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Effects of the balance training under single- and dual-task conditions along with mental imagery on balance in older adults above 65 years

Mousa Dehghan[1*], Roya Nezafat[2]

[1,2] Department of physical education, Behbahan Branch, Islamic Azad University, Behbahan, Iran

ABSTRACT

The purpose of this research to investigate the effects of Four weeks balance training under single- and dual-task conditions along with mental imagery On balance in older adults above 65 years. The statistical population consists of older persons, in nursing home of behbahan city. In this study, 48 patients with the following conditions were selected: (Normal vision, the ability to stand for at least one minute, walk independently or with a rod average distance of 10 meters And achieved scores above 24 on the test mental decline). And randomly divided into four groups, three experimental groups and one control group.The experimental groups were trained for four weeks And three sessions per week , According to plan their workouts. To assess balance in older people was used, Berg Balance test And the test of time walking and sitting, Before and after the exercise period . As well as for the analysis of statistical data was used, analysis of covariance (ANCOVA) and Tukey post hoc test (Tukey) . The findings showed that balance training, single task, dual and dual task with imagery is improving balance of older people. Also it was the best way to balance exercises for improving balance of older people using mental imagery is combined with a dual task.

Keywords: *Balance , single - task , dual-task, mental imagery, older people.*

Corresponding author: Mousa Dehghan

INTRODUCTION

Decade to decade, average life expectancy reflects the monotony increase. In fact, average life of a person who was born in 1900 is 47 years, while the person who is born now has an average life expectancy of more than 77 years. Continuous improvement in health care, reduction of illness and changes in lifestyle lead to monotonous rises in average life expectancy for men and women. As a result, there are lots of older adults in the general population. Also with increased medical interventions and improvement in lifestyle behaviors, many older adults are living and they shall live up to 80 to 90 years of age (United States Census Bureau, 2009).

Aging is part of the biological process that covers all living things, including human. Biological and social scientists have expressed different definitions of aging. From the biological point of view, aging is a biological changes over time in the life of the organism and appear over the time (Gorman, 1999). In this period of life, the person's physiological capacities and movement function reduces which may result in neuromuscular systems failure, psychological factors, environmental factors, lifestyle and other factors. One of the consequences of aging, which is associated with reduction in movement capacities, is reduction in ability to maintain balance and changes in walking pattern that increases the risk of falls in this stratum of society (Rugeli, 2010). Falls in the older adults, is a common problem that almost 30 percent of seniors experience it at least once a year. Half of all people above 65 years, who are falling, were sent to hospital and in 6 percent of older adults population serious damage occurs that in some of the cases it leads to death (Shumway-cook & Woollacatt, 2007). Most of the cases which leads to falls have several causes, but the reasons for falling are mostly divided into two categories: internal (individual) and external (environmental); some examples of internal factors include: impaired balance, neurological diseases, sensational disorders, musculoskeletal diseases, low blood pressure, spontaneous fracture and drugs. Also some external factors include inappropriate shoes, low ambient light, slippery surfaces and inappropriate furniture (Tinetti et al., 1988). The results of researches suggest that among internal factors that lead to falls, balance disorders are more prominent (Silsupadol et al., 2009).

Although in the past there was an idea that synergy of major moves such as standing and walking, are automatic and reflex (Fraizer & Mitra, 2008), but nowadays there are many empirical evidences that show the role (interference) of attention processing in all of the control of the situation patterns and motor synergies (Olivier et al., 2008, Salavati et al., 2009). This misconception stems from that, there was often controlling of the situation along with other tasks and without conscious effort, accomplished with success. Although maintaining the balance while standing to young people is looks like simple task which is easily can be done by other tasks, but doing multiple tasks in daily life, may be difficult for the older adults (Doumas et al., 2008 & Faulkner et al., 2007). Reducing the ability of older adults in doing multiple tasks, in difficult situations and precarious balance, is obvious.

Based on the evidences, part of falling in the older adults occurs during activities that require divided attention between postural control and other duties (Zilstra et al., 2001). It seems to be that needs for attention is required in performing a balance tasks in old age and it should be investigated. In order

to investigate the effect of cognitive function in balance control in older adults, dual task method that requires doing several tasks at the same time by an individual, is used. In this method, participants doing main task that needs attention, and simultaneously with doing main task, another task was given to the participants. Recent studies have shown that the ability to maintain balance while performing two or more tasks at the same time reduced and the rate of loss of balance, results in higher impairment in the older adults (Cook et al., 2001).With increasing age and the subsequent disruption of cortical areas responsible for processing sensory-motor balance control in older people, cognitive and attention requirements will be needed. Thus the need for a special move schedule that can meet the cognitive and attention needs of older people along with physical needs was felt. Considering the few studies that have been done in this regard, there is a need for further research.

According to previous points, the role of training strategies on performance of balance and cognitive tasks simultaneously is of great importance and given the fact that many activities in daily life requires a person to do several tasks at the same time and interference in the performance of any of these tasks may results in imbalance and falls in older adults so his research seeks to answer the following questions:

1- Does balance training program under single- and dual-task conditions results in improving balance in older adults?

2- Which training method effects balance in older adults more?

Research Methodology

This study used a quasi-experimental design with field study using experimental group and control group. In this research balance test was used to determine the balance in seniors. Furthermore, single and dual balance tasks along with mental imagery to improve balance in older adults were used. In this study, participants were exercise under the supervision of educator and researcher as follows:

Experimental Group 1, three days a week and 45 minutes per day performed single balance task.

Experimental Group 2, three days a week and 45 minutes per day performed double balance training task which includes balance task and cognitive task.

Experimental Group 3, three days a week and every day for 30 minutes performed double balance training task. The experimental group also performed mental imagery tasks three days a week, each day for 15 minutes. The control group did not do any exercise.

Participants

The population of this study comprised all older adults above 65 years at Behbahan city, all of which are in a nursing home.

How to select samples

In this study, from among 48 patients participants with the following conditions were selected (Normal vision, the ability to stand at least for one minute and walk a distance of 10 meters independently or with an ordinary rod, ability to follow simple commands and earn score higher than 24 on the mental decline test 12 (MMSE) and the absence of disease or medication which affects balancing) who were randomly divided into four groups including three experimental groups and one control group.

Measuring tool

Berg Balance Test (Donoghue, 2009)

Berg Balance test consists of a series of fourteen sub-tests to determine the right balance in the older adults. Each test is scored on a scale of five values. The higher score indicates a higher degree of functional independence in performing their duties and thus a higher level of balance abilities in that test. The maximum total score of the scale is 56 (Moghadam, 1389 & Davatgaran, 1384). This test has acceptable construct validity (with 0/72) for the older adults and the reliability of each part of the scale is 0/98, reliability between each section is 0/99, and the internal consistency of 0/96 (Davatgaran, 1384).

Equipment needed to perform the test is: ruler, two standard seats (one with and one without an arm resting place), stool or ladder, stopwatch or watch, 15 -foot of walk equal to 4.5 meter.

Time: 15-20 minute

Test of time for walking and sitting (TUG Bohannon, 2006)

Test of time for walking and sitting is as a rapid screening test for finding balance problems which affects daily activities in older adults. This test requires that the person get up with a command of "go" from a standard armchair (approximate height of 46 cm and elbow with height 65 cm), walk 3 meters, turn around and go back. Normal time to run the test for the older adults is less than 10 seconds (Davatgaran, 1384). Akbari, Kamrani and colleagues (1389) investigated validity and reliability of walking and sitting time test, showed that the test is acceptable in terms of construct validity (with an average of 0/68) for older adults. Also the test has appropriate time reliability (0/91).

Supplementary Protocol

Supplementary protocol was consist of standing on slim supporting surface with open and closed eyes, walk on the slim supporting surface, stand for semi-tandem (standing to attention) with open and closed eyes, walking around obstacles and on the sides and back, sitting and stand up, stand up from sitting and walking, abduction and adduction of the hip, walking and holding a book on the head, hit the ball in a standing position, throw the ball into the basket while standing, roll the ball with the feet, walk and hit the ball, side step, rolling a cane with feet, walk on the slim supporting surface with holding an object, draw letters on the floor with the right foot while standing, draw letters on the floor with the left foot while standing.

Cognitive tasks used for dual-tasks group was consist of count down, reverse spelling, telling stories, reverse counting of days of week and month. Participants attended in single-task group, performed balance training protocol in single-tasks condition, in a way that they just perform balance tasks without doing any cognitive activity along with tasks. Participants of dual-task group practice balance tasks with a cognitive task and all of the times they should kept their attention equally and simultaneously on both balance and cognitive task (constant secondary task). Finally, participants in the experimental group 3, perform balance tasks, cognitive tasks and mental imagery. Participants in training groups for four weeks, three sessions per week, each session 45 minutes were doing their exercises under the supervision of a researcher.

Statistical analysis of research data

Statistical methods used for analyzing was both descriptive and inferential analysis. The first step for descriptive analysis was used frequency, standard deviation, histograms for describing

the sample and its normal distribution according to the information gathered from participants and before any statistical inference about the effects, validity of the statistical model and normal distribution of the error using Kolmogorov-Smirnov test and homogeneity of error variances between groups were analyzed by Leven's test. The calculations were performed using SPSS software.

To determine the effect of single and dual balance training task and dual task along with mental imagery on balance, walking time in single task and walking time in dual-task and walking time in dual task along with mental imagery condition subjective analysis of covariance (ANCOVA) and Bonferroni post hoc test (Tukey) were used.

The results and findings of the study

In Table 1, mean and standard deviation of the balance pre-test and post-test scores were reported in four groups before analyzing covariance.

In Kolmogorov-Smirnov test (Table 2), with assumption of normal distribution of error scores of balance, walking time was not rejected, also in Leven's test (Table 2) p-value is more than alpha level (p>.05) so the assumption of variances between error of groups in scores of balance while walking, was not rejected.

For comparing the average of four experimental groups with each other, in two dependent groups multivariate analysis of variance tables was used to determine whether the mean score among groups or within groups differ from each other, or if they differ this difference is significant or not.

$$H_0 : \mu_{1balance} = \mu_{2balance} = \mu_{3balance} = \mu_{4balance}$$

$$\mu_{1gait} = \mu_{2gait} = \mu_{3gait} = \mu_{4gait}$$

At least one of the means are not equal = H_1

According to Table (3) the significance level of P≤.05 is less than alpha level. Wilks Lambda indicates that the null hypothesis is rejected and mean value is not equal in groups. So the mean value is different at least in one group. And according to Eta square, the effect size is 57%, now we are going to analyze mean value of groups separately using post hoc Tukey.

Results of covariance analysis (Table 3) showed that means of balance post-test score at least in two ways of training methods, individual task and dual task have significant differences, in other words the effect of training method on balance in older adults was significant (p=0/001 and F = 32) and according to Eta square it's effect size is 72%.

In Table 1, the mean value and standard deviation of balance and walking pre-test and post-test scores in single task condition in three groups have been reported before covariance analysis. According to Tukey's post hoc test in Table 4, the mean value of balance in older adults in dual-task training method compared with the mean value of their balance in single-task is significantly larger (P=0/003). As a result, dual-task training method compared to a single task is results in higher balance. Also, the mean value of balance in older adults along with mental imagery in dual-task training methods compared with the mean value of their balance in single-task is significantly larger (P=0/001). And consequently, dual-task training method along with mental imagery compared to single task is results in higher balance. Finally, the mean value of balance in older adults in dual-task training methods along with mental imagery compared to their mean value of balance in dual-task is significantly larger (P=0/011). This means that from among training methods for improving balance in older adults, the best way of training is dual-task along with mental imagery that has the greatest impact on the balance of the older adults.

Results of covariance analysis (Table 3) showed that the mean scores of pretest for time walking in at least two ways of training methods single-task, dual-task and dual-task along with mental imagery have significant different, in other words the effect of training method on walking time was significant for the older adults (p = 0/001 and F = 31) and according to Eta square, the effect size was 71%. According to Tukey test (Table 4), mean value of walking time in older adults in dual-task training methods compared with the mean value of their walking time in a single task is significantly less (p = 0/013) and as a result, dual-task training method in comparison with single-task leads to minor walking time in single-task condition. Similarly, the mean value of time for walking in older adults in dual-task training methods along with mental imagery in comparison with the mean value of their walking time in a single-task is significantly less (p = 0/001), so results in less walking time in dual-task training methods along with mental imagery in comparison with single-task. Also the mean value of walking time of older adults in dual-task training methods along with mental imagery in comparison with the mean value of their walking time in dual-task is significantly lower (p= 0/019) so the best training method to reduce the walking time in older adults is dual-task along with mental imagery, because it reduces the mean value of walking time of older adults in comparison with other forms of training methods.

Table 1. Mean and standard deviation of the balance pre-test and post-test, walking in single task and dual-task condition in three methods of training

variable	Training method	pretest		posttest	
		Mean	Std. Deviation	mean	Std. Deviation
balance	Single-task	46/08	1/73	47/92	1/09
	Dual-task	46/03	1/56	50/17	1/29
	Dual-task along with mental imagery	46/02	1/16	51/61	1/73
	Control group	46/20	1/22	45/75	0/7
Time of walking in dual-task condition	Single-task	12/15	0/58	10/54	0/37
	Dual-task	12/03	0/90	9/77	0/84
	Dual-task along with mental imagery	12/04	0/78	9/04	0/75
	Control group	11 /77	0/79	11/99	0/79

Table 2. Leven's test and Kolmogorov-Smirnov test for the validity of the analysis of covariance models

models

variable	Leven's test		Kolmogorov-Smirnov test	
	F	P	Z	P
Balance	2/08	0/054	1/30	0/064
Time for walking	1/95	0/07	0/64	0/8

Table 3. Multivariate analysis of variance and effect of exercise methods on balance and walking time.

variable	Source of changes	Degree of freedom	Mean of squares	F	P	Eta square
Wilks Lambda	Training groups	_	_	16/5	0/001	0/57
Balance	Training method	7	60/5	32	1/001	0/72
	error	88	1/83	_	_	_
Time of Walking	training method	7	17/5	31	0/001	0/71
	error	88	0/55	-	-	-

Table 4. Tukey post hoc for comparison of pairwise balance, walking time in single, dual and mental imagery task condition and imagery between three training methods

Variable	comparison between groups in posttest		mean difference	P
Balance	Single-task	dual-task	2/24	0/003
	Single-task	dual-task with imagery	3/69	0/001
	Single-task	dual-task with imagery	1/44	0/011
Time of walking	Single-task	dual-task	0/77	0/013
	Single-task	dual-task with imagery	1/50	0/001
	dual-task	dual-task with imagery	0/72	0/019

Discussion

The aim of this study is to investigate the effect of four weeks of balance program in single and dual task along with mental imagery on older adult's balance that aged above 65. The current research's results will be discussed in several parts. This section compares the results of this study with the results of other studies and then discussed and concluded. As it was mentioned in research finding, balance training results in improvement of balance and increase walking time in older adults and this means that balance trainings have a positive effect on enhancement of balance in older adults. The results of this study are consistent with Taghizadeh, (1392), Moghaddam (1389), Gasemi, Azamian Jazi and Nouri (1389), PourDehkordi, Aslankhani and Shams (1389), Kao & Maeda and Kurta (2007) researches.

For explaining the impact of balance training on increasing balance and walking time in older adults, with regard to previous researches, researcher suggest that in this period of life, a person accommodates with reduced capacity of physiological and movement function which may be the result of failure in neuromuscular systems, psychological factors, environmental factors, lifestyle and other factors. One of the consequences of aging which is associated with reducing the motor capacity is reducing the ability to maintain balance and changes in walking pattern that results in increasing the risk of falling in this stratum of society (Roglez, 2010). So the single balance training tasks with improved physiological capacity and increasing the efficiency of the neuromuscular system results in improving motor function and increase the balance in this stratum of society.

Another result of the present study is that balance trainings with cognitive trainings have a positive impact on increasing balance in older adults and increase the walking time in older adults. This finding is consistent with Silsopadol, Sou, Shamvi Cook and Vulakut (2006), Ayranmsh et al (1393) researches.

One of the important factors that cause failure of balance in older adults is cognitive factors and attention and almost all of these failures in balance operation are because of the weakness in appropriate division of attention between balance tasks with the tasks that is done with them simultaneously. Therefore, in this study the group which was training with dual task method, have the possibility that in addition to balance training exercises and walk based on training protocol, at the same time performed a cognitive task, which contributes to simultaneous involvement of balance and cognition. Thus, in this group disorders associated with cognitive problems and divided attention that is an important factor in indication of balance disorders with increasing age was trained with balance tasks and walking, whereas in the single task training group only balance activities and walking was handled. So the dual-task training improves cognitive abilities and the division of attention between tasks which is an important factor in the development of balance disorders among the older adults and makes better progress in Berg balance test and reduces walking time among older adults.

This finding is contradicted with results of Silsopadol et al. (2006, 2009) and Moghaddam (1389). The reasons for this inconsistency may be related to differences in study population and the number of participants of the research in relation to contradict researches. Participants in inconsistent researches were older adults aged above 65 which have failure in balance and their score in Berg balance test was less than 45, but participants in the presents study was older adults with age range of above 65 that their score in Berg balance test was upper that 46, on the other hand number of participants in inconsistent researches was 21, while in the present research was 48. Therefore, these two factors may cause differences in results of present study with previous inconsistent researches' results.

Another result of the present study which differentiates this study with those that carried out in the country and abroad is using dual-task along with mental imagery training. After

analyzing data it was revealed that combining balance training and mental training is the best effective training method using in the present study in improvement of older adults' balance and also increasing in walking time. In this regard researcher couldn't find any related research in line with this study to compare its results with them.

In addition to the reasons for having better outcome in mental training which was mentioned in this study, in order to have better outcome of combined trainings other reasons can be discussed in this study. Mental training has preparation effect and increase performance of physical exercises that can be done later (Jackson et al. 2001). According to studies which were done by Bohan et al. (1999) mental trainings are most effective in the early stages of learning. And with taken this into account that the present study was administered in a limited time, it seems to be that this feature in mental trainings results in improving combined training in this study. On the other hand, with regard to the use of mental trainings while older adults are tired and they become exhausted very quickly so using these trainings can have a better impact.

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