

Is Anticipatory Postural Adjustments Focused Training Effective for Fall Prevention and Quality of Life in the Elderly?

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ABSTRACT

Introduction: Two important problems of ageing include decreased Balance Confidence (BC) and consequently decreased Quality of Life (QOL). There is a relationship between BC and QOL, and that the elderly who have more fear of falling, have a significantly lower QOL.

Aim: To study the effects of anticipatory postural adjustments focused training that is a novel approach to balance rehabilitation, on Balance Confidence and Quality of Life of the elderly.

Materials and Methods: This study was an experiment with pre-test and post-test design, that was conducted in Aramesh Rehab Gym, Isfahan, Iran. The sample size included 40 elderly males with a history of falling. They were randomly allocated into Experimental Group (EG) (70.4±3.21 years) and Control Group (CG) (69.6±3.09 years). EG participated in a training program which provided different ways to catch a ball for eight

weeks, and CG did not receive any training. Before and after the intervention, all participants completed the Activities-Specific Balance Confidence (ABC) scale and the SF-36 questionnaire to evaluate BC and QOL, respectively. The Independent t-test and Mann-Whitney U test were used to analyse the data.

Results: Both the ABC scale mean score and the total mean score of QOL in the EG significantly increased compared to the CG in the post-test ($p < 0.05$). Also, in the post-test, the EG noticeably improved in every QOL survey domain compared to the CG ($p < 0.05$), except the mental health domain.

Conclusion: The findings appear to suggest that entertaining ball exercises that involve catching and throwing a ball in different conditions can improve the BC and the QOL, hence reducing the probability of falling in older people with records of a fall.

Keywords: Ball catching and throwing, Balance training, Exercise for elderly, Fear of falling, Perturbation training

INTRODUCTION

Since healthcare systems have improved provision of preventive care alongside control of contagious diseases have become more widespread. Overall life expectancy and the size of the elderly population have rapidly increased, in both developed and developing countries. Projections of population growth indicate that by 2050 the global elderly population will double. In Iran, the growth of the ageing population is also greater than the country's population growth. According to statistics presented in 2015, about 10% of the community was comprised of the elderly. It has also been projected that in 35 years, the population of the elderly may reach 33%. Consequently, it seems essential that we concentrate more on this growing segment of society [1].

Ageing is associated with functional impairment in many physical systems that intensify the risk of falling. Falling is an important public health concern since its aftermath is among the main agents of mortality for the elderly. One of the most significant consequences of falling is the fear of repeat falls, which is frequently experienced by a large number of the elderly and is the most common fear among the elderly [2]. In fact, the fear of falling is a psychological problem that reduces self-imposed functional mobility and Activities of Daily Living (ADL), which are not however due to physical challenges and motor difficulties. Reduction of functional mobility and ADL, in turn, reduces dynamic self-confidence, increases the fear of falling as well as the risk of falling in the elderly and this defective cycle continues [3]. Research suggests that there is a relationship between fear of falling and QOL and that the elderly who have more fear of falling, have a significantly lower QOL; furthermore, older people with a record of falls have a lower QOL than those who do not. Therefore, either falling or the fear of falling can cause a range of adverse health outcomes, including poor health condition, functional impairments and decreased self-esteem [4]. Because the

fear of falling is gaining importance and leaves a negative influence on physical, psychological, or social factors [5,6], many researchers have introduced various procedures to reduce this fear and to prevent falls to improve QOL among the elderly [7,8]. Within this wide range of methods, sports exercises have been of great interest to researchers, leading to the development of a variety of exercise protocols [9,10]. Accordingly, choosing the best exercise program with the most impact is an important area for research.

Human balance restoration, when confronted with a challenging situation, is accomplished by two Anticipatory Postural Adjustments (APAs) and Compensatory Postural Adjustments (CPAs) that are controlled by a central nervous system [11]. The APAs occur before a predictable perturbation or predictable motion in the predictive muscles, while the CPAs act after a perturbation, and they depend on the delay and extent of the APAs for the restoration of balance. As a result, these two mechanisms are interrelated, and the researchers have investigated that the on-time activation of the APAs will reduce the need for larger activation of the compensating muscles; therefore, the displacement of the Centre of Pressure (COP) reduces, the recovery of the balance enhance and any falling probability decreases [12]. Researchers have documented that the APAs in the elderly are impaired, delayed and ultimately led to a greater disturbance in the elderly's balance [13]. Meanwhile, in recent years, research has proved the feasibility of improving the APAs and CPAs for the elderly practising ball exercises such as catching and throwing a ball. Aruin AS et al., reported that a single training session on catching a ball reduces the delay in predicting muscle activation time and, as a result, the need for greater activation of the CPAs decreases. Eventually, the maximum displacement of the COP is reduced and the recovery of balance in the elderly happens more efficiently [14]. In addition, Aruin AS, introduced a novel approach (ball catching) to older people's balance rehabilitation [15]. Jagdhane

S et al., examined the feasibility of these physical practices for the first time in ball catch and throw exercises over four weeks on three subjects, and reported that these exercises reduced delay of muscle contraction, and that it was effective in restoring the balance of the elderly [16].

This research covers a novel approach, and there is no report to confirm the effect of these exercises on both the QOL and the BC of the elderly with the record of falling. It is assumed that eight weeks of APA-focused training (perturbation training), which is associated with fun activities and recreation can improve the ADL performance and the health condition of the elderly; thus, they can reduce the likelihood of falling for the elderly with a falling record. The originality of the present approach has come up with useful and helpful information for all people who are dealing and working with the elderly because the main concern of the study was to improve their QOL and prevent falls. This study examines whether perturbation training could decrease the probability of falling and improved the QOL in older people with a falling record.

MATERIALS AND METHODS

This study was an experiment with pre-test and post-test design, which was conducted in Aramesh Rehab Gym, Isfahan, Iran. The recruitment process was started in January 2018, and the study was completed by May 2018. The intervention included eight weeks of APA-focused training, three sessions per week and each session running for one hour.

Participants and Sample Size

The sample size included 40 elderly males whose standing balance were matched by "functional reach" test criterion and then randomly allocated into Experimental and Control Groups. The sample size was calculated by G-power software. The alpha level, beta level, and power were respectively considered to be 0.05, 0.20, and 0.80 and the required sample size was obtained 15 for each group. The fall-off rate was assumed to be 25%, and consequently, it was decided to recruit 20 persons in each group.

The inclusion criteria consisted of being male aged between 65 to 80 years, signing the informed consent form, having a history of at least one fall during the last six months, obtaining a score of 24 and more in Mini-Mental State Examination (MMSE), and suffering no medical excuse to exercise such as cardiovascular, respiratory and articular diseases. The exclusion criteria included: the will of participants to discontinue, being unable to consider order and discipline of training sessions, and absence in more than eight sessions.

This study was approved by the Ethics Committee of University of Isfahan (the approval ethical code is IR.UI.REC1396, 065). All the procedures of the study were explained to participants, and all their questions were answered before they were asked to participate in the study.

Measurement

Participants were evaluated twice (before and after the intervention). The assessment tools included: the ABC scale to measure BC and fear of falling, and the SF36 survey to measure the QOL. Tests were administered by an examiner who was blind to sampling of the study to reduce any chance of bias.

Balance Confidence

To measure the BC and the probability of falling, an ABC scale was used. Researchers have reported that the ABC scale does not suffer from the weak points of the fall efficacy scale, and includes a wider range of ADL. The ABC scale consists of a 16-item questionnaire that asks subjects to evaluate their confidence (from 0%= low to 100%=high) to perform ADLs. Each item has 100 scores, and the participants' score in this scale is the total score of all the items divided by 16. The minimum and maximum possible score in this

scale will be '0' and '100', respectively. A higher score in this scale means higher BC, less fear of falling and less chance of falling [17]. Also, the higher score in ABC is associated with higher scores in Berg Balance (BB) [18], Single Leg Stand (SLS) and Time Up and Go (TUG) tests [19]. Validity and reliability of the Persian version of this scale in Iranian society have been well reported [20].

Quality of Life

A SF-36 survey was used to measure QOL. Researchers have reported that the SF36 form is the most widely used tool in studies on QOL [21]. The survey consists of 36 items, each ranging from 0 to 100 scores. A lower score means a worse condition of the measured variable, and a higher score means a better condition of it. The survey is divided into 8 different domains of health conditions including: Functional Capacity (FC), Physical Aspects (PA), Pain (P), General Health (GH), Vitality (V), Social Aspects (SA), Emotional Aspect (EA), Mental Health (MH), and a total score of QOL. Each domain is scored from 0 to 100, and the total score of QOL is the total score of 8 domains divided by 8 [22]. The validity and reliability of the Iranian version of the survey have been reported to be high as well [23].

The Exercise Protocol

The exercise protocol included 10 minutes of warm-up, 40 minutes of the main training and 10 minutes of cool-down. Variables such as the number (low/high), distance (near/far), the direction (inside the chest/overhead), the type of catching (ground/air), the weight and type of ball (volleyball, basketball, medicine ball), sitting conditions (fixed chair, movable chair and Swiss Ball), standing conditions (large base of support/small base of support), and walking (slow/fast) were manipulated during the program to increase exercise pressure and exercise variation. The CG continued their daily routine.

STATISTICAL ANALYSIS

SPSS software (version 23.0) was used for this study. In the inferential statistics section, the Shapiro-Wilk test determined whether the distribution of data was normal. To compare the difference between two groups, before and after training, the Mann-Whitney U test was used for abnormal distribution of data and Independent t-test for normal distribution of data. The significant level for every data was $p < 0.05$.

RESULTS

Out of the 40 participants in the study that met the research criteria, 33 participants (18 in the EG and 15 in the CG) completed all the tests and measurements.

The [Table/Fig-1] demonstrates the demographic characteristics of participants in this study. According to [Table/Fig-1], there was no difference between the two groups about the demographic characteristics; therefore, the two groups are homogeneous.

Variable	EG (n=18)	CG (n=15)	t	p-value
Age (year)	70.4±3.21	69.6±3.09	0.42	0.56
Height (cm)	165.3±6.26	167±5.49	0.79	0.28
Weight (kg)	65.3±4.24	67.3±6.85	0.76	0.54
MMSE	26.9±1.55	27.1±1.53	0.35	0.45

[Table/Fig-1]: Demographic characteristics of participants (Mean±SD).
MMSE: Mini-mental state examination

The results of [Table/Fig-2] show that the mean scores of the ABC scale and the mean score of the total QOL in the EG compared to CG, were significantly increased in the post-test ($p < 0.05$).

The EG also showed an increase in the scores in all domains of the SF36 survey, except in the mental health domain, in compared to CG in the post-test ($p < 0.05$) [Table/Fig-3].

Time/variables	Before intervention		p-value	After intervention		p-value
	EG (n=18)	CG (n=15)		EG (n=18)	CG (n=15)	
ABC	65.61±5.41	61.13±6.81	0.271	80.27±4.48	64.33±7.89	0.003*
Total QOL	59.18±9.83	58.28±13.49	0.301	86.96±5.14	56.98±13.1	0.001*

[Table/Fig-2]: Comparison of ABC scale and the total score of QOL in study groups (Mean±SD).

Results of Mann Whitney U-test; ABC: Activities-specific balance confidence, QOL: Quality of life; *Indicates a significant difference at the α level 5%

Time/Variables	Before intervention		p-value	After intervention		p-value
	EG (n=18)	CG (n=16)		EG (n=18)	CG (n=16)	
Functional capacity	61/11±13/56	57/66±22/58	0.215	87.22±7.11	58±24.40	0.003*
Physical aspects	56.28±11.08	56.66±21.68	0.511	88.88±9.78	54.66±18.65	0.023*
Pain	54.58±14.58	53.66±12.45	1.002	87.50±9.81	56.50±14.96	0.001*
General health	64.44±18.14	58.66±19.31	0.126	86.11±11.31	54.66±21.33	0.009*
Vitality	63.33±15.24	56±14.54	0.752	91.11±6.07	54.66±10.93	0.041*
Social aspects	51.38±19.12	55.83±17.59	0.477	90.97±10.33	56.66±22.09	0.038*
Emotional aspect	67.11±23.74	65.6±26.04	0.363	86.11±10.63	56.26±29.09	0.017*
Mental health	59.25±21.56	62.21±21.33	0.847	77.77±19.8	64.43±23.46	0.085

[Table/Fig-3]: Comparison eight scores of QOL domains in study groups (Mean±SD).

Results of Mann Whitney U-test or Independent T-test; *Indicates a significant difference at the α level 5%

DISCUSSION

The purpose of the present study was to explore a novel approach to balance rehabilitation on the BC and QOL of the elderly who have a falling record. The results of this study indicate that the mean scores of ABC scale in EG significantly improved compared to the CG after the intervention, and the mean scores of this scale improved about 22.3% in the EG. Researchers have reported that this scale is one of the strongest predictors of falling in the elderly, and there is a correlation between the score of this scale and the probability of falling, and older adults who score below 67 have more fear of falling and are more likely to fall [24]. Therefore, since the mean scores of ABC scale in the EG changed from 65.61±5.41 to 80.27±4.84 after the exercise, it can be concluded that an eight-week of a ball catch and throw training program is probably one of the most effective exercises to improve the ADL performance and BC. Thus, it results in both reduced fear of falling and probability of falling, which would finally prevent from the irreparable consequences of falls. Sattin RW et al., used ABC scale to measure the BC and reported that a Tai Chi's training program increased BC of the elderly up to 11% [25]. Josephs S et al., showed that a twelve-week of Pilates training program scheduled as two sessions per week increased the BC of the elderly by 17% [26]. Also, Jagdhane S et al., reported that after four weeks of APA-focused training, the BC improved up to 4.6%, though this improvement was not significant [16]. One of the reasons why improvement resulted in a higher percentage compared with Jagdhane S et al., study was the higher number of subjects and the longer intervention time applied in the present study [16].

Justifications for explaining the ABC improvement score in the EG after training can be that the subjects who learned a new skill in completing an engaging and entertaining activity, to the extent that this learning increased their BC. Moreover, many participants stated that they revived memories of childhood and adolescence when catching and throwing balls. And, they were very enthusiastic about the exercises, which can explain the improvement of the ABC score.

Researchers have argued that the APAs in the elderly have been impaired compared to young people and such a disorder is more likely to occur in the elderly who have recorded a fall [13]. The researchers have also suggested that catching and throwing a ball help build and activate predictive muscles by influencing the APAs and decreases the delay in the onset of muscle contraction. As a result, they reduce the need for a larger contraction of the CPAs and the COP displacement. Therefore, the restoration of the balance maintains to be faster, and the risk of falling abates [14].

Conclusions drawn from the training which involved catching and throwing a ball positively influence the elderly's balance and BC in ADL. This is as a result of improvements in the anticipatory muscles activity and delay of the muscle contraction. That is why the mean scores of the ABC score improved in the EG.

Moreover, the findings obtained from the SF36 survey showed that the EG achieved a better score compared to CG in all domains of QOL, except for a mental health domain after the intervention. In addition, the total QOL score in the EG significantly improved. As age increases, physical performance impairment enhances and leaves a more negative effect on maintaining independence by increasing the need for help, which can make an impact on reducing the QOL of the elderly [27]. Hence, exercises that reduce physical performance impairment would improve the QOL of the elderly by increasing their self-esteem and independence in ADL and reducing the fear of falling. In line with findings of the present study, many researchers have reported improvement in the elderly's QOL measured with the SF36 survey followed by a Pilates training program [28], and water-based aerobic training program [29]. Taraldsen K et al., reported that elderly who do not perform physical activities have a lower QOL than those who do [30]. On the other hand, because of the fear of falling and their participation in sports exercises are highly associated with QOL, improving the ABC scale score, reducing the fear of falling and participating in a group of happy exercises can all justify the reasons why the QOL improved in the elderly.

LIMITATION

The study had certain limitations. It included only male elderly population. Further studies are recommended with larger sample size including both the genders and comparing the balance training group so that effects of perturbation training could also be evaluated.

To establish how long the effects are preserved, it is needed to repeat the tests every two/three months in a year.

CONCLUSION

The results of this study indicate that training such as throwing and catching a ball are important factors that will be influential in improving BC and increasing the effect of balance control in the elderly with the record of a fall as these practices are both entertaining and amusing. The findings of this study can present enough information about this field as it is itself a novel balance rehabilitation training and can be readily used to practice exercises. Thereby, the fear of falling, the likelihood of falling and the irreparable consequences of falling decreased consequently. Also, an eight-week novel APA-focused

training approach could improve the mean score of all domains of the QOL, except for the mental health of the elderly.

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