aging Clin Exp Res* 2005; 17: 385-389)

©2005, Editrice Kurtis

INTRODUCTION

Factors and predictors influencing the risk of falls and related injuries in the elderly have been studied by many authors, but results are sometimes contradictory (1-3). Nevertheless, the role of regular physical exercise in order to maintain balance capability and to reduce the risk of

falls and injuries is largely accepted (4, 5), and exercise habituation significantly affects the overall health status of older people (6).

During the aging process, there is considerable deterioration in balance capability. The loss of efficiency of neuromuscular connections and subsequent slowing of information processing leads to slower reaction times and locomotor apparatus adjustments. This in turn results in problems in maintaining the body's balance during static or dynamic situations. In order to slow down this process of deterioration, which leads to difficulty in performing fine, elastic and fluid movements, balance capability should be gradually and continuously stimulated through motor activity (7). This activity should include exercises and translocations which aim not only at retraining the individual from a neurophysiological standpoint, but also from a social-emotional one (8).

Dance is generally recommended to maintain good dexterity and coordination, fluid movement of the joints, muscle tone and trophism. In dance, movement of the head and trunk and the shifting of the center of gravity in every direction from the axis of support allow the development of all those factors which contribute to the maintenance of balance, such as coordination and joint mobility.

It is well-known that the best defense mechanism against injuries and risk of falls is a well-toned, strong, flexible body. Appropriate alignment and range of motion of large joints are required for dance activity; in the same way, dance exercises represent a potential relevant support in both increasing balance and decreasing the risk of falls and injuries (9). Some authors have recently demonstrated that dance exercise in athlete training improves the range of hip motion, joint mobility, and muscle flexibility in flexion-extension and lateral flexion of the spine (10, 11).

This study aims at showing possible improvements

Key words: Aging, balance, clinical trial, dance, falling risk.

Correspondence: Marco B.L. Rocchi, M.Sc., Istituto di Biomatematica, Università di Urbino "Carlo Bo", 61029 Urbino, Italy.
E-mail: m.rocchi@uniurb.it

Received January 16, 2004; accepted in revised form January 14, 2005.

in balance in adult and young old subjects after they have participated in an exercise program based on Caribbean dancing. This age group is already at risk for falling, mainly due to health-related problems (12).

In the literature, there are a few but significant examples of studies based on dance, all of which involved female subjects (13-16). Unlike these studies, our trial also involved male subjects and was based on Caribbean dancing, which is particularly effective in increasing joint movement, muscle tone and trophism, as well as orientation and coordination. We chose this form of dance mainly for its technical and biomechanical characteristics. The movements that are performed in the steps and basic movements allow proprioceptive stimulation that comes from the miologic, tendonous and articular apparatus. The biomechanical characteristics of Caribbean dances have been studied, and appear especially involved in improving the range of motion of the hips, due to the typical movements of both basic steps and advanced figures (17). With aging and the frequent onset of pathologies involving the foot, this stimulation often slows down. In choosing this particular kind of dance, we also considered its appealing and joyful qualities, its ability to reawaken the desire to move in middle-aged people, and to give them new energy and vitality. In short, we chose a motivating social group motor activity able to foster interpersonal relationships through the expressive body language of dance.

METHODS

This mono-institutional, controlled, randomized trial aimed at assessing improvements in balance in subjects who participated in an exercise program based on Caribbean dance, in comparison with a control group which did no physical activity.

Subjects

Participants were recruited from a recreation center for seniors in Grottammare (Marche, Italy). In order to participate in the study, candidates had to be 58 to 68 years old and free of any medical conditions that would make a cardiorespiratory fitness program inadvisable (i.e., unstable angina, ventricular arrhythmia, diastolic blood pressure >115 mmHg, systolic blood pressure >200 mmHg). Only candidates who did not exercise on a regular basis were eligible. Informed consent from all subjects was obtained before their enrolment in the trial. The protocol of this study was approved by the Ethical Committee for Human Research of Urbino University.

Procedures

Enrolled subjects were randomly allocated into two separate groups (exercise group= EG, and control

group= CG), using a randomization block method, with stratification (with respect to gender). To detect the difference of one point in the modification of the score on the Tinetti test between EG and CG, a sample size of 20 subjects in each group was required, assuming a statistical power (1-β) of 80% and a significance level (α) of 5%.

Deviations from the protocol (defined as absence >10% of total training sessions) were analyzed in accordance with the intention-to-treat principle. Blindness was guaranteed for the researchers who carried out baseline, intermediate and final evaluation of subjects.

Balance evaluation: Each subject's balance was assessed using 4 different tests, before they began the exercise program (baseline evaluation), 4 weeks later (intermediate evaluation) and 3 months later (final evaluation). The tests were chosen because they are the most easy-to-use ones in the literature, and are the following:

(i) Tinetti test: the subject sits on a chair with no armrests. Several movements are tested and points are assigned for each of the subject's responses. A point total <19 indicates a high risk of falling.

Table 1 - Exercise program.

Length of trial	3 months.
Frequency	Twice a week, Tuesdays and Fridays.
Length of each session	60 minutes. For first two weeks, dance sessions lasted 30 to 35 min, to allow time for gradual conditioning. Sessions were then lengthened to a maximum of 60 min.
Exercise intensity	Intensity of work-out is between 60 and 70% of maximum heart rate, and between 50 and 75% of V02max. In first sessions, work-out intensity was about 45% of maximum heart rate. Work-outs were then intensified until above-mentioned heart rate was reached. Subjective level of fatigue, assessed using traditional Borg Scale, ranges from light to quite heavy, thus falling between levels 11 and 13.
Contents	Basic steps and simplest movements of Puer-torican Salsa, Merengue and Bachata. Group dances. Exercises to improve joint mobility, co-ordination and strength. Activities to improve balance.
Equipment, means, instruments	Codified and non-codified, non-tradition-al (rugs and cushions of various sizes and consistencies, balls, chairs, benches, elastic tape, tissue paper, tennis balls, plastic bottles, stereo and music cds)
Location	A room used for recreational activities at center for seniors, Grottammare (Ascoli Piceno, Marche, Italy).
Exercise program	General conditioning activities (light exercises, stretching and breathing exercises) for first two weeks. During third and fourth weeks, specific exercises for static and dynamic balance as well as coordination and specific elements of dance. In following weeks: progres-sive development of dance activities, together with specific exercises for improving balance.

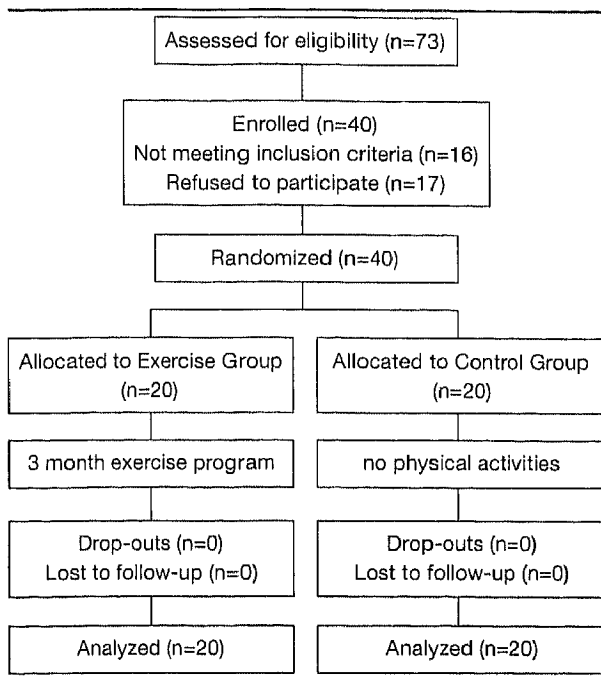


Fig. 1 - Flow-chart of subjects and trial profile.

(ii) Romberg test: the subject stands with eyes closed, heels together, and the tips of the feet pointing out at a 30° angle. Time of position maintenance is recorded.

(iii) Improved Romberg test: the subject stands with eyes closed and one foot in front of the other (heel-to-toe position). Time of position maintenance is recorded.

(iv) Sit-up-and-go test: the subject sits on a chair with no armrests, and is asked to stand up without the aid of arms and to walk 5 m in a straight line. Time expended to cover the distance is recorded.

Exercise program: The exercise group (EG) followed a 3-month exercise program (see Table 1). The control group (CG) engaged in no physical activities, but was en-

gaged in social and recreational activities, such as talking groups, board games, and card games.

Psycho-social investigation: A psycho-social investigation was performed at the end of the trial to assess the potential subjective benefits in the following areas: smoking, alcohol consumption, sexual habits, and sleep quality, by a 4-item questionnaire (responses on binary scale) developed by our operators.

Subjects in the EG group also completed a questionnaire (responses on a 5-point Likert scale) to assess how much they had enjoyed the exercise program.

Statistical analysis

Variations between EG and CG were compared using either the Mann-Whitney U-test or Student's t-test, as appropriate. Proportions were compared using either the chi-square test (if necessary, corrected using the Yates method) or Fisher's exact test, as appropriate. Ordinal variables were compared using either the Mann-Whitney U-test or the Wilcoxon test (respectively for unpaired and paired data). The significance level was fixed at $\alpha=0.05$ for all statistical analyses. Despite the small sample size, we also performed an explorative comparison between males and females, for better understanding of the gender response to dance training.

RESULTS

Forty subjects (14 males, 26 females) met the inclusion criteria and were enrolled in the trial. We think it is important to note the high percentage of male subjects enrolled, which is unusual for this kind of study. The flow of patients in the study is described in the trial profile of Figure 1.

The baseline characteristics of subjects are listed in Table 2. Exercise and control groups did not show significant differences in terms of gender, height, weight, or balance test scores. No deviations from the protocol and no drop-outs were recorded.

The results show a significant improvement in balance capability between final and initial assessment in EG

Table 2 - Baseline characteristics of subjects.

Variables	Control Group	Exercise Group	p-value
age (years)*	63.5 (3.7)	62.7 (4.1)	0.55
height (cm)*	163.0 (7.3)	165.0 (7.3)	0.14
weight (kg)*	63.7 (10.2)	69.1 (12.3)	0.31
Tinetti (score) [§]	23 (2)	23 (2)	0.78
Romberg (sec)*	55.3 (10.4)	54.8 (11.0)	0.88
Improved Romberg (sec)*	6.5 (1.9)	6.1 (1.9)	0.51
Sit-up-and-go (sec)*	5.9 (0.9)	6.2 (1.1)	0.35

*Mean (Standard Deviation), Student's t-test; [§]Median (Interquartile Range), Mann-Whitney's U-test.

Table 3 - Comparison between Exercise Group (EG) and Control Group (CG) variations (differences between final and baseline scores) in balance.

Balance tests	Baseline (IR) EG score	Baseline (IR) CG score	Final (IR) EG score	Final (IR) CG score	test	p-value
Tinetti [§]	23 (2)	23 (2)	23 (3)	21 (2)	U=26.5	<0.001
Romberg*	54.8 (11.0)	55.3 (10.4)	59.7 (10.8)	54.8 (11.1)	t=42.7	<0.001
Improved Romberg*	6.1 (1.9)	6.5 (1.9)	7.2 (1.6)	6.4 (1.7)	t=34.8	<0.001
Sit-up-and-go*	7.2 (0.6)	6.9 (0.5)	6.3 (0.5)	6.9 (0.6)	t=18.0	<0.001

*Mean (Standard Deviation), Student's t-test; [§]Median (Interquartile Range), Mann-Whitney's U-test.

subjects. Instead, CG subjects showed a slight, although not statistically significant, deterioration in balance capability. A comparison between EG and CG variations in balance test scores also showed a highly significant difference (Table 3).

Table 4 shows the results of the explorative comparison between male and female subgroups; no significant difference between genders was found.

The psycho-social survey results are listed in Table 5. They show a slight but not significant reduction in smoking and alcohol consumption, and an important and statistically significant improvement in sexual activity and sleep quality. In addition, 14 out of 20 subjects reported great satisfaction and 3 out of 20 subjects moderate satisfaction with dance activity.

Table 4 - Comparison of differences between final and baseline scores in balance (Exercise Group), with respect to gender.

Balance tests	Males	Females	p-value
Tinetti [§]	0	+1	0.88
Romberg*	+4.8	+4.9	0.79
Improved Romberg*	+0.9	+0.9	1.00
Sit-up-and-go*	-0.7	-1.0	0.66

*Mean, Student's t-test; [§]Median, Mann-Whitney's U-test.

DISCUSSION AND CONCLUSIONS

The group which engaged in the dance-based exercise program showed considerable improvement in balance capability compared with the control group, in accordance with the findings of Hopkins et al. (13) and Shigematsu et al. (14). In detail, the percentages of improvement in balance tests in the exercise group overlapped those observed by these authors. Unfortunately, there are no other studies based on dance exercise with which our results can be compared.

Conversely, the control group showed a slight, although not statistically significant, deterioration in balance capability, lending further support to the theoretical relationship between physical inactivity and functional deterioration already shown by several authors (13, 18, 19).

The improvement in balance performance observed in our trial appears to be similar to that obtained with different training models (e.g., T'ai Chi [20]) and better than some results observed in a trial on a home-based exercise program (21). It is well-known that all the four balance tests used as outcome measures in this trial are reliable and valid (see, for example, Franchignoni et al. [22]) and are predictive for falls risk in the elderly (23). Lastly, it is particularly interesting to note that the improvement in the Sit-up-and-go test observed in the exercise group was greater than the least clinical relevant difference for the same test, as reported by Piva et al. (24).

Table 5 - Results of psycho-social survey. Fisher's exact test compares differences between Exercise and Control Groups (only for total percentages).

	Exercise group	Control group	p-value
Reduction in smoking	Total: 10% Males: 0% Females: 15%	Total: 0% Males: 0% Females: 0%	0.49
Reduction in alcohol consumption	Total: 15% Males: 29% Females: 8%	Total: 5% Males: 0% Females: 8%	0.60
Improvement in sexual activity	Total: 30% Males: 43% Females: 23%	Total: 0% Males: 0% Females: 0%	0.02
Improvement in sleep quality	Total: 70% Males: 71% Females: 69%	Total: 10% Males: 14% Females: 8%	<0.01

The comparison between males and females did not show any significant difference; nevertheless, this finding should be interpreted only as an exploratory result, due to the small size of the subgroups.

Hence, we may state that the proposed motor activity, based on Caribbean dance, practised during middle age is helpful in improving balance and could thus play an important role in preventing falls in the elderly. It also seems to represent a valid and suitable alternative to other kinds of training in order to improve balance capability. However, the duration of acquired benefits must be studied further.

It is also important to note that there were no accidents or traumas of any kind during the exercise program; this result was presumably due both to the planned very gradual progression of exercise work-outs and to the low impact of the basic steps of Caribbean dances.

Lastly, the psycho-social survey conducted at the end of the trial showed improvements in the healthiness of subjects' lifestyle (reduction in smoking and alcohol consumption, improved sexual activity and sleep quality) and social life, to say nothing of the keen enjoyment of the dancing itself, as numerous other studies on this specific aspect have already pointed out (7, 25-27). Kostantinidou and Haraousou (27), for example, concluded their study with the following observation: "A dance movement therapy program had significant psychosocial benefits for the older adults and can improve their perception of their life."

ACKNOWLEDGEMENTS

The authors wish to thank the anonymous referees for their helpful remarks and suggestions.

REFERENCES

- Stel VS, Pluijijm SM, Deeg DJ, Smit JH, Bouter LM, Lips P. A classification tree for predicting recurrent falling in community-dwelling older persons. *J Am Geriatr Soc* 2003; 51: 1356-64.
- Close J, Ellis M, Hooper R, Glucksman E, Jackson S, Swift C. Prevention of falls in the elderly trial (PROFET): a randomised controlled trial. *Lancet* 1999; 353: 93-7.
- Stel VS, Smit JH, Pluijijm SMF, Lips P. Balance and mobility performance as treatable risk factors for recurrent falling in older persons. *J Clin Epidemiol* 2003; 56: 659-68.
- Wong CH, Wong SF, Pang WS, Azizah MY, Dass MJ. Habitual walking and its correlation to better physical function: implications for prevention of physical disability in older persons. *J Gerontol* 2003; 58A: 555-60.
- Lips P, Pluijijm SMF, Stel VS. Physical activity and the risk of falls in older men and women: the Longitudinal Aging Study Amsterdam. *J Bone Miner Res* 2001; 16: 563-4.
- Tanaka K, Sakai T, Nakamura Y, et al. Health benefits associated with exercise habituation in older Japanese men. *Aging Clin Exp Res* 2004; 16: 53-9.
- Fersh I. Dance/Movement Therapy: A holistic approach to working with the elderly. *Am J Dance Ther* 1980; 3: 33-43.
- Irwin K. Dance as prevention of, therapy for, and recreation from the crisis of old age. New York: American Dance Therapy Association, 1972.
- Kravitz SR. Dance medicine. *Clin Podiatry* 1984; 1: 417-30.
- Alricsson M, Harms-Ringdahl K, Eriksson K, Werner S. The effect of dance training on joint mobility, muscle flexibility, speed and agility in young cross-country skiers: a prospective controlled intervention study. *Scand J Med Sci Sports* 2003; 13: 237-43.
- Alricsson M, Werner S. The effect of pre-season dance training on physical indices and back pain in elite cross-country skiers: a prospective controlled intervention study. *Br J Sports Med* 2004; 38: 148-53.
- Sihvonen S, Era P, Helenius M. Postural balance and health-related factors in middle-aged and older women with injurious falls and non-fallers. *Aging Clin Exp Res* 2004; 16: 139-46.
- Hopkins DR, Murrah B, Hoeger WWK, Rhodes RC. Effect of low-impact aerobic dance on the functional fitness of elderly women. *Gerontologist* 1990; 30: 189-92.
- Shigematsu R, Chang M, Yabushita N, et al. Dance-based aerobic exercise may improve indices of falling risk in older women. *Age Ageing* 2002; 31: 261-6.
- Dowdy DB, Cureton KJ, DuVal HP, Ouzts H. Effect of aerobic dance on physical work capacity, cardiovascular function, and body composition of middle-aged women. *Res Q Exerc Sport* 1985; 56: 227-33.
- Rockefeller KA, Burke EJ. Psychophysiological analysis of an aerobic dance program for women. *Br J Sports Med* 1979; 13: 77-80.
- De Lucia R, Martin-Dominguez E. Biomechanics of Caribbean dance: a preliminary study. *Dance Ther Sport Med* 1997; 17: 7-17.
- Bassey EJ. Age, inactivity, and some physiological responses to exercise. *J Gerontol* 1978; 24: 66-7.
- Serfass RC. Physical exercise and the elderly. In Studd GA, ed. *Encyclopedia of Physical Education Fitness and Sports: Training, environment, nutrition, and fitness*. Salt Lake City: Brighton, 1980.
- Hain TC, Fuller L, Weil L, Kotsias J. Effects of Tai Chi on balance. *Arch Otolaryngol Head Neck Surg* 1999; 125: 1191-5.
- Papaioannou A, Adachi JD, Winegard K, et al. Efficacy of home-based exercise for improving quality of life among elderly women with symptomatic osteoporosis-related vertebral fractures. *Osteoporos Int* 2003; 14: 677-82.
- Franchignoni F, Tesio L, Martino MT, Ricupero C. Reliability of four simple, quantitative tests of balance and mobility in healthy elderly females. *Aging Clin Exp Res* 1998; 10: 26-31.
- Isles RC, Choy NL, Steer M, Nitz JC. Normal values of balance tests in women aged 20-80. *J Am Geriatr Soc* 2004; 52: 1367-72.
- Piva SR, Fitzgerald GK, Irrgang JJ, Bouzubar F, Starz TW. Get up and go test in patients with knee osteoarthritis. *Arch Phys Med Rehabil* 2004; 85: 284-9.
- Caplow L, Harpaz L, Samberg S. *Therapeutic dance movement: expressive activities for older adults*. New York: Human Science Press, 1978.
- Sandel SL. Movement therapy with geriatric patients in a convalescent home. *Hosp Comm Psych* 1978; 27: 738-41.
- Konstantinidou M, Harahousou Y. Dance movement therapy effects on life satisfaction of elderly people. Available at: <http://www.ocio.deusto.es/formacion/ocio21/pdf/P09074.pdf>. Accessed December 18, 2004.