Gait & Posture 52 (2017) 147–152

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Full length article

Home-based interventions improve trained, but not novel, dual-task balance performance in older adults: A randomized controlled trial

Suleeporn Wongcharoen[a], Somporn Sungkarat[a], Peeraya Munkhetvit[b], Vipul Lugade[c], Patima Silsupadol[a,*]

[a] Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai, Thailand
[b] Department of Occupational Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai, Thailand
[c] Whitaker International Program, New York, USA

ARTICLE INFO

Article history:
Received 7 March 2016
Received in revised form 8 September 2016
Accepted 21 November 2016

Keywords:
Aging
Gait
Cognition
Dual task
Home-based training

ABSTRACT

The purpose of this study was to compare the efficacy of four different home-based interventions on dual-task balance performance and to determine the generalizability of the four trainings to untrained tasks. Sixty older adults, aged 65 and older, were randomly assigned to one of four home-based interventions: single-task motor training, single-task cognitive training, dual-task motor-cognitive training, and dual-task cognitive–cognitive training. Participants received 60-min individualized training sessions, 3 times a week for 4 weeks. Prior to and following the training program, participants were asked to walk under two single-task conditions (i.e. narrow walking and obstacle crossing) and two dual-task conditions (i.e. a trained narrow walking while performing verbal fluency task and an untrained obstacle crossing while counting backward by 3 s task). A nine-camera motion capture system was used to collect the trajectories of 32 reflective markers placed on bony landmarks of participants. Three-dimensional kinematics of the whole body center of mass and base of support were computed. Results from the extrapolated center of mass displacement indicated that motor-cognitive training was more effective than the single-task motor training to improve dual-task balance performance ($p = 0.04$, $ES = 0.11$). Interestingly, balance performance under both single-task and dual-task conditions can also be improved through a non-motor, single-task cognitive training program ($p = 0.01$, $ES = 0.13$, and $p = 0.01$, $ES = 0.11$, respectively). However, improved dual-task processing skills during training were not transferred to the novel dual task ($p = 0.15$, $ES = 0.09$). This is the first study demonstrating that home-based dual-task training can be effectively implemented to improve balance performance during gait in older adults.

1. Introduction

A number of studies have attempted to determine the most effective intervention to improve dual-task balance performance in older adults [1–3], as an impaired ability to maintain balance while simultaneously performing cognitive tasks is associated with increased risk of falling [4,5]. To date, it is evident that dual-task training is more effective in improving dual-task balance and gait performance than single-task training [1,2,6]. Van het Reve and de Bruin [6] reported improvement in dual-task gait following dual-task motor-cognitive training, not single-task motor training, in healthy older adults. Silsupadol et al. [1,2] investigated the efficacy of three different training programs in older adults with balance impairment: single-task motor training, dual-task motor-cognitive training with fixed-priority instructions (equal-task emphasis), and dual-task motor-cognitive training with variable-priority instructions (alternating-task emphasis). It was found that only older adults in the dual-task training groups significantly improved their dual-task balance and gait performance, with the variable-priority group demonstrating greater improvements than the fixed-priority group. However, the implementation of these interventions into the community or home-based environment remains a challenge.

Most dual-task training studies have been conducted in a laboratory, or a controlled research setting, often with supervision by therapists or research assistants, though home-based training

* Corresponding author at: Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, 110 Intawaroroj Rd Sripoom, Chiang Mai 50200, Thailand.
E-mail address: psilsupa@gmail.com (P. Silsupadol).

http://dx.doi.org/10.1016/j.gaitpost.2016.11.036
0966-6362/

programs have been shown to be effective [7], feasible [8], and more desirable [9]. Older adults who received single-task home-based speed-of-processing training improved their processing speed equivalently to those who received laboratory-based training [8]. Furthermore, a single-task home-based strength and balance program was effective in improving strength and balance under single-task conditions in older adults [7]. To our knowledge, however, there are no studies that have examined the efficacy of dual-task home-based training on balance and gait.

Another important impediment to the intervention implementation is that transfer of dual-task training effects to novel dual-task conditions is not apparent. This lack of transfer might be due to the high specificity of the tasks chosen for the training [2]. Li et al. [10] found that a non-specific cognitive–cognitive task (i.e. two visual-discrimination tasks) improved standing balance performance in healthy older adults. However, changes in dual-task gait performance have not been clearly demonstrated.

Therefore, this study aimed to address these gaps in the literature by conducting a home-based program designed to improve dual-task performance with a broader transfer-of training effects in older adults. The purpose of this study was twofold: 1) to examine the effect of home-based interventions (i.e. single-task motor training, single-task cognitive training, dual-task motor-cognitive training, and dual-task cognitive–cognitive training) on dual-task performance in older adults. We hypothesized that home-based dual-task training would be feasible and effective in improving dual-task balance performance. Based on previous laboratory-based training studies [1,2,6], we postulated that the home-based dual-task training programs would be more effective than the home-based single-task training programs, with the dual-task motor-cognitive training demonstrating the greatest effectiveness; 2) to determine the generalizability of the four trainings to novel tasks. As broader non-specific task contexts generalize to novel dual-task conditions [10,11], we hypothesized that the dual-task cognitive–cognitive training would demonstrate the greatest generalizability to novel dual tasks.

2. Methods

2.1. Participants

Sixty community-dwelling adults aged 65 years old or older were recruited through flyers posted in the university and the surrounding communities, including the hospital, temples, and community centers. Inclusion criteria included the ability to walk at least 10 m without any assistive device, normal cognitive function based on the Mini-Mental State Examination-Thai [12], and willingness to exercise unsupervised at home. Participants were excluded if they had any significant diseases that impact gait, such as Parkinson's disease, severe osteoarthritis, or depression (based on the Geriatric Depression Scale) [13]. The study was approved by the University's research ethics committee (Number 557/2014). Written informed consent was obtained from all participants prior to enrollment in the study.

2.2. Randomization

Eligible participants were randomly assigned to one of four training groups according to a computer-generated list, with stratification by education level, using a permuted-block randomization design. The four training groups included: 1) single-task motor training (SM); 2) single-task cognitive training (SC); 3) dual-task motor-cognitive training (MC); and 4) dual-task cognitive–cognitive training (CC). The allocation sequence was carried out by a person external to the study, and concealed in opaque, sealed envelopes.

2.3. Intervention

Based on previous studies demonstrating balance and cognitive improvement following 5–25 h of training [1,2,10], older adults in this study participated in a 12-session (4 supervised and 8 unsupervised) training program, with 60 min per session, three times a week for four weeks in their homes. Each participant was visited weekly by the physical therapist to individually prescribe exercises, increase difficulty, as well as ensure safety and compliance [14]. Participants also received a booklet with instructions for each exercise prescribed. The booklet described exercises with detailed photographs, environmental requirements, and prioritization instructions for the dual-task training groups. Additionally, participants used the booklet to keep a record of their training and log any adverse events during the four weeks.

Across 12 sessions, the participants in the SM group received only balance training following Gentile's taxonomy of movement tasks, which progressed from stance activities, to stance activities plus hand manipulation, then gait activities, and finally gait activities plus hand manipulation [15]. Examples of balance activities included standing with a narrow base of support, semi-tandem stance with arm alternation, walking with a reduced base of support (narrow walking), and gait activities with arm alternation.

The participants in the SC group completed a variety of cognitive tasks over 12 sessions of training. The cognitive tasks predominantly focused on cognitive domains that were relevant to gait, such as visuospatial skills, executive function (e.g. planning and problem solving), attention, and working memory. Examples of cognitive training included calculation, verbal fluency, and the Stroop color-word task.

The participants assigned to the MC group received the same exercises as the SM group while simultaneously performing cognitive tasks as those in the SC group. During each session, participants were randomly instructed to vary focus on balance tasks, cognitive tasks, or equally emphasize both tasks. In order to confirm that participants were able to shift attention between balance and cognitive tasks, both balance and cognitive performance were recorded during the home visits. For example, during the narrow walking while performing verbal fluency task, the numbers of missteps and correct responses were recorded across the three prioritizations.

Lastly, the participants in the CC group received the same set of tasks as the SC group while practicing two of the cognitive tasks simultaneously. During each session, participants were randomly instructed to vary focus on one or the other cognitive task, or equally emphasize both tasks. The performances of both cognitive tasks were recorded during the home visits.

2.4. Procedures

Demographic information was collected for each participant including age, education level, sex, body mass index, physical activity level, medication use, history of falls and imbalance in the past year. Balance performance was assessed using the Berg Balance Scale and balance-related self-efficacy in daily activities was performed using the Activities-specific Balance Confidence Scale.

At baseline and after training, participants were first asked to perform the cognitive tasks while seated, including the verbal fluency task and the counting backward by 3 s task. Participants were then instructed to walk at their preferred pace for six meters under two single-task conditions (i.e. narrow walking and obstacle crossing) and two dual-task conditions (i.e. narrow walking while performing the verbal fluency task and obstacle crossing while performing the counting backward by 3 s task). The narrow