



Effects of Push and Release Training on Balance Improvement in Healthy Elderly

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Abstract

The effect of aging was seen as poor anticipatory postural adjustment and poor muscle activity in older adults. Push and release might be considered as unexpected perturbations and used by clinicians to treat people with balance impairments or have a risk of fall. The purpose of this study was to investigate the effects of push and release training on balance in the healthy elderly. Sixty healthy elderly received balance assessments using Mini- BESTest and FES-I. Participants were classified into two groups by simple random; experiment group (n = 30) and control group (n = 30). Experiment group received a push and release program by practice 90 times/set for three sets/day for six weeks. Control group received a stepping program by practice 90 times/set for three sets/day for six weeks. After that, these participants received balance assessments again. Post-training between two groups showed the difficulty of statistical significance Mini-BESTest score in experiment groups 22.8 ± 1.19 and control groups 16.5 ± 0.51 ($p \leq 0.05$). Push and release training can improve balance, postural stability and decrease fear of falling in the healthy elderly.

Keywords: *Push and release training, Anticipatory postural adjustment, Postural stability, Falls, Older persons*

1. Introduction

Regarding the World Health Organization (World Health Organization, 2007), fall is defined as the person coming to rest inadvertently on the ground or other lower level (World Health Organization, 2007), excluding intentional change in position to rest in furniture, wall or other objects (Fuller, 2000). Fall is a common health problem which affects one in every three elderly individuals over the age of 65 (Fuller, 2000; Rubenstein & Josephson, 2006). In Thailand, 35.6 percent of elderly experienced fell within six months to the survey (Assantachai, Praditsuan, Chatthanawaree, Pisalsarakij, & Thamlikitkul, 2003). Incidence of fall tends to increase with increasing age. Approximately 30 percent of community-dwelling elderly over the age of 65 years fall each year and increases to approximately 40 to 50 percent for those over the age of 80 years (O'Loughlin, Robitaille, Boivin, & Suissa, 1993). The living environment also affects fall incidence, fall in elderly can occur everywhere both outdoor and indoor such as in nursing homes (Rubenstein, 2006; Thapa, Gideon, Fought, & Ray, 1995). Approximately 50 percent of the elderly in nursing home facilities fall at least once a year (Rubenstein, 2006). In Thailand, a survey study reported that household environment such as a slippery floor and bathroom located outside of the house increase a chance to fall (Sophonratanapokin, Sawangdee, & Soonthorndhada, 2012). Fall can result in minor to major life-threatening injuries that require immediate attention or hospital admission (Akyol, 2007; Rubenstein & Josephson, 2006). Hip fracture is a common life-threatening problem that resulted from a fall that leads to hospital admission and long-term care (Salva, Bolibar, Pera, & Arias, 2004; Siegrist et al., 2016). In addition, fall can result in fear of falling and decreased physical activity that subsequently lead to impaired health-related quality of life (Scheffer, Schuurmans, van Dijk, van der Hooft, & de Rooij, 2008; Young & Williams, 2015) and the ability to live independently (Tinetti, Inouye, Gill, & Doucette, 1995).

Several factors could lead to falling. Fall risk factors can be categorized into two types; extrinsic and intrinsic factor (Phelan, Mahoney, Voit, & Stevens, 2015; Sartini et al., 2010). The most common extrinsic factors include environmental hazards such as slippery floors (Axer, Axer, Sauer, Witte, & Hagemann, 2010; Yoshida, 2007). Most intrinsic factors are an age-related degeneration of the multiple systems in the elderly (Choi et al., 2016). Important degenerative change in the elderly relating to the occurrence of falls is balance. One of the most common problems of postural control is anticipatory postural adjustments reflect a feedforward control mechanism wherein changes are seen in the background activity of muscles before an upcoming postural perturbation. Anticipatory postural adjustments are based



on previous experiences or anticipation and help in minimizing potential disturbances to balance due to an expected external perturbation or a forthcoming self-initiated movement (Kanekar & Aruin, 2014). Overall, a delay in anticipatory postural activity was seen in the elderly before the movement onset (Santos, Kanekar, & Aruin, 2010).

Prior studies of anticipatory postural adjustments in the elderly were mainly based on using self-initiated movements. Thus, it was demonstrated that anticipatory postural adjustments activity associated with self-generated body perturbations is significantly delayed in the healthy elderly, with postural muscles being recruited closer to the activation of prime mover muscles (Rogers, Kukulka, & Soderberg, 1992; Woollacott & Manchester, 1993). Valkovic, Brozová, Růžička, & Benetin (2008) report push and release test lends support towards investigating the ways of improving anticipatory postural control in people with balance impairments due to elderly or neurological disorders (Valkovic et al., 2008). This exercise helps to prevent falls. Also helps to improve the independence movement safely in daily activities for people with stroke (Mansfield et al., 2015). However, there is no report on the effect of push and release training to prevent the risk of fall in the elderly. Therefore, this study was to investigate the effects of push and release training on balance in the healthy elderly.

2. Objectives

The objectives of this study were to investigate the effects of push and release training on balance in the healthy elderly.

3. Materials and Methods

3.1. Subjects

The participants in this study were male and female healthy elderly persons with ages ranging from 60-80 years who could demonstrate the ability to walk without using walking aids device. The participant has independence in basic daily activities, able to understand and follow instructions, no history of neurological diseases such as Parkinson's disease or stroke and they had balance problem indicating by a score less than or equal 16 on the Mini-BESTest were recruited from the suburban communities in Pathum Thani, Thailand. They were excluded from this study if they (1) were on medications that affect balance (Chen, Zhu, & Zhou, 2014; van der Velde, Stricker, Pols, & van der Cammen, 2007), (2) had disorders signs or symptoms of vertigo, nystagmus, blindness or severe vision impairments that affect their ability to walk independently, (3) had uncontrolled cardiovascular conditions, neuropathy, a severe musculoskeletal problem that affects balance performance, and (4) had body mass index (BMI) of equal or more than 30 kg/m² (World Health Organization, 1998). All participants were signed informed consent forms before participated in this study. Study's protocol was approved by the ethics committee of Rangsit University (RSEC 51-2560).

The sample size, sixty healthy elderly participants (thirty participants in the experiment; push and release training and control; stepping training groups) was calculated based on the assumption (Akobeng et al., 2007) and power and α error probability was set at 0.05 and 0.95, respectively (Faul, Erdfelder, Lang, & Buchner, 2007). In order to meet the target sample size, one hundred elderly persons were screened regarding the inclusion and exclusion criteria mentioned earlier. Fourteen persons were excluded from the study because they had a score of more than 16 on the Mini-BESTest. Eighteen elderly persons were excluded from the study because of personal reasons that did not relate to health problems, e.g. vital sign not stable, chest pain at rest or dizziness. Besides, eight were excluded from the study because they persons had neurological diseases (2 persons), e.g. Parkinson's disease and stroke; severe musculoskeletal problems (4 persons), e.g. acute on chronic knee pain, lower back pain, and kyphosis and medications that affect balance (2 persons). These procedures to ensure that the elderly who volunteered to participate in this study could be the representative of the target population and results from this study could be generalized.



3.2. Treatment protocol

- The experimental group (push and release training)

The participants were instructed to maintain upright stance while standing barefoot on the floor surface with their feet shoulder-width apart and their arms hanging naturally at the sides of the body with their eyes open (Figure 1A) (Jacobs, Horak, Van Tran, & Nutt, 2006). Researcher stood behind the participants, and participants were instructed to do whatever necessary, including taking a step, to regain their balance as an involuntary movement. The researcher stood behind the participant, place one hand on each scapula and isometrically hold against the participant's backward push (Figure 1B) until heels are about to be lifted, not allowing trunk motion. Suddenly release. Do not allow any pre-leaning by the participant (Franchignoni, Horak, Godi, Nardone, & Giordano, 2010). The researcher also acted as attendants to prevent the subjects from falling if their responses were inadequate to retain balance (Jacobs et al., 2006). The 6-week exercise intervention will consist of one-on-one push and release training as a session, by which 90 times per session, three sessions per day, and three days per week.

- The control group (stepping training)

The participants were instructed to maintain upright stance while standing barefoot on the floor surface with their feet shoulder-width apart and their arms hanging naturally at the sides of the body with their eyes open (Figure 1A) (Jacobs, Horak, Van Tran, & Nutt, 2006). The researcher stood behind the participants and commanded them to step backwards and repeated as a voluntary movement (Figure 1C). The six-week exercise intervention will consist of one-on-one push and release training as a session, by which 90 times per session, three sessions per day, and three days per week.



Figure 1 Performing the Push and Release training, experimental (A-B) and control (C)

3.3. Outcome Measures

The Mini Balance Evaluation Systems Test (Mini-BESTest) is a 14-item balance scale that measures dynamic balance specifically anticipatory postural adjustment, postural responses, sensory orientation while standing on a foam surface and inclined base of support, and dynamic stability during gait (Franchignoni, Horak, Godi, Nardone, & Giordano, 2010). Each task is rated on a 2-point ordinal scale from 0 to 2; a score of 0 indicates that a person is unable to perform the task, while 2 indicating a normal performance. The maximum score for this scale is 28. A score of less than 16 (out of 28), the Mini-BESTest



demonstrated a posttest accuracy of 85% with a sensitivity of 85% and specificity of 75% suggesting that the Mini-BESTest had the highest accuracy in identifying older adult with a history of falls (Yingyongyudha, Saengsirisuwan, Panichaporn, & Boonsinsukh, 2016).

The Falls Efficacy Scale – International (FES-I) is a self-report questionnaire, providing information on the level of concern about falls for a range of activities of daily living (ADL) (Yardley et al., 2005). The FES-I is a 16-item questionnaire are rated according to “how concerned you are about the possibility of falling”, using the following responses (score in parentheses): not at all (score 1) to very concerned (score 4). Thus, the total score ranges from 16 to 64 points. Higher values indicate less fall-related self-efficacy (and more concern about falling) (Morgan, Friscia, Whitney, Furman, & Sparto, 2013). Test-retest reliability of the FES-I has ranged from 0.79 to 0.96 in older adult populations (Yardley et al., 2005).

3.4. Procedures

Sixty healthy elderly persons were recruited based on the inclusion and exclusion in this study. Subject’s characteristics and general health status, including body weight, height, and body mass index (BMI) were gathered before starting other tests. Functional balance performance and fear of falling of subjects were determined using the Mini-BESTest (Yingyongyudha et al., 2016) and FES-I (Thiamwong, Suttichayachitapananakul, & Panyachiwin, 2011), respectively. The participants were permitted to ambulate with an assistive device if they chose to do so and were instructed to complete the questionnaires based upon how they currently were feeling.

Study participants were randomized using the randomization sampling participants into two groups (experimental group and control group). In each group will conduct a 6-weeks exercise program according to the practice guide developed by the researcher. The program consists of a push and a release training in the experimental group and stepping training in the control group. Quality and quantity of exercises will be controlled by the researcher. Pre and post-assessment of all variables for all groups will be performed before and after the 6-weeks intervention period. Duration of a single assessment amounts to 60 min per participant.

3.5. Data analysis

The demographic and clinical characteristics of the subjects were described using a descriptive statistic. Baseline characteristics between the experimental group and the control group were examined using independent t-test. The total score of Mini-BESTest and FES-I were compared between baseline and after training in each group using paired samples t-test. Independent t-tests were also performed for comparing total score Mini-BESTest and FES-I after training between the two groups (experimental group and control group). The SPSS software version 23 was used to perform statistical analysis. Statistical significance difference was set at a level of the p-value of less than 0.05.

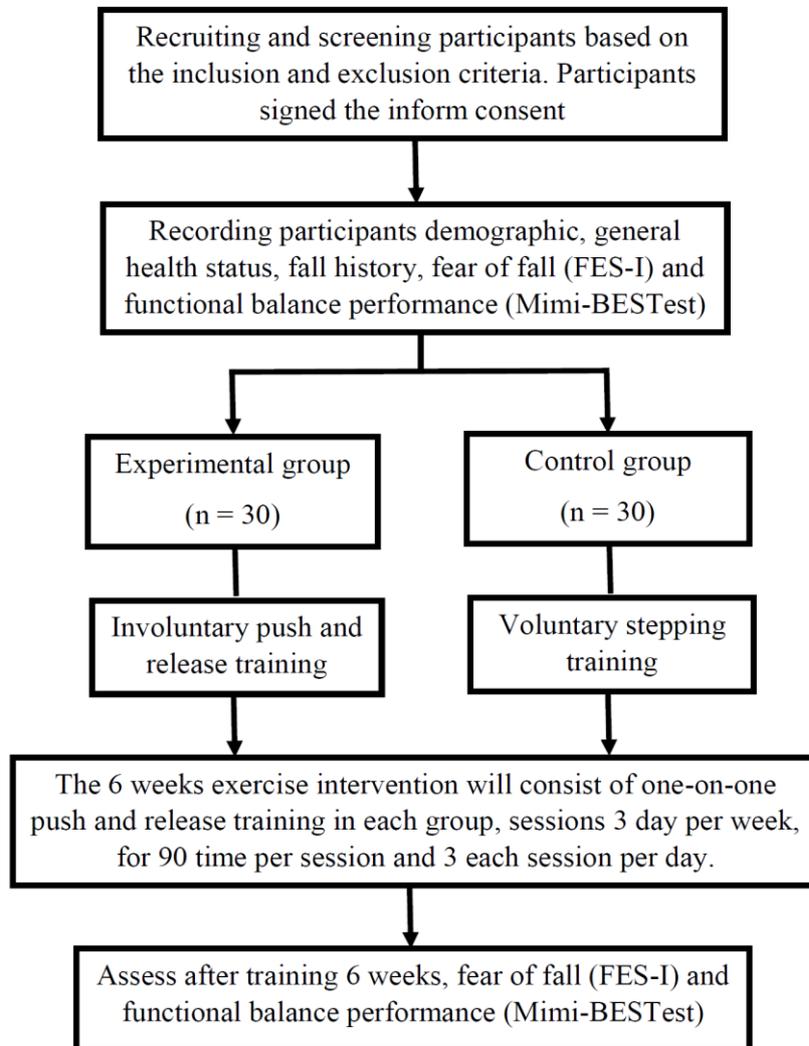


Figure 2 A flowchart of the study procedure

4. Results and Discussion

Sixty elderly participants, thirty in each experimental group and control group, have participated in this study. Demographic and characteristics of the participant were shown in Table 1. Experimental and control groups did not differ in age, weight, high, body mass index (BMI), systolic blood pressure, diastolic blood pressure and heart rate ($p > 0.05$). Twenty-seven percent of the elderly in the experimental group and forty-seven percent in the control group had fallen equal or more than once in the past six months. The most falls occurred outdoor as a result of the trip, slip and postural transition such as moving from sitting to standing or standing to sitting, sitting on a chair and stepping up or down the stairs.

**Table 1** Participants demographic and subject's characteristics

Demographic & Characteristics		Experimental group (n = 30)	Control group (n = 30)	p-value
Age (years):		67.8 ± 5.66	65.6 ± 4.9	0.499
Gender (%):	Male	43	33	-
	Female	57	67	
Fall history within six months (%):	Fall	27	47	-
	Non-fall	73	53	
Types of fall (%):	Slip	30.43	33.70	-
	Trip	47.83	49.21	
	Postural transition	21.74	17.36	
Weight (kg):		67.13 ± 10.73	62.8 ± 11.3	0.130
Height (cm):		159.30 ± 6.02	162.00 ± 8.45	0.160
BMI (kg/m ²):		26.40 ± 4.41	25.79 ± 3.81	0.074
Systolic BP (mmHg):		125.61 ± 5.11	124.77 ± 6.36	0.327
Diastolic BP (mmHg):		83.10 ± 3.98	82.74 ± 4.62	0.574
Heart Rate (bpm):		80.63 ± 9.47	79.13 ± 8.79	0.527

Values are shown in mean ± SD, kg; kilogram, cm; centimeter, BMI; Body mass index, bpm; beats per minute, and BP; blood pressure.

Table 2 shows the functional balance performance score on the Mini-BESTest and the FES-I for experimental and control groups. The score of Mini-BESTest; the experimental group was 14.8 ± 0.49 score, and the control group was 14.05 ± 0.99 score, indicating declined balance performance in the elderly. There was no difference in score of Mini-BESTest when assess on the experimental group and control group ($p > 0.05$), indicating that participants in the two groups had no difference in balance. Similar results were seen in the FES-I scores was no significant difference in the experimental group (15.9 ± 3.78 scores) and control group (17.00 ± 2.90 scores).

The score of Mini-BESTest and the FES-I compare between baseline and after training in each group (within the group). During assess by the Mini-BESTest in the experimental group, score baseline was 14.8 ± 0.49 scores had significantly less than after training was 22.8 ± 1.19 score ($p < 0.001$). Similarly, in the control group score baseline, 14.05 ± 0.99 scores had significantly less than after training was 16.5 ± 0.51 score. This finding indicates an ability to maintain balance performance in the elderly. There was a difference in the experimental group score baseline was 15.9 ± 3.78 score had significantly more than after training was 4.67 ± 1.14 score. Similarly, in control group score baseline was 17.00 ± 2.90 scores had significantly more than after training was 4.5 ± 1.10 score ($p < 0.001$) when assessed by FES-I, indicate this elderly's confidence to performed several activities of daily living (ADLs) without falling and did not fear of falling (FOF).

The mean score of after training between the experimental and control groups when assess by Mini-BESTest and FES-I. Significant differences of the mean score were found between experimental group and control group when assess by Mini-BESTest ($p < 0.0001$), while the differences between group were not found when assess by FES-I ($p = 1.000$).

**Table 2** Score of Mini-BESTest and FES-I

Assessment	Experimental group (n = 30)		Control group (n = 30)		p-value (within group)	p-value (between group)
	baseline	after training	baseline	after training		
Mini-BESTest	14.8 ± 0.49	22.8 ± 1.19	14.05 ± 0.99	16.5 ± 0.51	0.001*	0.0001**
FES-I	15.9 ± 3.78	4.67 ± 1.14	17.00 ± 2.90	4.5 ± 1.10	0.001*	1.0000

Values are shown in mean ± SD, Mini-BESTest; Mini Balance Evaluation Systems Test and FES-I; Falls Efficacy Scale – International, * Significant difference between baseline and after training in each group (within the group) at $p < 0.001$, ** Significant difference between experimental group and control group after training at $p < 0.0001$.

Discussion

This study aimed to investigate the effects of push and release training on balance in the healthy elderly. The results of the study found that twenty-seven percent of the elderly in the experimental group and forty-seven percent in the control group had fallen equal or more than once in the past six months. The characteristics of the control group have the participant with a history of falls found greater than the experimental group. Although fall history was a risk factor for falls, but the scores of the Mini-BESTest in the baseline of experimental and control groups were not significantly different. Thus, maybe shows that fall history may not be a factor affecting the performant among the elderly participant.

In this study using the Mini - BESTest and the FES-I to assess balance performance and risk of falls and the fear of falls in the elderly. There are significant differences in a push and a release training, statistics ($p < 0.001$) relate to balance in the elderly in the experimental group and control group. The results of both training groups before and after training can increase balance ability that showed the Mini-BESTest scores significantly increased, and the fear of falls also decreases. Further, the FES-I score is a psychological effect that the trainer will have confidence in daily life but not the performance for control balance in daily.

In the present study, the difference between the mean score of after training between the experimental and control groups when assess by Mini-BESTest ($p < 0.0001$). Consistent with previous studies by Valkovic et al., (2008) which reported that the push and release test lends support towards investigating the ways of improving anticipatory postural control in people with balance impairments due to elderly or neurological disorders (Valkovic et al., 2008). In the previous study, this dynamic balance and stepping versus tai chi training can improve balance control in the elderly, ranging from 5 % to 10 % for the stepping tests (maximum step length and rapid step test) and 9 % for TUG related. In this study, the push and release training improve balance performance (Denkinger, Lukas, Nikolaus, & Hauer 2015) due to an increase in ankle strategy, knee strategy, hip strategy, balance control, and prevent the risk of falling (Denkinger et al., 2015).

Pull test has mechanisms to help increase the balance strategy, which consists of an ankle strategy knee strategy and hip strategy. Some risks can fall easily due to physiological factors. Changes in whether the orthopedic system, the skeletal and nervous system framework or in the heart, lung and blood vessel systems, which in the elderly, the mechanism of balance control functions of the systems in various organs will decrease the balance in balance and impaired as the age increases. The sensory receptors will decrease with age. Including disorders of the function of Westin Bull in the inner ear due to the degeneration of these organs, balance or posture are important factors. In doing various activities, daily life is walking or standing. If you lose your ability to maintain balance while standing, walking, or changing posture, then there is a high risk of falls. Therefore, the pull test helps to increase balance strategy, reduce the risk of falls in the elderly. Mansfield et al., 2015. This exercise helps to prevent falls. Also helps to improve the independence movement safely in daily activities for people with stroke (Mansfield et al., 2015). Push and release have been developed form pull test assists in identifying the person with balance impairment (Valkovic et al., 2008).



This study, however, had some limitations. As only the healthy and active elderly persons were recruited to participate in this study; therefore, results from this study can be applied to the same characteristics of elderly participants.

5. Conclusion

The results of two groups before and after training can increase balance ability that showed the Mini-BESTest scores significantly increased, and the fear of falls also decreases. The FES-I score is a psychological effect that the trainer will have confidence in daily life but not the performance for control balance in daily. Therefore, the results of FES-I are not different between each other. Consequently, push and release involuntary training can improve balance, postural stability and decrease fear of falling in the healthy elderly. Push and release training appears to be a feasible approach to reducing falls among older adults in clinical settings. Finally, the results of the current trial may help to further develop theories and models explaining balance and resistance training effects in general and particularly in older adults.

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7. References

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