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The Effect of Otago Exercise Program Training on Balance and Fear of Falling in Elderly Individuals

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Abstract

Background: Balance is an index to determine the independence level of elderly individuals in their daily activities. This study aimed to examine the effects of Otago Exercise Program (OEP) on balance and fear of falling among elderly.

Methods: : This clinical trial with pre/posttest design was conducted on 88 individuals aged 60 years and over who had referred to Imam Reza geriatric clinic and Kholdebarin retirement center in Shiraz. The participants were selected through simple random sampling. In the pretest, the two groups were assessed via 30-second chair stand, timed up and go, and four-stage balance tests to determine their balance status. Their fear of falling was also evaluated using the Fall Efficacy Scale-International (FES-I). The OEP was administered to the intervention group over one month in form of two 1.5-hour sessions per week. However, the control group received no trainings. The exercises were performed by the participants in their houses 5-6 times a week each lasting for 40-60 minutes over eight weeks. The participants were also followed up via telephone contacts weekly to ensure the performance of the exercises. The data were analyzed using the SPSS 21.

Results: The results showed that the implementation of OEP had a significant effect on improvement of balance among the elderly participants. Furthermore, the results revealed the effectiveness of OEP in reducing the fear of falling among the participants. The mean score of fear of falling was 18.88 in the intervention group and 30.30 in the control group. However, no significant differences were found between the pretest and posttest scores in the control group.

Conclusion: The study results indicated that OEP could be effective in improving postural stability as well as dynamic and static balance and declining the fear of falling.

Trial Registration: Registration number of this study is IRCT20131117015426N7 and the date of registration is 2019.06.17.

Keywords: Elderly, Otago Exercise Program, Balance, Fear of Falling

Background: Aging is accompanied with spontaneous attritional changes in most body systems and physiological functions [1]. In Iran, individuals aged 60 years and above comprise 8.2% of the population and it has been predicted that this measure will be doubled in 25 years [2], representing elderly population explosion in the country.

Disability among elderly individuals is caused by various factors, including loss of mobility and balance. In addition, increased age is accompanied with a decline in major sensory systems involved in balance, namely visual, somatosensory, and vestibular systems. As a result, the body will not be able to identify deviations from the center of gravity and produce quick and appropriate responses to modify the standing position [3]. Changes associated with aging also have a negative impact on balance and walking ability, including reduction of strength, muscle mass, and bone density, body fat redistribution, breathing ability impairment, selective atrophy of the components of the central nervous system that control balance and walking, and decline in peripheral sensory function. Increased use of medications could negatively affect elderly individuals' balance and walking performance, as well [4]. These negative effects could lead to falling, which is one of the basic reasons for fractures among elderly individuals [5]. Nearly one-third of individuals aged over 65 years fall at least once a year, and this measure is increased in higher ages [6]. The outcome of falling in elderly individuals is either complete recovery or death. Falling is responsible for nearly 40% of trauma-related deaths in this population [7]. In addition to physical complications, falling can be accompanied with mental consequences. In this context, fear of falling has been introduced as a mental status restricting physical activities. Fear of falling among elderly people can lead to excessive care, motor limitations, and dependence on others, which can in turn result in decline in their motor functions [8]. The prevalence of fear of falling among elderly people has been reported to vary from 22% to 59% [9-11].

One of the methods used to prevent falling is performance of Otago Exercise Program (OEP), which is a home-based technique empowering elderly individuals' strength and balance to prevent falling [12]. It has been reported that this program was effective in reduction of number of falls and their associated injuries in 35% of elderly people, with the highest effects being observed in individuals aged higher than 80 years [13]. Previous studies have also revealed the impact of exercise programs on elderly individuals' balance, falling, and fear of falling. For instance, Buchner et al. showed that strength and endurance exercises significantly decreased the risk of

falling in elderly population [14]. In the same line, Zhen-Bo et al. conducted a study in 2007 and stated that regular and continuous physical activities could significantly reduce the risk of falling and improve mobility and motion safety in elderly women [15]. Moreover, Suzuki et al. showed in 2009 that exercises and physical activities could promote balance, flexibility, muscular strength, and walking ability among elderly people [16]. Furthermore, Mohammadzadeh et al. carried out a research in 2012 and indicated that Pilates exercises had a significant effect on dynamic balance and walking performance among elderly men with the history of falling [17]. Mosayebi Samani also demonstrated in 2013 that aerobic and balance activities were effective in improving elderly individuals' balance and decreasing their fear of falling [18]. In 2015, Borhanenejad et al. reported a significant negative relationship between fear of falling and physical activities. They also mentioned that most elderly people in Iranian society did not have proper physical activities [19]. Dadgari et al. showed in 2016 that OEP played a critical role in improvement of balance status and reduction of falling and fear of falling among elderly people [20]. However, Binns and Taylor conducted a study in 2011 and stated that OEP training had no significant effects on elderly individuals' balance and strength [21]. Nonetheless, Robertson et al. came to a similar conclusion to that of the study by Dadgari et al. and reported that OEP reduced the rate of falling by 35% [13]. Zarei et al. also indicated in 2017 that balance exercises were effective in reduction of motor fluctuations, increase of balance, and decline of fear of falling among elderly people [22]. However, Duckham et al. conducted a research in 2011 and revealed that home-based exercise programs had no considerable impacts on bone mineral density at the femoral neck [23].

Review of the literature revealed contradictory results regarding the effectiveness of exercise programs in balance, falling, and fear of falling in elderly population. Indeed, limited studies have been done on OEP training for elderly people in Iran. Therefore, the present study aims to determine the effect of OEP training on elderly individuals' balance and fear of falling in Iran.

Methods

Study design: This clinical trial with pre/posttest design included an intervention and a control group, community-based and pragmatic, With parallel groups and randomized

Study settings and selection of participants: Eligibility criteria for participants and losses has shown in diagram 1. The research population included all elderly people referred to Imam Reza geriatric clinic and Kholdebarin retirement center in Shiraz. Out of the 104 individuals who met

the inclusion criteria, 88 ones were selected randomly. In the present clinical trial, random allocation of the participants is done via permuted block randomization. Accordingly, A and B represent the individuals receiving and not receiving the intervention, respectively. This method is run on 22 blocks in four permutations by considering all possible quadruple permutations (ABBA, ABAB, AABB, BBAA, BAAB, and BABA) and assigning a code between 0 and 9 (based on the table of random numbers) to each permutation (AABB, code 0; ABAB, code 1; ABBA, code 2; BAAB, code 3; BBAA, code 4; and BABA, codes 5-9). Then, based on the table of random numbers, a starting point is randomly selected, 12 digits are randomly chosen (in a row or column), and the permutation assigned to each digit is written down. It should be noted that the permutations are placed next to each other from left to right. Afterwards, allocation of the 88 participants to groups A and B is determined.

The inclusion criteria of the study were aging 60 years and above, obtaining scores ≤ 45 in Berg balance scale, not being dependent on aid devices such as walker and cane, obtaining scores ≥ 22 in mini-mental status exam, and gaining scores ≤ 32 in dizziness handicap inventory.

After the above-mentioned assessments, the participants underwent pretest using timed up and go, 30-second chair stand, and four-stage balance tests and Falls Efficacy Scale-International (FES-I). Then, they were divided into an intervention and a control group (n=44) via permuted block randomization. In the timed up and go test, the participants were required to stand up from a chair, walk on a straight line for three meters, and return and sit on the chair again. In case the above-mentioned process lasted for more than 12 seconds, the person was considered to be at risk of falling [40-42]. The reliability and validity of this test were assessed in the study conducted by Aslankhani et al. in 2015.

Study limitations: The individuals' specific characteristics and the resultant differences among the participants were among the uncontrollable limitations of this study. Another research limitation was the small sample size resulted from resources limitations. Additionally, the participants were faced with numerous restrictions, including commuting problems, for taking part in OEP training sessions. One other study limitation was the participants' worries about the complications of the program for the cardiovascular system. Thus, individuals are recommended to be screened via exercise test prior to the performance of OEP. Finally, this study was only conducted on elderly individuals. Hence, by doing this program during adulthood on a regular basis, based on the

continue theory, elderly individuals will have a better balance status, causing lower physical, mental, and economic consequences for them and their families.

Data collection

Recruitment: start date was 2018.10.05 and ended at 2018.10.25

Procedure: data collection started at OEP training together with an educational movie and performance of exercises were administered to the intervention group by the researcher approved by a rehabilitation specialist. This was done twice a week for four weeks. However, the control group participants received no trainings and were asked to carry out their daily activities.

During each visit with the intervention group participants in a hall, at least 30 minutes were devoted to each individual. OEP included warm up, effective exercises in muscle strength, and effective exercises in balance. In strength exercises, the participants fastened 1-3 kg weight cuffs to their shins based on their capacities. Balance exercises involved parallel-leg standing, parallel-leg walking, walking on heels, walking on toes, sitting with the help of both hands, and sitting without support. In the last part of the OEP, the participants were required to walk for 30 minutes daily. The individuals did the OEP five times a week for eight weeks. They were also followed up via telephone contacts once a week. After eight weeks, they were assessed using 30-second chair stand, four-stage balance test, and timed up and go tests again and their scores were recorded.

Outcome variables: For the objectives of this study (Detection of mean score for 30-second chair stand, Four stage balance and timed up & go tests in the elderly in the intervention group before and after the intervention, in the intervention group compared to the control group before the intervention, Intervention group compared to control group after intervention, in Control group before and after the intervention.) dynamic, static and postural balance and for other objectives (detection mean score of fear of falling in the elderly in the intervention group before and after the intervention, In the elderly control group, before and after the intervention, comparison mean score of fear of falling in the elderly in the intervention group compared to control group ,after the intervention than before), fear of falling were computed.

Definition of study variables

30-second chair stand

In the 30-second chair stand, the participants were required to sit in the middle of a chair, put their hands on their opposite shoulders, put the soles of their feet on the ground, stand up, and sit down. They were asked to continue this process for 30 seconds. The number of times the individuals could stand up was counted. In case the number was lower than the considered age- and sex-based average, the individual was considered to be at risk of falling [43].

Four-stage balance test

The four-stage balance test included four steps and the participants were asked to stand at each step for ten seconds while maintaining their balance. In case the participants could not maintain their balance at the tandem stand stage for ten seconds, they were considered to be at risk of falling.

Fall Efficacy Scale-International (FES-I)

FES-I developed by Yardley et al. contained 16 items. The items were responded via four options ranging from 'not worried at all' to 'completely worried'. Thus, the total score of the questionnaire could range from 16 to 64, with higher scores representing higher fear of falling or lower self-efficacy. This instrument was translated into Persian by Khajavi et al. [44]. The intra-class correlation coefficient of the questionnaire was 98% and its internal consistency was approved by Cronbach's alpha of 98%.

Berg balance scale

Berg balance scale contained 14 items to assess balance. Each item could be scored from 0 to 4, indicating the lowest and highest performance levels, respectively. Thus, the maximum score of the scale was equal to 56. This scale has been reported to benefit from very high reliability and validity [24, 37].

Dizziness handicap inventory

Dizziness handicap inventory contained 25 items divided into three dimensions as follows: physical (six items), emotional (nine items), and functional (10 items). The items could be responded as 'always', 'sometimes', and 'never' receiving 4, 2, and 0 scores, respectively. Thus, the maximum score of the questionnaire was 100 indicating the highest disability to maintain balance, while its minimum score was 0 representing lack of disability to maintain balance. In the study by Jafarzade et al., the Cronbach's alpha of the inventory was reported to be 0.9 [38].

Mini-mental status exam

Mini-mental status exam developed by Folstein in 1975 is the most common instrument for screening cognitive disorders around the world, which has been translated into various languages and standardized in different cultures. This exam evaluates various cognitive functions and brings about an overall estimation of an individual's cognitive status. It is a short exam and can be executed within 10 minutes. The reliability and validity of this exam were investigated in the study performed by Foroughan et al. in 2006. Accordingly, it was found to have acceptable reliability (0.78). Indeed, it showed the sensitivity of 90% and specificity of 84% at the cut-off point of 21 [39].

Statistical analyses:

In order to assess the impact of OEP on the participants' balance and fear of falling, independent t-test and paired t-test were used in case of normal distribution of the data, while Wilcoxon and Mann-Whitney tests were employed in case the data did not follow normal distribution. All analyses were performed using the SPSS 21 software, and $p < 0.05$ was considered to be statistically significant.

Results

Based on descriptive statistics presented in Table 1, 72.7% of the participants were female, 74.5% were married, and 38.2% had diplomas. The mean age of the participants was 68.9 years.

Table 1. Descriptive characteristics of the study participants.

According to Table 2, the intervention group participants obtained significantly higher scores in timed up and go, 30-second chair stand, four-stage balance, and fear of falling tests compared to the control group ($p < 0.001$). This implies that the intervention was effective and OEP training enhanced the participants' postural, dynamic, and static balance and reduced their fear of falling.

Table 2. Comparison of the two groups' mean scores of balance tests and fear of falling before and after the intervention.

Exclusion criteria: 1-Unwillingness to cooperate in research 2. Having defective vision or hearing impairment 3. Having a disabling neurological and muscular disorder that can lead to inability to do daily activities. 4 - Neurological disorders or defective disabling of the nervous system 5. Suffering from debilitating vascular diseases 6. Take medications that may affect balance.

Discussion: This study aimed at assessment of the effect of OEP training on elderly individuals' balance and fear of falling. The results revealed the significant impact of OEP on the participants' postural, dynamic, and static balance and fear of falling. In the same line, Shubert et al., Renfro et al., Thiamwong et al., and Dadgari et al. reported that OEP could significantly improve elderly people's postural, static, and dynamic balance [20, 45-47]. Additionally, Rahmani et al. showed that performing Pilates exercises for eight weeks could improve elderly people's balance and reaction time [48]. Moreover, Safakhil et al. indicated that stretching and massage exercises could promote elderly individuals' dynamic balance [49]. Kushyar et al. also demonstrated that performance of fun physical activities could prevent balance disorders, enhance elderly people's balance, and reduce their fear of falling [50]. Thiamwong et al. also revealed in their research that balance exercises training could significantly reduce elderly people's fear of falling by enhancing their balance status [46]. However, Binns and Taylor reported that OEP had no significant effects on elderly individuals' muscle strength and balance [21]. The discrepancy between the results of that study and the present one could be due to the insufficient number of training sessions and not observing order in performance of exercises.

Conclusion: In the current study, doing OEP for three months significantly enhanced the participants' postural, dynamic, and static balance and decreased their fear of falling. The intervention included stretching exercises, exercises strengthening muscles (particularly those of lower extremities), and balance exercises. Strengthening the muscles of lower extremities could increase pelvic and spinal bones density and muscles density, thereby enhancing balance. On the other hand, balance is associated with visual, vestibular, and proprioceptive systems. The proprioceptive system is composed of sensory receptors located in muscles, joints, and ligaments surrounding joints. These receptors detect stretches and tensions and send the related information to the brain for processing. Based on the received information, the brain sends signals to muscles to contract or relax in order to create the intended movement [51]. The nervous compatibilities resulting from exercising promote balance via application of more efficient neural units, reorganization in the somatosensory cortex, increase of synaptic connections' power and efficiency, increase of nervous system's activity, reduction of neural inhibitory reflexes, decrease

of nervous pathways' resistance to impulse transmission, and facilitation of the senses' input transmission [52]. Establishment of balance is accompanied with reduction of fear of falling as a mental problem, which results in isolation, depression, increased dependence on others, and reduced independence. Overall, regular performance of OEP can lead to establishment of balance, causing elderly people to spend this period more healthily, more actively, and with higher self-esteem. The result of this study is usable for elderlies.

List of abbreviations:

OEP: Otago Exercise Program

FES-I: Fall Efficacy Scale-International

Declarations:

Competing interests: The author(s) declare that they have no competing interests.

Authors' contributions: HM conceived the study and supervised all phases of the study. SS drafted the manuscript and carried out the data analysis. SS was responsible for participant acquisition and data collection. AA managed the data entry and participated in the data collection for the inter-rater tests. All authors read and approved the final manuscript

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Ethics approval and consent to participate: This study was conducted in compliance with the established ethical guidelines of the Declaration of Helsinki. Under the Swedish Ethical Review Act 2003:460 this study did not require ethical clearance, we applied for and received ethical guidance from the Ethical Advisory Board in Southern Sweden. The researcher gave oral and written information and obtained written informed consent from all participants before the interviews. Participation was voluntary, and the participants had the right to withdraw at any time without further explanation. The participants gave consent for direct quotes from their interviews to be used in this paper. To ensure confidentiality, each quotation was assigned a pseudonym in the form of a number. Data were stored securely and anonymously in compliance with the Data Protection Act.

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Availability of data and materials: Data and material available from the corresponding author upon reasonable request.

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Tables and diagrams:

Table1

Variables		Frequency	Percentage
Sex	Female	40	72.7
	Male	15	27.3
Marital status	Single	3	5.5
	Married	41	74.5
	Widowed	11	20
Education level	Illiterate	2	3.6
	High school diploma	16	29.1
	Diploma	21	38.2
	Higher than diploma	16	29.1
Group	Intervention	25	45.5
	Control	30	54.5
Variable	Minimum	Maximum	Mean
Age	60	88	68.90

Table2

Variable	Stage	Pretest	Posttest	T	P
Timed up and go test	Control	14.70	14.46	1.564	0.129
	Intervention	14.52	9.92	12.011	0.001
30-second chair stand	Control	8.233	8.30	-0.528	0.601
	Intervention	9.04	13.24	-20.176	0.001
Four-stage balance test	Control	7.133	6.866	-1.610	0.118
	Intervention	7.60	9.84	-10.647	0.001
Fear of falling	Control	29.833	30.30	-1.676	0.105
	Intervention	28.44	18.88	13.516	0.001

Diagram 1:

Figures

Figure 1

Study flowchart

Supplementary Files

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