



Contents lists available at ScienceDirect

Geriatric Nursing

journal homepage: www.gnjournal.com

Feature Article

Effectiveness of a balance-focused exercise program for enhancing functional fitness of older adults at risk of falling: A randomised controlled trial

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ARTICLE INFO

Article history:

Received 9 December 2016

Received in revised form

8 February 2017

Accepted 11 February 2017

Available online xxx

Keywords:

Functional fitness

Balance

Falls

Older adult

ABSTRACT

This study examined the effectiveness of a balance-focused training program (i.e., Exercise for Balance Improvement Program, ExBP) in improving functional fitness of older nonfallers at risk of falling. Sixty-one participants were randomly assigned to receive 16 weeks of ExBP or Tai Chi (TC) training, or no treatment (CON) with an 8-week follow-up. The Senior Fitness Test battery was applied to assess functional fitness. After the intervention, results revealed significant improvements in all fitness components in the ExBP group. Compared with the CON group, the ExBP group demonstrated more improvements in lower extremity muscle strength, agility and balance, and aerobic endurance. The ExBP group also displayed more improvements in aerobic endurance than the TC group in posttest and follow-up test. Therefore, the balance-focused exercise can be applied as an effective way in improving overall functional fitness among older nonfallers who are at risk of falling.

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Introduction

A longstanding consensus suggests that physical function declines with advancing age, particularly in older adults.¹ Falling as a result of declines in physical fitness, particularly in muscular strength and power, has been recognised as a major cause of accidental death and personal injury among older populations.² Early detection of falling risk factors plus appropriate fall prevention is considered an effective method for avoiding fall-related adverse experiences such as fracture, fear of falling, or depression.³ Because of the inconspicuous falling risk factors for people who have not experienced a fall, most fall prevention studies have focused on one-time fallers or recurrent fallers, instead of those without a history of falls.⁴ However, the absence of a history of falls does not preclude the possibility of being at risk of falling.^{5,6}

Functional fitness in older adults is defined as the physical capacity to perform normal everyday activities safely and independently

without undue fatigue.⁷ Functional fitness comprises the basic physical capacities required for maintaining an active and independent lifestyle—flexibility, muscle strength, agility and balance, and aerobic endurance.⁷ Previous studies have demonstrated close and negative associations between functional fitness and falling risks among older adults.⁸ Older adults with one or multiple falling experience(s) have reported significantly reduced muscle strength and balance, compared with age-matched nonfallers.⁹ However, for those without a history of falls but who are at risk of falling, lower functional fitness capacities were also evident, specifically in agility and balance as well as aerobic endurance.¹⁰ Therefore, appropriate interventions for maintaining and enhancing physical function prior to a fall could also contribute to reducing falling risks and preventing falls among older adults.

The value of exercise in preventing falls and maintaining functional fitness has been well documented.^{11–13} However, no comprehensive exercise program exists. Specific exercise program for the target group is very much needed. The exercise for balance improvement program (ExBP) is newly developed exercise aimed to improve balance and prevent falls for older nonfallers at risk of falling.¹⁴ A feasibility test determined that the ExBP is an appealing and feasible exercise that is suitable for older adults to perform in their daily lives.¹⁴ An evaluation of the effectiveness of the ExBP revealed that the program can significantly improve dynamic balance and static balance with compromised sensation by using equipment-based laboratory tests.¹⁵

The authors thank all the older adults involved in the study and the student helpers involved in data collection. Special thanks goes to the staff of ELCHK, Shatin Community Centre for the Golden-Aged.

Conflicts of interest: none.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Considering the close associations between balance and other fitness components, a balance-focused exercise program could be beneficial to improve other fitness components, and thus can improve the overall functional fitness. Previous studies were mainly conducted by using general exercise (e.g., Tai Chi, TC), and there are inconsistent results regarding to balance improvement.¹⁶ Therefore, whether a balance-focused exercise can be effective and how much the extent is in other fitness components' improvement warrants further exploration. This study aimed to examine the effectiveness of a 16-week balance-focused exercise intervention on functional fitness among older nonfallers at risk of falling. The results of this study can provide a comprehensive understanding of the value of the ExBP and generate critical insight into functional fitness maintenance among older nonfallers at risk of falling.

Materials and methods

Trial design

This was a single-blind randomised controlled trial with three parallel groups: an intervention group, engaging in ExBP (ExBP group); an active control group, engaging in TC (TC group); and a no-treatment control group (CON group). Participants were randomly assigned to one of the three groups through a drawing of lots at a ratio of 1:1:1 without any stratification. Priority was given to guarantee equal participant numbers between the ExBP and TC groups contingent upon insufficient participants. Two student helpers, with no involvement in other procedures of the study, performed participant allocation. Neither the testers nor the data analyst knew participant names and their assignments. This study received approval from the Committee on the Use of Human and Animal Subjects in Teaching and Research of the University. All participants signed a written consent form before participating in the study. Finally, this study was conducted according to the principles as indicated in the Declaration of Helsinki.

Study sample

This study recruited a group of independent older adults, aged 65–74 years, from a local community senior centre (with more than 2000 members) through advertisements and flyers. Eligible participants were those who had not experienced a fall within the prior 12 months but who were at risk of falling. A fall is defined as the sudden, unintentional change of position that causes people to land on the ground, floor, or any other object.² The risk of falling was assessed using a fall risk test (FRT; Biodex Balance System^{SD}, Medical Systems, New York, USA). Participants were identified to be at risk of falling if they performed outside of the age-dependent normal stability scores. Moreover, the eligible participants should have no experience in balance-related physical training (including TC) in the prior year. Those who had taken more than three types of medicine daily and those with cognitive or physical diseases that may prohibit them from exercising were excluded from the study. The entire study, which involved recruitment, intervention, and data collection, was conducted at a local senior centre from December 2013 to August 2014.

Interventions

Participants in the ExBP group participated in 16 weeks of ExBP training. The ExBP focuses on the training of the following eight aspects: 1) control of centre of mass; 2) muscle strength and power in the lower limbs (particularly for ankle dorsiflexion and knee extension); 3) range of motion (particularly in the ankle joint); 4) plantar tactile sensitivity and joint proprioception around the knee

and ankle; 5) gait pattern, agility, and response time; 6) balance control with compromised sensation; 7) distribution of attention; and 8) confidence in performing balance-requiring tasks. The detailed contents of the ExBP were introduced previously.¹⁴

Participants in the TC group participated in a 10-form Yang-style TC program. The therapeutic elements of this TC program such as continuous and slow movement, different degrees of motion, progressive knees flexion, straight and extended head and trunk positioning, whole body rotations, symmetrical and diagonal extremities, and constant shifting of body mass between right and left legs were found to improve balance and thus make the 10-form Yang-style TC program to be a suitable exercise mode for the active control group.¹⁷

Participants in the CON group received no treatment. Except that the ExBP and TC practice, all participants were asked to maintain their usual lifestyles. If any changes in their daily living habits were reported (e.g., physical activity, sleeping quality, diet, and medicine), participants were instructed to take a daily record and report to a student helper with no involvement in other research procedures weekly.

Two physical trainers for seniors with qualified certificate run the two intervention programs separately. Both the two interventions were all conducted in a set of 90-min training sessions, with 3 sessions per week, for 16 weeks, in addition to an 8-week follow-up. Each training session consisted of a 15-min warm up, 25-min practise, 10-min break, another 25-min practise, and a 15-min cool down. Exercise intensity was monitored using the Cantonese-translated version of the Borg 6–20 Rating of Perceived Exertion (RPE) scale.¹⁸ The average value of exercise intensity through the 16-week training ranged from RPE 11 (light) to RPE 13 (somewhat hard). The training venue was located in community, which is quite near from participants' living place. The average attendance rate for the participants was 92.1% for the ExBP group and 88.5% for the TC group.

Instruments

The Fall Risk Test (FRT) is a commercially available, equipment-based measurement that is widely used for assessing the status of falling risk.¹⁹ The FRT measures the postural control abilities of participants standing on a movable platform and is thus considered a dynamic balance test.²⁰ In this study, the participants were asked to stand barefoot on the platform, with their hands by their sides, eyes open, and looking straight ahead. Three trials with two practise trials were performed with a 10-s rest period. This test produced fall risk scores, which can be compared with age-dependent normative data (1.79–3.35 for participants aged 54–71 years; 1.90–3.50 for those aged 72–89 years) to identify potential fall candidates. Previous studies have demonstrated the effectiveness of the FRT in distinguishing balance abilities and have determined that it exhibits moderate-to-high test–retest reliability (intraclass correlation coefficient = .80).^{19,21}

The Senior Fitness Test (SFT) battery is widely used to measure the functional fitness of older adults in the areas of ageing and physical activity.^{22,23} It was first developed and validated by Rikli and Jones for the early identification of older people at risk of losing functionality.⁷ The rationales behind the SFT as well as the validity and reliability of its testing items are thoroughly described in the SFT Manual.²² Under the consideration of testing duration and venue, the following tests were selected for this study, the 30-s chair stand (CS) test and 30-s arm curl (AC) test for lower and upper extremity muscle strength, respectively; the 2 min step (Step) test for aerobic endurance; the chair sit-and-reach (SR) test and the back scratch (BS) test for lower and upper body flexibility, separately; and the 8 ft up-and-go (UG) test for agility and dynamic balance.

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