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Effectiveness of Individual and Group-Based Exercises on Balance, Gait and Depression in the Elderly: A Randomized Controlled Pilot Trial

Original scientific paper

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Abstract

Balance, gait, and mental status are key determinants of health and quality of life in older adults. This randomized controlled trial aimed to compare the effects of individual and group-based exercises on these parameters among elderly residents of a private retirement home in Istanbul, Turkey. Twenty-four participants aged over 65 were randomly assigned to either the individual exercise group (IG) or the group-based exercise group (GG). Both groups performed active range of motion, balance, and stretching exercises, three times per week for eight weeks. While IG participants exercised independently, GG participants trained under the supervision of a physiotherapist. Baseline and post-intervention assessments included the Berg Balance Scale (BBS), Tinetti Balance Test (TBT), Tinetti Gait Test (TGT), and Beck Depression Inventory (BDI). There were no significant baseline differences. After eight weeks, the GG showed significant improvements in BBS (p=0.013), TBT (p=0.011), and BDI (p=0.039) compared to IG, indicating beneficial effects on balance and mental status.

Keywords: *Balance, Depression, Exercise, Gait, Geriatrics.*

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The rising prevalence of health issues linked to aging has emerged as a notable focal point within the realm of public health (Patel et al., 2014). Age-related medical conditions such as cognitive decline, diabetes, frailty, musculoskeletal conditions and cardiovascular diseases are placing a substantial economic strain on healthcare systems (Crowe et al., 2010; Bul et al., 2023). Especially musculoskeletal problems are prevalent among the elderly population and can significantly impact their quality of life. These issues include decreased muscle strength, which can lead to difficulties in performing daily activities and an increased risk of falls. Additionally, balance problems are common, posing a risk for falls and related injuries (Dasdemir and Celikhisar, 2021). As of 2019, the global population aged 60 and over was 962 million, and this number is projected to rise rapidly, reaching 1.4 billion in 2030 and 2.1 billion in 2050. With this demographic shift, the prevalence of musculoskeletal problems is expected to increase, necessitating a focus on interventions to address these issues and improve the overall well-being of the aging population (Murdoch et al., 2018).

Balance is a critical parameter in older ages, as it plays a pivotal role in maintaining functional independence and preventing falls among the elderly population (Gouveia et al., 2020). Decreased muscle strength and balance problems are common age-related musculoskeletal issues that can significantly impact an individual's ability to perform daily tasks and maintain stability while static and dynamic conditions such as standing or walking. As individuals age, maintaining strong musculoskeletal health becomes increasingly important for preserving mobility and independence (Hayashida et al., 2014).

The risk of falling is higher in elderly people living alone at home. A study by found that living alone was associated with a greater number of falls in previous years (Saygin et al., 2018). Furthermore, conditions such as loss of balance and pain are associated with depressive symptoms in the elderly. A study highlighted that the prevalence of depressive symptoms was higher among institutionalized elderly and can be aggravated by the development of functional dependence and the presence of diseases (Oliviera et al., 2014).

Walking, balance, and depression are interconnected aspects that have been extensively studied in various populations, particularly in individuals post-stroke, with multiple sclerosis (MS), and in the elderly. The relationship between walking and balance is crucial, as demonstrated by studies showing a strong correlation between walking capacity, balance performance, and changes in disease progression (Fritz et al., 2015). Furthermore, the relationship between emotional aspects, such as depression, and walking ability has been highlighted, indicating that improvements in walking resistance and balance can lead to better outcomes in depression scores (Cuerda-Ballester et al., 2023). Additionally, walking impairment has been associated with a loss of independence, which in turn can influence depression and depressive symptoms (Ensari et al., 2015). Frailty, decreased walking ability, and depression have also been linked, suggesting that interventions targeting walking ability and frailty could be beneficial in treating and preventing depression in the elderly (Schinkel-Ivy et al., 2017). Moreover, balance confidence has been shown to be related to features of balance and gait, emphasizing the importance of psychological factors in walking ability (Yin et al., 2023). Overall, these findings underscore the intricate relationship between walking, balance, and depression, highlighting the need for comprehensive interventions that target physical improvement to improve overall well-being.

The implementation of exercise interventions, whether individual or group-oriented, has shown significant physical and psychological effectiveness in geriatric populations. Physically, multiple studies have established that structured exercise regimens can improve functional fitness among older adults. In support of this, Lee highlighted that exercise interventions can enhance walking speed and balance, thereby facilitating better daily functioning and overall confidence in physical abilities among community-dwelling elderly individuals (Lee, 2016).
Similarly, research by Campos et al. confirms that various exercise modalities, including aerobic and resistance training, lead to notable enhancements in muscular strength and balance, essential for mitigating the risk of falls (Campos et al., 2016). Several studies have emphasized the effectiveness of targeted

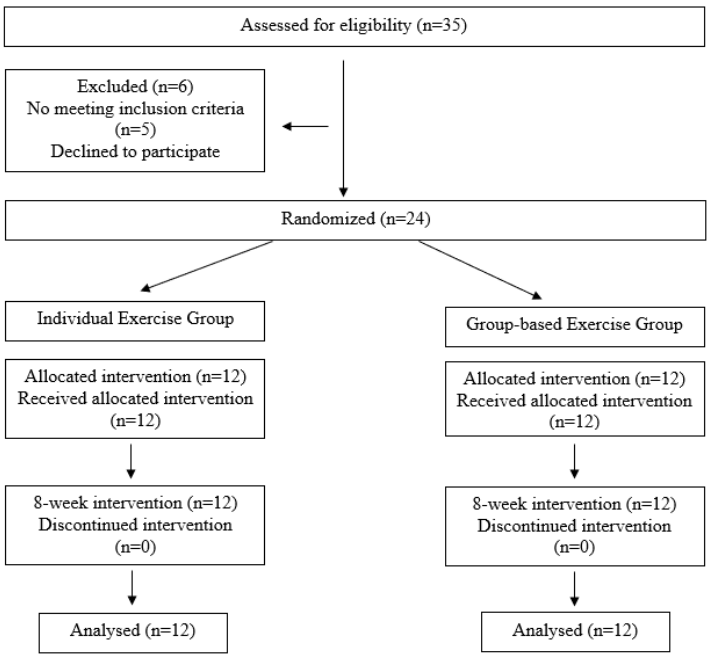
interventions, such as strength and balance training, in improving musculoskeletal health and reducing the risk of falls in older adults (Sahin et al., 2022). For example, a systematic review demonstrated that exercise programs focusing on strength and balance training significantly reduced the rate of falls and fall-related injuries among older adults. These interventions not only improve muscle strength and balance but also enhance overall functional capacity, thereby promoting independence and quality of life in older individuals. This review also stated that the difference between exercise programs given in models such as individual vs group-based is inconclusive (Sherrington et al., 2019). In addition to physical effects, psychological benefits through exercise interventions are also an important issue. In particular, the synergistic effects of group exercise promote social interaction, which alleviates feelings of isolation and fosters a sense of community among participants, and this is thought to be effective in psychological well-being (Wei et al., 2022; Mehra et al., 2016).

The present study aimed to assess the impact of individual and group-based exercises on balance, gait and mental status in older retirement home residents. We hypothesize that older people who perform group-based exercise will show significant improvements in these outcomes compared to their peers who exercise unsupervised and individually.

Methods

Study Design and Study Population
This randomized, pretest-posttest control group study (Fig. 1) was conducted at a private retirement home in Istanbul. At the retirement home where this research was conducted, all 35 elderly individuals meeting initial screening criteria were invited to participate in the study. Of these, 6 individuals did not meet the predefined inclusion criteria, and 5 individuals declined to participate, resulting in a limited final sample of 24 eligible elderly individuals whose eligibility was further assessed. Inclusion criteria were: (1) age ≥ 65 years; and (2) independence in activities of daily living. Participants were ineligible for inclusion if they exhibited: (1) severe cognitive impairment leading to an inability to follow instructions (Mini-Mental State Examination score < 22); (2) hearing or visual impairments; (3) dementia, headaches, or dizziness; (4) other neurological, neuromuscular, or orthopedic diseases; or if they had participated in any experimental rehabilitation or drug studies within the preceding 3 months. Fig. 1 depicts a flowchart illustrating the study participants.

Figure 1.
Flowchart Illustrating the Study Process



Ethical Approval

Approval for the study was granted by the Istanbul Bilgi University Human Research Ethics Committee (No. 2023-40162-088), and written informed consent was obtained from all participants. The research protocol was designed according to the CONSORT guidelines. All procedures adhered to the principles of the 1964 Declaration of Helsinki and its subsequent revisions or comparable ethical standards. The participants received detailed information about the study protocols and provided written consent.

Randomization

Eligible participants were assigned randomly to either the individual exercise group (IG) or the group-based exercise group (GG). A unique code number for each participant was written on paper and enclosed in an envelope. These envelopes were then distributed randomly to the two groups by a research assistant unaware of the code numbers. Subsequently, the research assistant contacted each participant via telephone to disclose their group allocation. The current study's sample size was calculated based on a previous study examining the effects of a multicomponent exercise program on older adults (Tarazona-Santabalbina et al., 2016). It was calculated with an alpha error rate (α) of 5% and a beta error rate (β) of 20%. Sample size was increased by 20% to accommodate possible participant dropouts during follow-up. As a result, the final sample size consisted of 24 elderly individuals equally divided into two groups, with 12 participants in each group.

Procedure

The study ensured that every participant received information beforehand, specifically regarding the risk of falls and specific information stating that the exercise programs would occur three times a week for a total duration of eight weeks. Prior to the intervention, participants in the individualized exercise group (IG) were tasked with selecting three days of the week during which they would independently carry out the exercise program. They had the flexibility to modify these sessions' days and times based on their requirements. Conversely, participants in the GG were instructed to attend three training sessions that were organized by a single physiotherapist. All assessments were conducted by two intervention blinded physiotherapists with over three years of clinical experience.

Group-Based Exercise Program

The exercises are started with warm-up walking (for five minutes), followed by hip-knee flexion while standing, weighted knee flexion-extension while sitting (with 1 kg ankle cuff), ankle dorsiflexion-plantarflexion, weight transfer to the right and left in the sitting position, sit-to-stand exercises, reciprocal arm and leg raises, standing heel and toe raises with eyes open, mini squats, anterolateral, anteromedial, posterolateral, posteromedial excursions consisted of standing on one leg, tandem walking, hamstring, hip flexor and gastro-soleus stretches and cool down (walking for five minutes). The program took approximately 45-minutes. A physiotherapist led and supervised the sessions. Walking sessions were held together, and during all other exercises and movements, the participants were positioned around the physiotherapist in a circle.

Individual Exercise Program

The same exercise program mentioned above was performed individually by 12 other participants, unsupervised. The exercises were given to the participant in a booklet and introduced. A tracking book to mark completed exercise dates and exercise equipment (1 kg ankle cuff weight) were provided. A physiotherapist visited the patients for initial training and called the participants regularly to follow up on the exercise program and to monitor any adverse effects (weeks 2, 4, and 8).

Assessments

Following the participants' introduction to the study, we procured written informed consent from each of them. Subsequently, the participants completed research data forms, facilitating the collection of data on sociodemographic characteristics. Sociodemographic characteristics form included age, sex, educational level, marital status, participants' health status, including questions on chronic disease, history of hospitalization and medication use. Following this, they completed the

Beck Depression Inventory (BDI) and were evaluated with the Berg Balance Scale (BBS), Tinetti Balance Test (TBT) and Tinetti Gait Test (TGT).

The BBS was employed to assess participants' functional balance abilities and identify fall risks, particularly in the elderly. This scale, which predicts fall risks, involves evaluating 14 activities performed in daily life. The items are: sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with eyes closed, standing with feet together, reaching forward with outstretched arm, retrieving object from floor, turning to look behind, turning 360 degrees, placing alternate foot on stool, standing with one foot in front, and standing on one foot. The 14 items in the scale evaluate both static and dynamic balance. At the end of the 14-item evaluation, the patient is scored between 0-56. Individuals at high risk of falling receive a score of 0-20. Those with a moderate risk of falling receive 21-40 points (Bogle Thorbahn and Newton, 1996). The BBS evaluation lasted approximately 10 minutes and was performed by an intervention-blinded physiotherapist.

The TBT and TGT were used to evaluate the balance and walking functions of the participants. These tests are useful tools for detecting problems affecting gait and balance. A lower score on both scales equals a greater risk of falling or the suspicion of underlying pathology affecting balance and gait (Tinetti et al., 1986; Almeida et al., 2016). Balance is evaluated with the first 9 questions over 16 points, and gait is evaluated with the next 7 questions over 12 points. The test evaluates the integrity of movements during daily living activities with 16 items. Scoring is done by observation and performing the specified movements correctly is evaluated as 2 points, performing the specified movements with adaptation is evaluated as 1 point, and failure to perform the movement is evaluated as 0 points. If the total score of the test is 18 or less, it indicates that the risk of falling is high, between 19 and 24, it is moderate, and if it is 24 and above, the risk of falling is low.

The BDI was used to determine the participants' depressive symptoms. This tool comprises 21 inquiries concerning the individual's emotions over the past week, addressing depressive symptoms such as hopelessness, irritability, guilt, or feelings of being punished, alongside physical symptoms like fatigue, weight loss, and decreased libido. Each query is rated on a scale of 0 to 3, yielding a maximum BDI score of 63. A depression cutoff point is set at 12, with scores falling between 1 and 11 indicating subsyndromal depression (Beck et al., 1996).

Statistical Analysis

We used IBM SPSS Statistics for Windows (version 27.0; IBM, Armonk, NY, USA) to analyze the data. Categorical variables are presented as numbers and percentages, while continuous variables are expressed as means and standard deviations (SD). To assess the normality of variable measurements, Shapiro-Wilk tests were conducted. Independent samples t-tests and paired t-tests were employed for pairwise comparisons and within- and between-group assessments, respectively, as they aligned with the assumption of normal distribution. A significance level of $p<0.05$ was applied to determine statistical significance.

Results

The average ages of participants in the IG and GG were comparable, with mean ages of 79.70 ± 4.42 and 79.20 ± 2.94 years, respectively. Furthermore, the majority of participants in both groups were female, accounting for 83.3% and 66.7% of the IG and GG, respectively. Other demographic characteristics of the two groups were also similar (Table 1). We also did not observe significant differences in mean and SD of baseline BBS, TBT, TGT and BDI scores between the IG and GG (Table 1).

Table 1.
Baseline Demographic Characteristics of the Participant Groups

Characteristic	Individual exercise group (N=12)	Group-based exercise group (N=12)	p-value
Age (y)	79.70±4.42	79.20±2.94	0.768
Sex			
Female	10 (83.3)	8 (66.7)	
Male	2 (16.7)	4 (33.3)	
Education level			
Elementary school	6 (50.0)	4 (33.3)	
Middle school	3 (25.0)	5 (41.7)	
High school	2 (16.7)	1 (8.3)	
University	1 (8.3)	2 (16.7)	
Marital status			
Single	8 (66.7)	9 (75.0)	
Married	4 (33.3)	3 (25.0)	
Chronic disease			
Yes	9 (75.0)	7 (58.3)	
No	3 (25.0)	5 (41.7)	
Berg Balance Scale score	38.90±6.90	40.60±11.31	0.401
Tinetti Balance Test score	7.50±2.22	10.30±3.43	0.061
Tinetti Gait Test score	5.00±2.21	5.10±1.91	0.402
Beck Depression Inventory score	10.80±6.05	8.50±3.92	0.128

Values are presented as mean±standard deviation or number (%).

There were no participants withdrawing from the study from either the IG or GG, resulting in 12 participants in each group completing the study. Following this, within-group and between-group assessments were conducted by calculating mean values for each scale before and after the eight-week intervention.

There was a significant difference in the mean BBS scores before and after the 8-week intervention within the GG (p=0.012). The mean and SD of BBS scores increased from 40.60±11.31 before the intervention to 49.90±7.63 after the intervention. However, there were no significant changes observed within the IG (p=0.530). Additionally, a significant difference was noted between the two groups in the mean BBS scores 8 weeks post-intervention (p=0.013).

The mean and standard deviation of the pre-intervention TBT score in both groups increased significantly after the intervention (p=0.022 and p=0.023, respectively). In addition, the mean TBT scores of the two groups showed a significant difference after the 8-week intervention (p=0.011).

The mean and standard deviation of TGT score before the intervention increased after the intervention in the IG and GG. However, the two groups showed no significant difference in mean TBT scores after 8 weeks of intervention (p=0.380). The mean BDI scores before and after the 8-week intervention differed significantly in the GG (p=0.024). The mean and SD of BDI scores before the intervention, 8.50±3.92, decreased to 4.90±2.68 after the intervention. However, we observed no significant changes in the IG (p=0.343). We also observed a significant difference between the two groups in the mean BBS scores 8 weeks after the intervention (p=0.039) (Table 2).

Table 2.
Within-Group and Between-Group Comparisons of Bbs, Tbt, Tgt and Bdi Scores Before and Eight Weeks After the Intervention

	Individual exercise group (N=12)		Group-based exercise group (N=12)		p-value (between-group)
	Score	p-value (within-group)	Score	p-value (within-group)	
BBS					
Pre-intervention	38.90±6.90	0.530	40.60±11.31	0.012*	0.013*
Post-intervention	40.20±8.03		49.90±7.63		
TBT					
Pre-intervention	7.50±2.22	0.022*	10.30±3.43	0.023*	0.011*
Post-intervention	9.20±2.09		12.40±2.75		
TGT					
Pre-intervention	5.00±2.21	0.019*	4.90±2.02	0.001*	0.380
Post-intervention	5.90±2.07		6.70±1.88		
BDI					
Pre-intervention	10.80±6.05	0.343	8.50±3.92	0.024*	0.039*
Post-intervention	9.80±6.40		4.90±2.68		

*Values are presented as mean±standard deviation. *p<0.05 BBS: Berg Balance Scale, TBT: Tinetti Balance Test, TGT: Tinetti Gait Test, BDI: Beck Depression Inventory*

Discussion

Exercise has been shown to have a significant positive impact on the physical and mental state of elderly individuals living in retirement homes (Jiménez-Pavón et al., 2020). Our study aimed to compare the effectiveness of individually performed and group-based exercise programs on gait, balance, and mental status in elderly individuals living in a retirement home. Consistent with our hypothesis, the group-based exercise program was found to be more effective in improving balance and reducing depressive symptoms. However, no significant difference was observed between the groups in terms of gait parameters. The study conducted by Wu et al. also indicates that community-based exercise is more effective compared to individual home-based exercise in improving balance. After 15 weeks of Tai Chi exercise, single leg stance time increased by 1.3 seconds in the home exercise group and this difference was not found to be significant. In those who exercised in a group session, an increase of 3.9 seconds was observed and this difference on balance was significant (p=0.03). The center of pressure sway, which is another indicator of balance, also indicates significant improvement in this group (Wu et al., 2010). Similarly, in our study, a group-based exercise program revealed a significant improvement in Berg Balance Scale (p=0.013) and Tinetti Balance Test (p=0.011) scores compared to individual exercise. Although both groups showed significant improvement in the Tinetti Gait Test, no significant difference was found between them when compared (p=0.380). This may be due to the fact that the sample consists of individuals who are independent in daily life and the assessment tool scored out of 12 may not be sensitive enough to capture significant change in our study.

In a study indicating that there is no difference on physical performance between group exercise and individual exercise, it was stated that this result may be due to the young study sample and that group exercises

may be more effective on the elderly population (Gönen et al., 2022). In another study conducted by Patterson et al., it was stated that group exercise was more effective than individual exercise in physical function and quality of life endpoints (Patterson et al., 1997). The increase of optimal physical functions, especially balance and gait parameters, plays a very important role in mobility and activities of daily living.

Additionally, minimally supervised exercise has been found to be safe and can improve functional performance, indicating its potential to positively influence mental well-being (Nelson et al., 2004). Engaging in physical activity has been associated with a reduction in depression levels and an increase in adaptation to old age among elderly individuals (Gökşin and Aşiret, 2021). The literature indicates that exercise programs improve the mental health and quality of life of residents through social interaction, meaningful use of time, purposeful activity, and empowerment (Alexandratos et al., 2012). Our study results also revealed that a group-based exercise program indicated a significant improvement in the Beck Depression Inventory score ($p=0.039$) compared to individual exercise.

The limitations of this study include the small sample size absence of evaluation on additional physical parameters like strength and endurance, and restriction to a single study location. Therefore, there is a need for further studies in which all variables and long-term effects are examined with larger samples.

Conclusions

This preliminary study indicates that group-based supervised exercise programs may be more effective than individual exercises in enhancing balance and mental well-being among elderly individuals residing in retirement homes. The observed benefits appear to extend beyond the physical effects of exercise, potentially stemming from increased social interaction, mutual support, and heightened motivation within group settings. These findings emphasize the importance of incorporating social components into exercise interventions and suggest promising avenues for future research, such as exploring the psychosocial mechanisms underlying these outcomes and assessing participants' subjective experiences. The results also underscore the practicality and potential cost-effectiveness of implementing group exercise programs in institutional settings, pointing to the need for broader adoption and further implementation research to facilitate their integration into routine care for aging populations.

Authorship Contributions

FC, HS and MGP conceptualised and designed the study. FC acquired and analysed the data, with support from HS and MGP. All authors contributed to interpreting the data and the drafting and critical revision of the paper. All authors approved the final manuscript for submission.

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References

Alexandratos, K., Barnett, F., & Thomas, Y. (2012). The impact of exercise on the mental health and quality of life of people with severe mental illness: A critical review. *British Journal of Occupational Therapy*, 75(2), 48–60. https://doi.org/10.4276/030802212X13286281650956

Almeida, L. R. S., Valença, G. T., Negreiros, N. N., Pinto, E. B., & Oliveira-Filho, J. (2016). Comparison of self-report and performance-based balance measures for predicting recurrent falls in people with Parkinson disease: Cohort study. *Physical Therapy*, 96(7), 1074–1084. https://doi.org/10.2522/ptj.20150168

Beck, A. T., Steer, R. A., & Brown, G. (1996). Beck Depression Inventory–II manual for the Beck Depression Inventory-II. Psychological Corporation. https://doi.org/10.1037/t00742-000

Bogle Thorbahn, L. D., & Newton, R. A. (1996). Use of the Berg Balance Test to predict falls in elderly persons. *Physical Therapy*, 76(6), 576–583. https://doi.org/10.1093/ptj/76.6.576

Bul, M., Shaikh, F., McDonagh, J., & Ferguson, C. (2023). Frailty and oral anticoagulant prescription in adults with atrial fibrillation: A systematic review. *Aging Medicine*, 6(2), 195–206. https://doi.org/10.1002/agm2.12214

Campos, L., Nakamura, P., & Kokubun, E. (2016). Comparison of physical fitness in elderly

submitted to different physical exercise interventions. *Revista Brasileira de Atividade Física & Saúde*, 21(1), 78–85. https://doi.org/10.12820/rbafs.v.21n1p78-84

Crowe, M., Sartori, A., Clay, O. J., Wadley, V. G., Andel, R., & Wang, H. X. (2010). Diabetes and cognitive decline: Investigating the potential influence of factors related to health disparities. *Journal of Aging and Health*, 22(3), 292–306. https://doi.org/10.1177/0898264309357445

Cuerda-Ballester, M., Martínez-Rubio, D., García-Pardo, M. P., Proaño, B., Cubero, L., Calvo-Capilla, A., et al. (2023). Relationship of motor impairment with cognitive and emotional alterations in patients with multiple sclerosis. *International Journal of Environmental Research and Public Health*, 20(2), 1234. https://doi.org/10.3390/ijerph20021387

Dasdemir Ilkhan, G., & Celikhisar, H. (2021). The effect of incontinence on sleep quality in the elderly. *International Journal of Clinical Practice*, 75(5), e13965. https://doi.org/10.1111/ijcp.13965

Ensari, I., Adamson, B. C., & Motl, R. W. (2015). Longitudinal association between depressive symptoms and walking impairment in people with relapsing-remitting multiple sclerosis. *Journal of Health Psychology*, 21(11), 2732–2741. https://doi.org/10.1177/1359105315584837

Fritz, N. E., Newsome, S. D., Eloyan, A., Marasigan, R. E. R., Calabresi, P. A., & Zackowski, K. M. (2015). Longitudinal relationships among posturography and gait measures in multiple sclerosis. *Neurology*, 84(20), 2048–2056. https://doi.org/10.1212/WNL.0000000000001580

Gökşin, İ., & Aşiret, G. D. (2021). The effect of progressive muscle relaxation on the adaptation of elderly women to depression and old age: A randomised clinical trial. *Psychogeriatrics*, 21(3), 333–341. https://doi.org/10.1111/psyg.12673

Gönen, T., & Yakut, Y. (2022). The effect of individual exercise and group exercise training on physical performance in healthy women. *Black Sea Journal of Health Science*, 5(3), 526–532. https://doi.org/10.19127/bshealthscience.1078848

Gouveia, É. R., Ihle, A., Gouveia, B. R., Kliegel, M., Marques, A., & Freitas, D. L. (2020). Muscle mass and muscle strength relationships to balance: The role of age and physical activity. *Journal of Aging and Physical Activity*, 28(2), 262–268. https://doi.org/10.1123/japa.2018-0113

Hayashida, I., Tanimoto, Y., Takahashi, Y., Kusabiraki, T., & Tamaki, J. (2014). Correlation between muscle strength and muscle mass, and their association with walking speed, in community-dwelling elderly Japanese individuals. *PLOS ONE*, 9(11), e111810. https://doi.org/10.1371/journal.pone.0111810

Jiménez-Pavón, D., Carbonell-Baeza, A., & Lavie, C. J. (2020). Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. *Progress in Cardiovascular Diseases*, 63(3), 386–388. https://doi.org/10.1016/j.pcad.2020.03.009

Lee, T. (2016). Effects of exercise intervention on the functional fitness of community elderly. *MATEC Web of Conferences*, 71, 03010. https://doi.org/10.1051/matecconf/20167103010

Mehra, S., Dadema, T., Kröse, B., Visser, B., Engelbert, R., Helder, J., & Weijs, P. (2016). Attitudes of older adults in a group-based exercise program toward a blended intervention: A focus-group study. *Frontiers in Psychology*, 7, Article 1827. https://doi.org/10.3389/fpsyg.2016.01827

Murdoch, W. W., Chu, F. I., Stewart-Oaten, A., & Wilber, M. Q. (2018). Improving wellbeing and reducing future world population. *PLOS ONE*, 13(9), e0202851. https://doi.org/10.1371/journal.pone.0 202851

Nelson, M. E., Layne, J. E., Bernstein, M. J., Nuernberger, A., Castaneda, C., Kaliton, D., et al. (2004). The effects of multidimensional home-based exercise on functional performance in elderly people. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 59(2), 154–160. https://doi.org/10.1093/gerona/59.2.m154

Oliveira, S. C. de, Santos, A. A. dos, & Pavarini, S. C. I. (2014). The relationship between depressive symptoms and family functioning in institutionalized elderly. *Revista da Escola de Enfermagem da USP*, 48, 65–71. https://doi.org/10.1590/s0080-623420140000100008

Patel, K. V., Phelan, E. A., Leveille, S. G., Lamb, S. E., Missikpode, C., Wallace, R. B., et al. (2014). High prevalence of falls, fear of falling, and impaired balance among older adults with pain in the U.S.: Findings from the 2011 National Health and Aging Trends Study. *Journal of the American Geriatrics Society*, 62(10), 1844–1852. https://doi.org/10.1111/jgs.13072

Patterson, R. B., Pinto, B., Marcus, B., Colucci, A., Braun, T., & Roberts, M. (1997). Value of a supervised exercise program for the therapy of arterial claudication. *Journal of Vascular Surgery*, 25(2), 312–318. https://doi.org/10.1016/s0741-5214(97)70352-5

Sahin, S., Şenuzun Aykar, F., Yildirim, Y., & Jahanpeyma, P. (2022). The impact of the Otago Exercise Program on frailty and empowerment in older nursing home residents: A randomized controlled trial. *Annals of Geriatric Medicine and Research*, 26(1), 25–32. https://doi.org/10.4235/agmr.21.0095

Saygin, Ö., Ceylan, H. İ., & İrez, G. B. (2018). The effect of gender and living place on the number of falls, the risk of falling, the fear of falling and balance over 65 years of age. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi*, 16(4), 82–95. https://doi.org/10.33689/spormetre.466278

Schinkel-Ivy, A., Wong, J. S., & Mansfield, A. (2017). Balance confidence is related to features of balance and gait in individuals with chronic stroke. *Journal of Stroke and Cerebrovascular Diseases*, 26(2), 237–245. https://doi.org/10.1016/j.jstrokecerebrovasdis.2016.07.022

Sherrington, C., Fairhall, N. J., Wallbank, G. K., Tiedemann, A., Michaleff, Z. A., Howard, K., et al. (2019). Exercise for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews*, 2019(1), CD012424. https://doi.org/10.1002/14651858.CD012424.pub2

Tarazona-Santabalbina, F. J., Gómez-Cabrera, M. C., Pérez-Ros, P., Martínez-Arnau, F. M., Cabo, H., Tsaparas, K., et al. (2016). A multicomponent exercise intervention that reverses frailty and improves cognition, emotion, and social networking in the community-dwelling frail elderly: A randomized clinical trial. *Journal of the American Medical Directors Association*, 17(5), 426–433. https://doi.org/10.1016/j.jamda.2016.01.019

Tinetti, M. E., Williams, T. F., & Mayewski, R. (1986). Fall risk index for elderly patients based on number of chronic disabilities. *American Journal of Medicine*, 80(3), 429–434. https://doi.org/10.1016/0002-9343(86)90717-5

Wei, L., Hu, Y., Tao, Y., Hu, R., & Zhang, L. (2022). The effects of physical exercise on the quality of life of healthy older adults in China: A systematic review. *Frontiers in Psychology*, 13, Article 1000136. https://doi.org/10.3389/fpsyg.2022.895373

Wu, G., Keyes, L., Callas, P., Ren, X., & Bookchin, B. (2010). Comparison of telecommunication, community, and home-based Tai Chi exercise programs on compliance and effectiveness in elders at risk for falls. *Archives of Physical Medicine and Rehabilitation*, 91(6), 849–856. https://doi.org/10.1016/j.apmr.2010.01.024

Yin, H., Gao, C., Quan, Z., & Zhang, Y. (2023). The relationship between frailty, walking ability, and depression in elderly Chinese people. *Medicine*, 102(45), e35876. https://doi.org/10.1097/MD.0000000000035876