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Effect of different types of exercise on postural balance in elderly women: A randomized controlled trial

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ABSTRACT

Different types of exercise are indicated for the elderly to prevent functional capacity limitations due to aging and reduce the risk of falls. This study aimed to evaluate the effect of three different exercises (mini-trampoline, MT; aquatic gymnastics, AG and general floor gymnastics, GG) on postural balance in elderly women. Seventy-four physically independent elderly women, mean age 69 ± 4 years, were randomly assigned to three intervention groups: (1) MT (n = 23), (2) AG (n = 28), and (3) GG (n = 23). Each group performed physical training, including cardiorespiratory, muscular strength and endurance, flexibility and sensory-motor exercises for 12 weeks. To determine the effects on each intervention group, five postural balance tasks were performed on a force platform (BIOMEC 400): the two-legged stand with eyes open (TLEO) and two-legged stand with eyes closed (TLEC); the semi-tandem stand with eyes open (STEO) and semi-tandem stand with eyes closed (STEC) and the one-legged stand. Three trials were performed for each task (with 30 s of rest between them) and the mean was used to compute balance parameters such as center of pressure (COP) sway movements. All modalities investigated such as the MT, AG and GG were significantly ($P < 0.05$) efficient in improving the postural balance of elderly women after 12 weeks of training. These results provide further evidence concerning exercise and balance for promoting health in elderly women.

1. Introduction

Aging is a natural phenomenon that touches all people during their life. This phenomenon is characterized by biological changes such as muscle mass and strength reduction, loss of mobility and balance and motor coordination impairment (Granacher, Muehlbauer, Gollhofer, Kressig, & Zahner, 2011). All these changes contribute to an increased risk of falls among the elderly (Horak, 2006). In fact, poor postural balance can be a predictor of fall occurrences in elderly subjects (Lord, Sherrington, & Menz, 2001). With increased age, the mechanisms of postural control become impaired from these changes and also due to disuse syndrome (physical inactivity) that can directly affect the neuromuscular system in maintaining balance.

An efficient strategy to improve postural balance and reduce the biological changes of aging and/or physical inactivity is to practice regular physical exercise (ACSM, 2009). Evidence supports the beneficial effects of physical exercise for improving postural balance and reducing the risk of falls in elderly people (Alfieri et al., 2012; Avelar, Bastone, Alcântara, & Gomes, 2010; Mian et. al., 2007; Resende et al., 2008).

Seco et al. (2013), who evaluated 227 elderly subjects, reported a significant improvement of balance in force platform measurements after 36 weeks (3× per week) of an exercise program related just to general gymnastics. Other studies (Aragão, Karamanidis, Vaz, & Arampatzis, 2011; Avelar et al., 2010), which used sensorimotor exercises and AG, also found similar positive results in balance on force platform measurements, even with a lower duration and frequency of training (2× per week for 14 weeks and 2× per week for 6 weeks, respectively).

On the other hand, some results in the literature were obtained using only indirect measures of balance, such as balance scales and

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functional tests (Jehu, 2012). With regard to balance conditions, Aragão et al. (2011) employed a two-legged stand task in their study, while Alfieri et al., (2012) used a one-legged stand, which would better challenge the balance. Jehu (2012) performed functional tests and did not report any improvement in balance after the intervention (at 12 weeks). Although the results from these studies are relevant, it would also be interesting to apply the tests with a main balance parameter related to the COP, which is a reliable and valid measurement, and further in other balance tasks including: the two-legged stand; the semi-tandem stand with eyes both open and closed, and finally in a one-legged stand, which is a last predictive task for falls. Also, it would be relevant to determine whether a specific type of intervention, such as a MT or aquatic exercise, which apparently promotes more sensory-motor stimulus from the specific properties of their action, can promote better results in balance than exercises such as GG. Some studies (Alfieri et al., 2012; Avelar et al., 2010) have not compared more than two types of exercises within the same experimental design and also never compared the MT with other modes of exercise, which in turn limits the conclusions and consequently warrant a new investigation on health promotion for the elderly.

Finally, it would be interesting to investigate the effect of these exercises in women, since the female sex is more susceptible to neurophysiological changes with aging and to chronic degenerative diseases such as osteoporosis, which in turn may impair the postural balance and increase the risks of falls (Burke et al., 2010). Women represent also a greater percentage of the population in the world and show greater adherence to exercise programs compared to men (Burke et al., 2010; Rydwik et al., 2013).

The main purpose of this study was to determine the effect of three different types of exercise (MT, AG and GG) on five postural balance tasks from force platform measurements in elderly women.

2. Materials and methods

2.1. Design and subjects

This study was a controlled and randomized clinical trial registered with the ReBEC: Brazilian Registration of Clinical Trials – http://www.ensaiosclinicos.gov.br: Rio de Janeiro (RJ): Institute of Communication and Scientific and Technological Information in Health (Brazil); 2010 – Identifier RBR-7ptrb5; and conducted from April to September 2012.

The inclusion criteria were: women over 60 years old, physically independent in accordance with Spirduso (1995), a good mental state using the mini-mental questionnaire (score >18, Hughes, Duncan, Rose, Chandler, & Studenski, 1996), not performing physical activity for ≥ 2 months, absence of any mental or physical illness that could interfere in assessment tests; surgeries in the locomotor system, severe orthopedic, neurological or respiratory dysfunction, visual and/or vestibular changes. The exclusion criterion was the inability to perform the tests proposed.

From all criteria, 96 elderly women residents of the community were included in the present study. All participants were recruited by advertisement, such as in newspapers, flyers and personal connections. However, the final sample of the study included only 74 elderly, as better detailed in Fig. 1. All participants were informed about the study and agreed to participate voluntarily and signed an informed consent. The research project was approved by the local Ethics Committee (CEP/UEL:036/2012).

The sample size of the present study was defined by calculation of the mean and standard deviation of the results reported by Pluchino, Lee, Asfour, Roos, and Signorile (2012). The significance level was 0.05 with the power of the sample estimated at 80%. The estimated sample size, using the mean baseline value of the COP balance parameter from the trained group (0.39 ± 0.23 cm) compared to control (0.61 ± 0.34 cm), was 19 individuals in each intervention group. However, 23 participants were recruited to compensate for losses. The principle of intention to treat was used with possible dropouts, and the missing data were included with the mean of the remaining data. This strategy does not change the mean of the sample and prevent statistical power.

First, all participants answered a structured interview on personal information and health condition. The questionnaires on mental state (mini-mental) and fear of falling (falls) were also applied, as well as collecting anthropometric measurements. Afterward, the participants were allocated randomly to three groups by a numerical sequence with a sealed paper placed in a box and carried out by an investigator who was not involved with the intervention. On the first day of the assessment, the paper allocated to each participant was opened by the investigator (professionally trained in physical education) who provided the intervention. All physical education professionals engaged in the study (with the assistance of physical education students) and responsible for each intervention were not involved in balance data

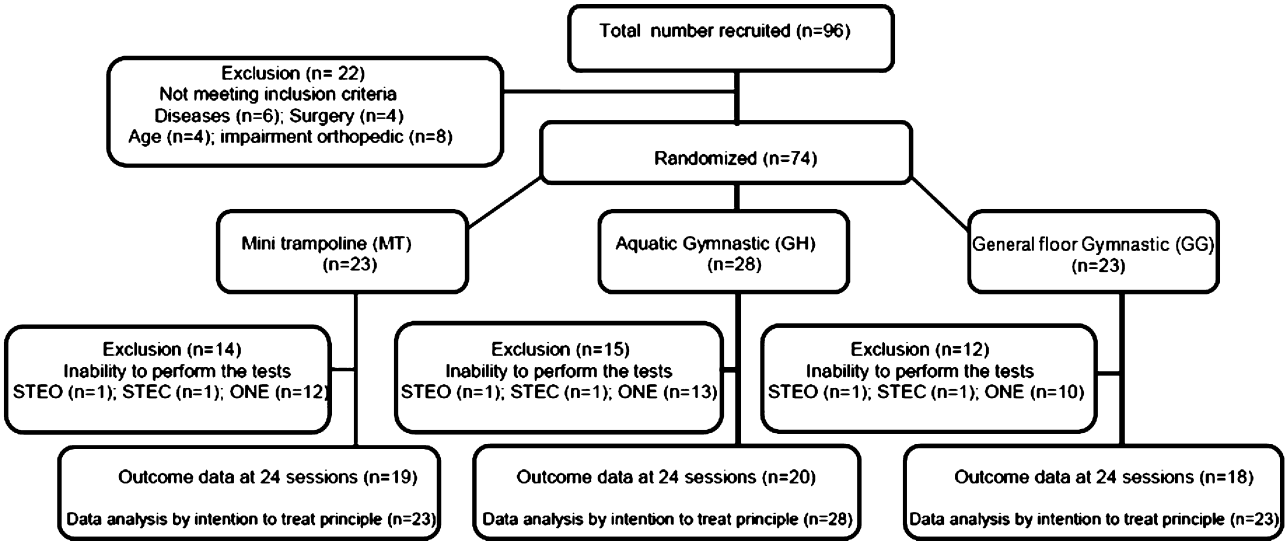

Fig. 1. Design and flow of participants in the study. Three groups were allocated randomly: mini trampoline (MT), aquatic gymnastic (GH), and general floor gymnastic (GG). Balance task condition related to STEO: semi-tandem with eyes open; STEC: semi-tandem with eyes closed; ONE: one-legged stand.