Research Article

Comparing the Effectiveness of Aerobic and Core Stability Exercises on Balance in Older Adult Men

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ABSTRACT

Introduction: Aging is associated with changes in the neuromusculoskeletal system, which can lead to impairments in balance. This study compares the effects of aerobic and core stability exercises on healthy older men's static and dynamic balance.

Materials and Methods: In this study, 30 adults aged 60 to 70 years were selected through purposive sampling and randomly divided into three groups as follows: aerobic exercises, core stability exercises, and a control group. The interventions were carried out separately for the two experimental groups over 6 weeks. Static balance was assessed using the Romberg and Sharpened Romberg balance tests, while dynamic balance was assessed using the functional reach and timed up-and-go tests. The data were analyzed using the one-way multivariate analysis of covariance test with the SPSS software, version 26.

Results: The mean scores of post-tests for the balance tests in the two experimental groups improved compared to their pre-test scores and the post-test scores of the control group. Moreover, both aerobic and core stability exercises had a significant effect on the static and dynamic balance of the elderly (P=0.001). When examining the effects of exercises on dynamic balance, the findings showed a significant difference in favor of aerobic exercises compared to core stability exercises (P=0.017). However, no significant difference was observed concerning static balance (P=1.00) when comparing the effects of the exercises.

Conclusion: Aerobic and core stability exercises have a positive impact on the static and dynamic balance of the elderly. Furthermore, for improving dynamic balance in older men, aerobic exercises appear to be more effective than core stability exercises.

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Introduction

The number of older adults in the world's population is rapidly increasing. By 2030, one out of every six people worldwide will be aged 60 years or older. The world's population of older adults, aged sixty and over, is projected to increase from one billion in 2020 to two billion in 2050. This phenomenon is known as population aging [1].

Aging is characterized by physiological, psychological, and social changes [2]. The neuromusculoskeletal system, as a physiological system, and its subsystems, including skeletal, muscular, and neural components are all affected by aging [2]. These changes include joint degeneration, reduced proprioception, a decline in the number of lower extremity cutaneous receptors, decreased neural conductivity, and a reduction in the mass and strength of skeletal muscles, which can lead to balance impairments [3].

The proprioceptive system plays a crucial role in balance control across all age groups, including older adults, and it is more significant than the vision and vestibular systems [4]. Aging has been shown to have a detrimental effect on the proprioceptive system [5]. Recent research results indicate that common issues among older adults include reduced balance and an increased frequency of falls while standing or walking [6]. Falls are the leading cause of accidental death among people over 65 years old [7]. Consequences of non-fatal falls include reduced activity levels, lower quality of life, fear of falling, fractures, and brain injuries [7]. One out of two older adults over 80 years old, and one out of three older adults over 65 years old experience a fall [8].

Exercise has been identified as a critical component of fall prevention programs [9], and numerous studies have explored the impact of exercise interventions on balance, fall risk, and other health-related factors in older adults [10]. However, there is still uncertainty about which type of exercise is the most effective for preventing falls in older adults [11]. Research has shown that a combination of aerobic exercise and resistance training improves balance in older adults [12]. In another study, Joung and Lee (2019) reported that both creative dance and stretching had a positive effect on balance and mobility in older adults, with creative dance having a greater impact on dynamic balance and mobility [13]. Additionally, the significant effects of walking and cycling on older adults' static and dynamic balance have been confirmed [14].

It has also been observed that even a single session of core stability exercises can enhance postural stability [15]. Other exercise protocols, such as core stability-mindfulness exercises, have had a positive effect on the static and dynamic balance of older women [16]. Sajedi et al. (2020) showed that core stability training is an appropriate intervention for enhancing static and dynamic balance in blind children [17]. In a recent study, the significant effect of core stabilization exercises on the balance of males and females aged between 65 and 75 years has been confirmed [18].

Due to conflicting evidence from previous studies regarding the relative effectiveness of aerobic exercises versus core stability exercises on balance, it is necessary to compare the effects of these exercises on balance. Accordingly, this study compares the effect of two training programs, aerobic exercise and core body stability exercises, on the balance of older men.

Materials and Methods

This study was conducted in 2022 and followed a comparative, quasi-experimental research design with a cross-sectional approach. The study employed a pre-test and post-test design with a control group.

The study population consisted of healthy older adult men aged 60 to 70 years in Khorramabad City, Iran. To ensure the participants' general health, they underwent a medical examination. The sample size, calculated using G*Power software, version 3.0.1, with $\alpha=0.05$, β (statistical power) of 0.8, and effect size of 0.91, was determined to be 30 individuals.

The inclusion criteria were being male and falling within the age range of 60 to 70 years [19]. Meanwhile, the exclusion criteria were having a recent history of injury or acute fracture in the two years preceding the study, a history of cardiovascular diseases, diabetes, vision, and hearing problems, a history of spine surgery (as reported by participants), and missing more than two training sessions.

The participants provided informed consent, completed a personal characteristics form, and answered the physical activity readiness questionnaire. To allocate participants randomly, pieces of paper with numbers 1, 2, and 3 were placed in a container, and each participant chose a paper to determine their group. The subjects were then randomly divided into three groups as follows: Two experimental groups and one control group.

Before commencing the training programs, a pre-test was administered to all three groups to measure static balance (using the Romberg test with a validity level of 87% and a reliability level of 99%, and the Sharpened Romberg test with a validity level of 77% and a reliability level of 91%) and dynamic balance (using the functional reach test [FRT] with a validity of 77% and a reliability of 79% and the timed up and go [TUG] balance test with a validity of 81% and a reliability of 99%) [20].

The training sessions for the two experimental groups, focusing on aerobic and core stability exercises, were conducted for six weeks, with three sessions per week, each lasting 45-50 min. These exercises were designed and implemented according to the instructions of the US Department of Health and Human Services [21].

In the aerobic exercise group, the participants began each session with a 10-min warm-up and simple stretching exercises. Over the six weeks, exercise intensity gradually increased from slow walking (40% to 50% of maximum heart rate) to fast walking (50% to 60% of maximum heart rate) and finally to slow running (60% to 70% of maximum heart rate). Heart rate was monitored using a fingertip oximeter.

For the core stability exercises group, the training protocol included a 10-min warm-up and stretching, followed by specific core stability exercises as described in Table 1 and Figure 1. A researcher and a trainer were present during exercise sessions, making necessary adjustments as required.

The control group continued their daily routine activities without any specific exercise program. After six weeks, a post-test was conducted for all three groups using the aforementioned balance tests. Descriptive statistics were used for data analysis, and the Shapiro-Wilk test was employed to assess the normal distribution of data. The one-way multivariate analysis of covariance and the Bonferroni post hoc tests were utilized for data analysis, with a significance level set at $P \leq 0.05$. Meanwhile, statistical analysis was performed using the SPSS software, version 26. The weekly training schedule is given in Table 1. The exercises performed are shown in Figure 1.

Balance tests

1. Romberg's test (static balance)

The Romberg's test assesses static balance. The participant stands on a flat surface without shoes, feet close together, and arms hanging by their sides. They should close their eyes or use a blindfold. The test measures how long the individual can maintain this position. If they can stand for 30 s without falling or swaying significantly, their balance is considered normal, and the Romberg test result is negative. Falling, increased sway, or moving their legs or hands to regain balance results in a positive test [22].

2. Sharpened Romberg test (static balance)

Similar to Romberg's test, the sharpened Romberg test assesses static balance. The participant stands on a flat surface without shoes, with their dominant leg in front of the non-dominant leg, and arms crossed on the chest. They closed their eyes, and a stopwatch was used to record the time. If they can maintain a stable position for 30 s without falling or swaying significantly, the test result is negative. Any fall, increased sway, leg movement, or opening of hands indicates balance weakness and results in a positive test [23].

3. TUG test (dynamic balance)

The TUG test evaluates dynamic balance. A chair without handles is placed three meters from a marked line. The participant is asked to stand up from the chair without using their hands, walk three meters, and return to sit on the chair. They must cover the distance at maximum walking speed without running. The participant practices this three times before the test. The test is performed three times, and the average time is recorded as the subject's result [23].

4. FRT (dynamic balance)

The FRT measures dynamic balance. A ruler is attached to a wall. The participant stands beside the wall with their dominant leg, feet shoulder-width apart, and their fists raised parallel to the ground next to the wall. They stand facing the wall at a distance of 1.5 to 2 m. The participant leans forward while keeping their hand parallel to the ground for at least 30 s. The movement of their fist is measured on the ruler while they lean forward. This test is repeated three times, and the average measurement is used as the assessment criterion [24].

Results

The demographic characteristics of the subjects (age, height, weight) are presented in Table 2.

Table 1. Core stability exercise

Week	Day	Exercises	Sets	Repetition's (r) or Time (s)	Rest (s)
1	Sunday Tuesday Thursday	Half squat	3	8 r	50
		Drawing-in maneuver	3	8 r	30
		Chest lift	3	8 r	30
		Spine twist supine	3	8 r	20
		One leg lift side	3	6 r	30
		Bird dog	3	6 r	30
		Half cobra	3	10 s	20
		Plank	3	10 s	30
2	Sunday Tuesday Thursday	Half squat	3	10 r	50
		Drawing-in maneuver	3	10 r	30
		Chest lift	3	10 r	30
		Spine twist supine	3	10 r	20
		One leg lift side	3	8 r	30
		Bird dog	3	8 r	30
		Half cobra	3	12 s	20
		Plank	3	12 s	30
3	Sunday Tuesday Thursday	Squat	3	10 r	50
		Drawing-in maneuver	3	10 r	30
		Spine twist supine	3	10 r	20
		One leg lift side	3	10 r	30
		Crunch	3	10 r	30
		Pelvic curl or bridge	3	8r	30
		Bird dog	3	12 r	30
		Back extension prone	3	15 s	30
		Plank	3	15 s	30
4	Sunday Tuesday Thursday	Squat	3	12 r	50
		Drawing-in maneuver	3	12 r	30
		Spine twist supine	3	10 r	20
		One leg lift side	3	10 r	30
		Crunch	3	12 r	30
		Pelvic curl or bridge	3	10 r	30
		Bird dog	3	10 r	30
		Back extension prone	3	15 s	30
		Plank	3	20 s	30

Week	Day	Exercises	Sets	Repetition's (r) or Time (s)	Rest (s)
5	Sunday Tuesday Thursday	Squat	3	12 r	50
		Drawing-in maneuver	3	12 r	30
		One leg lift side	3	12 r	30
		Bird dog	3	10 r	30
		Pelvic curl or bridge	3	10 r	30
		Back extension prone	3	20 s	30
		Plank	3	25 s	40
		Side plank	3	10 s	30
6	Sunday Tuesday Thursday	Squat	3	12 r	50
		Drawing-in maneuver	3	12 r	30
		One leg lift side	3	12 r	30
		Bird dog	3	12 r	30
		Pelvic curl or bridge	3	10 r	30
		Back extension prone	3	20 s	30
		Plank	3	25 s	40
		Side plank	3	10 s	30

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The normal distribution of the data was confirmed using the Shapiro-Wilk test. The results of the subjects' scores in the pre-test and post-test are given in Table 3.

The results of the Levene test confirmed the homogeneity of variance and the results of Box's M confirmed the homogeneity of the covariance matrix.

Static balance

When analyzing the static balance test, the results of the one-way multivariate analysis of the covariance test ($F_{(4, 48)}$=42.825, P<0.001, Wilks' Λ=0.048, partial η^2=0.781) indicate a significant finding. The rejection of the null hypothesis at a significance level of P≤0.05 suggests a notable difference in the mean scores of the Romberg and Sharpened Romberg balance tests among the groups (Table 4).

The Bonferroni post hoc test was employed to discern which pair of groups exhibited differences in means (Table 5).

The results of the Bonferroni post hoc test revealed that the mean scores of the Romberg and Sharpened Romberg tests in the aerobic and core stability exercise groups are significantly different from those in the control group (P=0.001). The performance of the core stability exercise group demonstrated improvement compared to the aerobic exercise group in both tests, although this difference did not reach statistical significance (P=1.00). Consequently, based on the study's findings, the null hypothesis was accepted.

Dynamic balance

When assessing the dynamic balance test, the outcome of the one-way multivariate analysis of the covariance test ($F_{(4, 48)}$=50.734, P<0.001, Wilks' Λ=0.037, partial η^2=0.809) indicates a statistically significant finding. At a significance level of P≤0.05, the null hypothesis is rejected, signifying a notable difference in the mean scores of the FRT and TUG balance tests among the groups (Table 6).

Figure 1. Core stability exercises

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The Bonferroni post hoc test was used to determine which pair of groups showed the difference in means (Table 7).

The results of the Bonferroni post hoc test revealed that the mean scores of FRT in the aerobic and core stability exercise groups are significantly different from those in the control group (P=0.001). Furthermore, when comparing the aerobic exercise and core stability exercise groups, no significant difference was observed.

Similarly, the results of the Bonferroni post hoc test showed that the mean scores of the TUG test in the aerobic and core stability exercise groups were significantly different from those in the control group (P=0.001). However, when comparing the aerobic exercise and core stability exercise groups, a significant difference was detected. Specifically, the mean scores of the two experimental groups favored the aerobic group, indicating that the aerobic group's performance in the TUG test surpasses that of the core stability group, and this difference is statistically significant (P=0.017). Figure 2 shows a visual representation of the comparison of post-test scores of balance tests among groups.

Discussion

In this study, we explored the effects of 6-week aerobic and core stability exercises on the dynamic and static balance of older adult men. The results demonstrated that both aerobic and core stability exercises have a significant impact on static balance. Concerning the ef-

Table 2. Demographic characteristics of subjects

Variables	Group	Mean±SD	Data Normality (Shapiro-Wilk)	
			F	P
Age (y)	Aerobic exercise	68.00±1.700	0.855	0.066
	Core stability exercise	67.60±1.838	0.902	0.229
	Control	67.80±1.874	0.898	0.209
Height (cm)	Aerobic exercise	170.20±5.633	0.895	0.191
	Core stability exercise	172.00±3.916	0.859	0.074
	Control	169.30±4.990	0.919	0.351
Weight (kg)	Aerobic exercise	76.90±10.115	0.942	0.572
	Core stability exercise	75.60±2.952	0.917	0.334
	Control	70.30±5.889	0.910	0.278

SD: Standard deviation.

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Table 3. The subjects' scores of balance tests

Test / Group	Mean±SD					
	Control		Core Stability Exercise		Aerobic Exercise	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Romberg	27.50±1.433	27.30±1.888	27.80±1.398	35.90±2.233	26.90±1.449	34.30±3.560
Sharpened Romberg	11.20±4.237	11.60±4.718	10.90±4.408	20.30±6.549	12.60±5.037	21.60±5.891
FRT	26.30±4.668	26.80±5.051	26.70±3.128	33.30±2.751	26.60±2.914	32.00±2.309
TUG	8.27±1.211	8.26±1.200	8.08±0.875	7.19±0.933	8.03±0.918	6.95±0.916

Abbreviations: SD: Standard deviation; FRT: Functional reach test; TUG: Timed up and go.

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fects of these exercises on dynamic balance, the study revealed a non-significant difference in the FRT between the two groups, with a slight advantage observed in the core stability group. However, a significant difference was observed in the TUG test, favoring the aerobic exercise group.

To the best of our knowledge, this is the first study to directly compare the effects of core stability and aerobic exercises on the static and dynamic balance of older adult men. Prior research utilized various assessment methods for static and dynamic balance. Nevertheless, some studies have indicated the positive impact of core stability exercises on postural stability and balance [15-18]. This improvement may be attributed to enhancements in the proprioceptive system, which plays a crucial role in balance control and is especially important in older adults [25].

Additionally, core stability exercises can facilitate feedforward activation of the transversus abdominis muscle, thereby enhancing control over disturbing forces on balance and posture [18, 26]. Another contributing factor

Table 4. The results of multivariate analysis of covariance test comparing static balance between groups

Test	Value	F	Error df	Sig.	Hypothesis df	Observed Power	η_p^2
Wilks' lambda	0.048	42.825	48	0.001	4	1.00	0.781

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Table 5. Bonferroni test results in relation to static balance

Test	Group (I)	Group (J)	Mean Difference (I-J)	Sig.	Standard Error
Romberg	Aerobic exercise	Core stability exercise	-0.131	1.00	0.756
		Control	7.984	0.001	0.721
	Core stability exercise	Aerobic exercise	0.131	1.00	0.756
		Control	8.116	0.001	0.686
	Control	Aerobic exercise	-7.984	0.001	0.721
		Core stability exercise	-8.116	0.001	0.686
Sharpened Romberg	Aerobic exercise	Core stability exercise	-0.395	1.00	0.764
		Control	8.561	0.001	0.728
	Core stability exercise	Aerobic exercise	0.395	1.00	0.764
		Control	8.956	0.001	0.693
	Control	Aerobic exercise	-8.561	0.001	0.728
		Core stability exercise	-8.956	0.001	0.693

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could be the recruitment and training of hip abductors, essential stabilizers of the pelvic-hip complex during upper and lower extremity movements [27]. Furthermore, the activation of core muscles can elicit appropriate postural responses by the central nervous system, further aiding in balance control [18].

On the other hand, aerobic exercises improve cardiovascular function, endurance, strength, and overall fitness in older adults, all of which are critical for daily activities [12]. Our results are in line with previous studies, indicating that aerobic exercises, such as creative dance and stretching, can have positive effects on balance [13]. Similarly, improvements in static and dynamic balance have been reported following walking and cycling exercises [14]. These improvements may be attributed to enhanced neuromuscular coordination, neuroplasticity, proprioception, and sensory-motor cortex reorganization [13, 28].

In comparing the effects of these two exercise types, no significant difference was observed in improving static balance. Both exercises had a positive effect on static balance, suggesting their potential utility for this aspect of balance. However, for dynamic balance, a significant difference was found in favor of aerobic exercises over core stability exercises in the TUG test. This distinction is likely due to the complex and reflexive nature of aerobic activities like walking and running, which demand rhythmic coordination between the lower limbs, core, and upper limbs. Maintaining dynamic balance during such activities requires rapid reflexes and stability, making aerobic exercises more effective in this regard [29].

Conclusion

Aerobic and core stability exercises demonstrated a positive impact on the static and dynamic balance of elderly individuals. However, for improving dynamic balance in older men, aerobic exercises appear to be superior to core stability exercises. It is essential to note that this study had a single-gender focus and a limited sample size, warranting caution when generalizing the findings.

Table 6. The results of multivariate covariance analysis comparing dynamic balance between groups

Test	Value	F	Error df	Sig.	Hypothesis df	Observed Power	η_p^2
Wilks lambda	0.037	50.734	48	0.001	4	1.00	0.809

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Table 7. Bonferroni test results in relation to dynamic balance

Test	Group (I)	Group (J)	Mean Difference (I-J)	Sig.	Standard Error
FRT	Aerobic exercise	Core stability exercise	-1.22	0.096	0.538
		Control	4.877	0.001	0.540
	Core stability exercise	Aerobic exercise	1.22	0.096	0.538
		Control	6.099	0.001	0.539
	Control	Aerobic exercise	-4.877	0.001	0.540
		Core stability exercise	-6.099	0.001	0.539
TUG	Aerobic exercise	Core stability exercise	-0.196	0.017	0.065
		Control	-1.073	0.001	0.065
	Core stability exercise	Aerobic exercise	0.196	0.017	0.065
		Control	-0.877	0.001	0.065
	Control	Aerobic exercise	1.073	0.001	0.065
		Core stability exercise	0.877	0.001	0.065

FRT: Functional reach test; TUG: Timed up and go.

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Study limitations

This study faced three primary limitations. First, the sample size was restricted due to constraints in participant availability. Second, the study did not investigate the durability of changes in dynamic and static balance over time, leaving the duration of these effects uncertain. Third, the study focused exclusively on older men within a specific age range.

Suggestions

To address these limitations, future research should consider conducting similar studies involving different age groups and including both men and women. Furthermore, examining various exercise protocols, either separately or in combination, with larger and more diverse participant samples can provide stronger evidence and more generalized results.

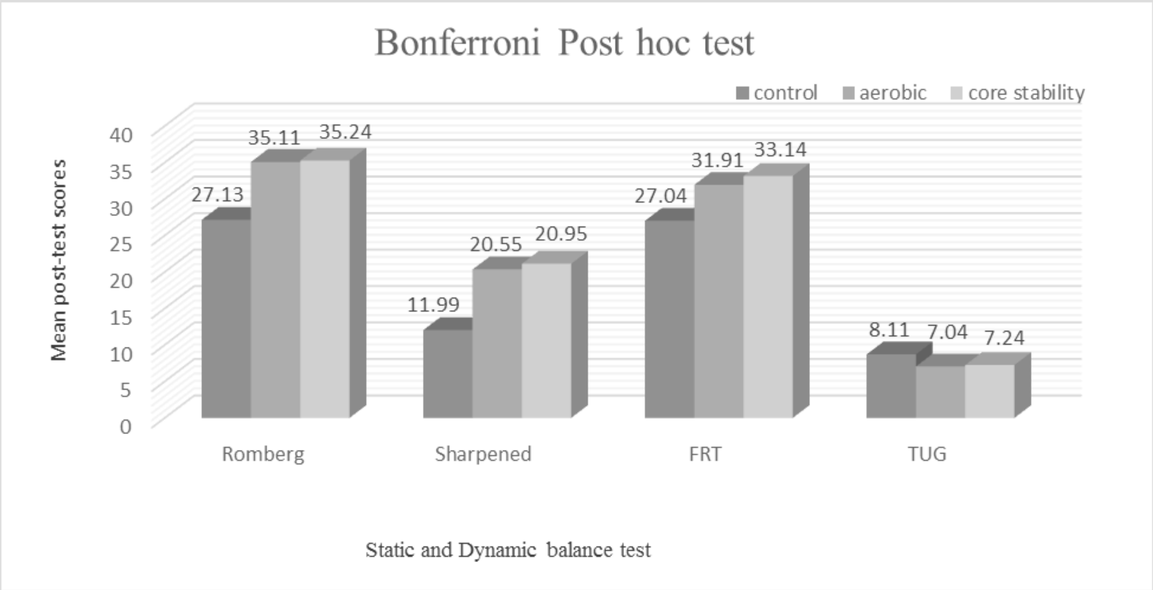

Figure 2. Comparison of post-test scores of balance tests among groups

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Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of Allameh Tabataba'i University, Tehran, Iran (Code: IR-ATU.REC.1401.025). All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information and were free to leave the study whenever they wished, and if desired, the research results would be available to them.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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References

[1] WHO. WHO global report on falls prevention in older age. Geneva: WHO; 2021.

[2] Mauk KL. Gerontological nursing: Competencies for care. Massachusetts: Jones & Bartlett Publishers; 2010. [Link]

[3] Długosz-Boś M, Filar-Mierzwa K, Stawarz R, Ścisłowska-Czarnecka A, Jankowicz-Szymańska A, Bac A. Effect of three months pilates training on balance and fall risk in older women. International Journal of Environmental Research and Public Health. 2021; 18(7):3663. [DOI:10.3390/ijerph18073663] [PMID]

[4] Colledge N, Cantley P, Peaston I, Brash H, Lewis S, Wilson J. Ageing and balance: The measurement of spontaneous sway by post urography. Gerontology. 1994; 40(5):273-8. [DOI:10.1159/000213596] [PMID]

[5] Ribeiro F, Oliveira J. Aging effects on joint proprioception: the role of physical activity in proprioception preservation. European Review of Aging and Physical Activity. 2007; 4(2):71-6. [DOI:10.1007/s11556-007-0026-x]

[6] Phu S, Vogrin S, Al Saedi A, Duque G. Balance training using virtual reality improves balance and physical performance in older adults at high risk of falls. Clinical Interventions in Aging. 2019; 14:1567-77. [DOI:10.2147/CIA.S220890] [PMID]

[7] Alissa N, Akinlosotu RY, Shipper AG, Wheeler LA, Westlake KP. A systematic review of upper extremity responses during reactive balance perturbations in aging. Gait & Posture. 2020; 82:138-46. [PMID]

[8] Low DC, Walsh GS, Arkesteijn M. Effectiveness of exercise interventions to improve postural control in older adults: A systematic review and meta-analyses of center of pressure measurements. Sports Medicine. 2017; 47(1):101-12. [DOI:10.1007/s40279-016-0559-0] [PMID]

[9] Sherrington C, Tiedemann A, Fairhall N, Close JC, Lord SR. Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. New South Wales Public Health Bulletin. 2011; 22(4):78-83. [DOI:10.1071/NB10056] [PMID]

[10] Sun M, Min L, Xu N, Huang L, Li X. The effect of exercise intervention on reducing the fall risk in older adults: A meta-analysis of randomized controlled trials. International Journal of Environmental Research and Public Health. 2021; 18(23):12562. [DOI:10.3390/ijerph182312562] [PMID]

[11] Thomas E, Battaglia G, Patti A, Brusa J, Leonardi V, Palma A, et al. Physical activity programs for balance and fall prevention in elderly: A systematic review. Medicine. 2019; 98(27):e16218. [DOI:10.1097/MD.0000000000016218] [PMID]

[12] Bai X, Soh KG, Omar Dev RD, Talib O, Xiao W, Soh KL, et al. Aerobic exercise combination intervention to improve physical performance among the elderly: A systematic review. Frontiers in Physiology. 2022; 12:798068. [DOI:10.3389/fphys.2021.798068] [PMID]

[13] Joung HJ, Lee Y. Effect of creative dance on fitness, functional balance, and mobility control in the elderly. Gerontology. 2019; 65(5):537-46. [DOI:10.1159/000499402] [PMID]

[14] Kashefi M, Talab RH, Azar MP, Ardakani MD. [The effect of two kinds of aerobic exercise on the static undynamic balance of old men (Persian)]. Iranian Journal of Ageing. 2014; 9(2):134-41. [Link]

[15] Szafraniec R, Barańska J, Kuczyński M. Acute effects of core stability exercises on balance control. Acta of Bioengineering and Biomechanics. 2018; 20(4):145-51. [PMID]

[16] Mahmoudi S, Heyrani A. [The effect of 8 weeks of core stability and core stability mindfulness exercises on the balance of older women in nursing centers of Kermanshah (Persian)]. Journal of Motor and Behavioral Sciences. 2020; 3(3):247-56. [Link]

[17] Sajedi L, Parsaie N, Biglari M, Sattarzade MH. Effect and permanency of core stability training on static and dynamic balance in blind children. International Journal of Motor Control and Learning. 2022; 4(3):10-5. [DOI:10.52547/ijmcl.4.3.10]

[18] Ponde K, Agrawal R, Chikte NK. Effect of core stabilization exercises on balance performance in older adults. International Journal of Contemporary Medicine. 2021; 9(1):12-7. [DOI:10.37506/ijocm.v9i1.2926]

[19] Pons-Terrés JM, Romero-Naranjo FJ, Carretero-Martínez A, Crespo-Colomino N. Perceptions towards wellness and life quality through body percussion-bapne method and cognitive stimulation in elderly people. Procedia-Social and Behavioral Sciences. 2014; 152:1108-13. [DOI:10.1016/j.sbspro.2014.09.283]

[20] Pourmahmoudian P, Noraste AA, Daneshmandi H, Atrkar Roshan Z. [Functional balance assessment scales in elderly (Persian)]. Iranian Journal of Ageing. 2018; 13(2):132-53. [DOI:10.32598/sija.13.2.132]

[21] US Department of Health and Human Services. "Physical activity guidelines for Americans. : Washington: US Department of Health and Human Services; 2018.

[22] Agrawal Y, Carey JP, Hoffman HJ, Sklare DA, Schubert MC. The Modified Romberg Balance Test: Normative data in U.S. Adults. Otology & New-otology. 2011; 32(8):1309-11. [DOI:10.1097/MAO.0b013e31822e5bee] [PMID]

[23] Abdoli B, Shams A, Shamsipour Dehkordi P. [The effect of practice type on static and dynamic balance in elderly 60-75-year-old women with no history of falling (Persian)]. Daneshvar Medicine. 2012; 19(97):46-54. [Link]

[24] de Waroquier-Leroy L, Bleuse S, Serafi R, Watelain E, Pardessus V, Tiffreau AV, et al. The Functional Reach Test: Strategies, performance and the influence of age. Annals of Physical and Rehailitation Medicine. 2014; 57(6-7):452-64. [DOI:10.1016/j.rehab.2014.03.003] [PMID]

[25] Puntumetakul R, Chalermsan R, Hlaing SS, Tapanya W, Saiklang P, Boucaut R. The effect of core stabilization exercise on lumbar joint position sense in patients with subacute non-specific low back pain: A randomized controlled trial. Journal of Physical Therapy Science. 2018; 30(11):1390-5. [DOI:10.1589/jpts.30.1390] [PMID]

[26] Watson T, Graning J, McPherson S, Carter E, Edwards J, Melcher I, et al. Dance, balance and core muscle performance measures are improved following a 9-week core stabilization training program among competitive collegiate dancers. International Journal of Sports Physical Therapy. 2017; 12(1):25-41. [PMID]

[27] Garrison JC, Bothwell J, Cohen K, Conway J. Effects of hip strengthening on early outcomes following anterior cruciate ligament reconstruction. International Journal of Sports Physical Therapy. 2014; 9(2):157-67. [PMID]

[28] Mirmoezzi M, Amini M, Khaledan A, Khorshidi D. [Effect of 8-week of selected aerobic exercise on static and dynamic balance in healthy elderly inactive men(Persian)]. Iranian Journal of Ageing. 2016; 11(1):202-9. [DOI:10.21859/sija-1101202]

[29] Letafatkar A, Daneshmandi H, Hadadneghad M, Abdolvahedi Z. [Advanced corrective movements (from theory to practice) (Persian)]. Tehran: Avayezohoor; 2016. [Link]