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A Pilot Study: Comparative Effects of Tai-Chi Combined with Frenkel Exercises versus Swiss-Ball Combined with Frenkel Exercises on Balance and Fear of Falling in Older Adults

Dr. Devendra Singh Shekhawat¹, Dr. Parul Sharma², Dr. Hemendra Kumar Sharma³, Dr. Parth Bhardwaj⁴, Dr. Aryan Pachar⁵, Dr. Gaurav Soni⁶, Dr. Priyanka sharma⁷

¹Associate Professor, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. physiodevendra@gmail.com, ORCID ID: <https://orcid.org/0009-0005-1862-4027>.

²Assistant Professor, Jaipur National University Institute of Medical Sciences and Technology, Jaipur, Rajasthan, India. drparulsharma99@gmail.com

³Associate Professor, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. Hemendra.physio@gmail.com

⁴Lecturer, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. Parthbhardwaj00@gmail.com

⁵Tutor, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. Aarupachar516@gmail.com

⁶Lecturer, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. Gauravsoni2609@gmail.com

⁷Assistant Professor, Mahatma Gandhi Physiotherapy College, Mahatma Gandhi University of Medical Sciences and Technology, Jaipur, Rajasthan, India. sharmapriyanka7077@gmail.com

ABSTRACT: Background: Ageing is associated with physiological changes that may adversely affect postural control, balance, and functional independence, thereby increasing the risk of falls among older adults. Falls are an important public health concern because they are associated with morbidity, mortality, reduced functional independence, and increased healthcare burden. Exercise-based interventions such as Tai-Chi and Swiss-ball exercises have been reported to improve balance and fall-related outcomes in older adults. However, the comparative effects of these interventions when combined with Frenkel exercises require further investigation. Therefore, the present study compared the effects of Tai-Chi exercises combined with Frenkel exercises and Swiss-ball exercises combined with Frenkel exercises on balance and fall-related self-efficacy in elderly individuals.

Methods: This exploratory pilot study was conducted among 50 elderly participants who were randomly allocated into two equal groups of 25 participants each. Group A received Tai-Chi exercises combined with Frenkel exercises, whereas Group B received Swiss-ball exercises combined with Frenkel exercises. Both groups received the intervention for 8 weeks, 5 days per week. Outcomes were assessed at baseline, 4 weeks, and 8 weeks using

the Berg Balance Scale (BBS) for balance and the Fall Efficacy Scale (FES) for fall-related concerns. Between-group differences at 8 weeks were analysed using analysis of covariance (ANCOVA), adjusting for baseline outcome scores, age, and gender.

Results: Both groups demonstrated progressive improvement in BBS scores and reduction in FES scores over the 8-week intervention period. Mean BBS scores increased from 37.20 to 47.16 in Group A and from 33.80 to 42.84 in Group B. Mean FES scores decreased from 79.88 to 66.52 in Group A and from 79.20 to 69.24 in Group B. Baseline BBS scores differed significantly between groups; therefore, baseline-adjusted ANCOVA was performed. After adjustment for baseline BBS, age, and gender, a significant between-group difference was observed in 8-week BBS scores, with Group A demonstrating a higher adjusted mean score than Group B ($F(1,45) = 9.29$, $p = 0.004$, partial $\eta^2 = 0.17$). For FES, baseline scores were comparable between groups, and ANCOVA adjusted for baseline FES, age, and gender demonstrated a significant between-group difference at 8 weeks ($F(1,45) = 16.97$, $p < 0.001$, partial $\eta^2 = 0.27$), favouring Group A.

Conclusion: Both Tai-Chi combined with Frenkel exercises and Swiss-ball combined with Frenkel exercises were associated with improvements in balance and fall-related outcomes over 8 weeks. After adjustment for baseline scores and demographic variables, Tai-Chi combined with Frenkel exercises demonstrated more favourable outcomes than Swiss-ball combined with Frenkel exercises. These findings suggest that Tai-Chi combined with Frenkel exercises may be a useful physiotherapy-based intervention for improving balance and reducing fall-related concerns in elderly individuals.

1. INTRODUCTION

The process of aging entails ongoing, gradual changes in a person's or a biological system's structural and functional traits. These alterations might happen organically or be impacted by a number of internal and external variables [1]. In India, almost 40% of the elderly population has some sort of balance issue. Diabetes mellitus, muscular weakness, visual and auditory problems, and dizziness may all contribute to balance impairment in older persons [2].

One of the biggest health risks for geriatric population is falls. Every year, falls cause around 424,000 deaths worldwide, and 37.3 million falls necessitate medical care [3]. Every year, between 28–35% of people 65 and older fall, and that number rises to about 32–42% of those over 70 [4]. Falls can cause significant morbidity, mortality, disability, functional limits, and higher healthcare costs. They are the second most common cause of unintentional injury-related death globally [3,5]. Therefore, key elements of fall prevention and geriatric rehabilitation include enhancing balance and lowering fear of falling.

For older persons to preserve their functional independence and quality of life, fall avoidance is crucial. Bathrooms and private rooms have been identified as common areas for falls in hospitals or nursing homes [6,7]. Falls can happen during regular everyday activities. Particularly in older persons, fall-related injuries such as hip fractures and traumatic brain injuries can have significant long-term physical and functional repercussions [8]. Postural stability may also be further compromised by neurological and sensory impairments. Compared to people without neurological impairment, older persons with mild-to-moderate neurological impairment may fall at a rate that is almost three times greater [9].

Exercise-based therapies that focus on balance, coordination, postural control, and movement confidence may play a significant role in geriatric physiotherapy since falls and balance impairment are multidimensional. Tai-Chi combines slow, controlled, and coordinated motions with regulated breathing to increase balance, muscular strength, flexibility, proprioceptive awareness, and postural control, potentially lowering fear of falling [10].

Coordination is the ability to organize and control movement through the interaction of intramuscular and intermuscular activity and sensory feedback. Age-related changes may impair coordination and slow reaction time. Frenkel exercises consist of progressively challenging, slow, and controlled movements designed to facilitate coordination through visual and sensory feedback. These exercises may therefore contribute to improved movement control and functional performance [11].

Swiss-ball exercises, also called stability-ball exercises, offer an unstable support surface that tests balance, coordination, postural control, and trunk stability. Swiss-ball training has been shown to improve core muscular strength and balance in earlier studies [11]. Thus, combining Frenkel exercises with either Tai-Chi or Swiss-ball exercises may provide complementary effects on balance and fall-related outcomes.

Previous research has reported significant improvements in balance and reductions in fear of falling among older adults participating in Tai-Chi combined with Frenkel exercises [12]. Exercise programs incorporating balance training, functional activities, and progressive exercise have also been associated with improvements in physical function and reduction of fall risk in older adults [13,14]. However, because falls are multifactorial, exercise should be considered alongside assessment and management of other risk factors, including medication use, environmental hazards, muscle weakness, visual impairment, and functional limitations [14,15]. Appropriate footwear, regular vision assessment, community-based exercise, and education of older adults and caregivers may further support comprehensive fall-prevention strategies [16].

Therefore, the purpose of this study was to compare the effects of Tai-Chi combined with Frenkel exercises versus Swiss-ball combined with Frenkel exercises on balance and fall-related self-efficacy in older adults.

Objective of study

To compare the effects of Tai-Chi exercises combined with Frenkel exercises and Swiss-ball exercises combined with Frenkel exercises on balance and fear of falling among elderly individuals over an 8-week intervention period.

2. MATERIALS AND METHODS

2.1. Evaluation of Study Subjects

A total of 50 participants aged 50–70 years were recruited for this comparative study from the Physiotherapy Outpatient Department of Mahatma Gandhi Hospital, Jaipur, Rajasthan. Both male and female participants were included in the study. Participants were screened according to the predefined inclusion and exclusion criteria before enrolment.

Eligible participants were required to have a history of at least two falls during the preceding six months and the ability to walk independently, with or without a walking aid. Participants who were willing to participate in the 8-week intervention program were included. Written informed consent was obtained from all participants before their enrolment in the study.

Participants were randomly allocated to either Group A or Group B in a 1:1 ratio using a computer-generated randomization sequence. Allocation was performed prior to commencement of the intervention

Group A (n = 25): Participants received Tai-Chi exercises along with Frenkel coordination exercises.

Group B (n = 25): Participants received Swiss-ball exercises along with Frenkel coordination exercises.

The intervention was continued for a period of 8 weeks. The dependent outcome measures used to evaluate the effects of the interventions were the Berg Balance Scale (BBS) and Falls Efficacy Scale (FES). The BBS was used to assess functional balance, whereas the FES was used to assess participants' confidence and concern regarding falling during daily activities.

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

- Age between 50 and 70 years.
- Both male and female participants.
- Willingness to participate in the 8-week study.
- History of at least two falls during the preceding six months.
- Ability to walk independently, with or without a walking aid.

Exclusion Criteria

Participants were excluded if they met any of the following criteria:

- Neurological conditions affecting balance, fainting or dizzy spells, or cognitive, behavioural, or perceptual problems.
- History of head injury.
- Recent fractures.
- Cancer.
- Kidney disease.
- Uncontrolled diabetes mellitus.
- Seizure disorder.
- Cardiovascular conditions that contraindicated or prevented participation in exercise.

2.2. Outcome measure

Berg Balance Scale (BBS): The Berg Balance Scale was used to assess functional balance. The scale consists of 14 functional tasks, with each item scored from 0 to 4 according to the participant's ability to perform the task. The total score ranges from 0 to 56, with higher scores indicating better balance performance. BBS was assessed at baseline, 4 weeks, and 8 weeks.[27]

Falls Efficacy Scale (FES): The Falls Efficacy Scale was used to assess participants' confidence in performing activities of daily living without falling. The scale consists of 10 activities, each rated from 1 (very confident) to 10 (not confident at all), giving a total score ranging from 10 to 100. Higher scores indicate lower confidence and greater fear of falling.[28]

2.3. Procedure

Participants in both groups received supervised exercise training 5 days per week for 8 weeks. Each session lasted approximately 60 minutes.

Group A (Tai-Chi + Frenkel exercises): Participants performed 30 minutes of Easy Tai-Chi exercises followed by 30 minutes of Frenkel coordination exercises. The Tai-Chi program consisted of an eight-form sequence incorporating upper- and lower-limb movements, trunk movements, weight shifting, stepping, and progressive postural-control activities. The sequence included Commencing Form, Repulse Monkey, Grasping the Peacock's Tail, Wave Hands Like Clouds, Fair Lady Works at Shuttles, Golden Cock Stands on One Leg, Brush Knees and Twist Steps, and Closing Form. The Tai-Chi exercises were progressed according to the participant's ability. [17]

Group B (Swiss-ball + Frenkel exercises): Participants performed 30 minutes of Swiss-ball exercises followed by 30 minutes of Frenkel coordination exercises. The Swiss-ball program included pelvic tilting and weight-shifting exercises, upper- and lower-limb movements, multidirectional reaching while sitting on the ball, bridging with the lower limbs supported on the ball, and lower-limb abduction and adduction exercises. [18]

Frenkel coordination exercises: Both groups performed the same 30-minute Frenkel exercise program, including sitting, standing, weight-transfer, stepping, directional-change, lower-limb movement, and straight-line walking activities. The exercises were progressively advanced by increasing movement complexity, altering speed, and incorporating start-and-stop commands. Exercises were performed slowly and under supervision to facilitate controlled movement and coordination. [19]

All exercises were performed under appropriate supervision. Participants were instructed to stop exercise in case of dizziness, pain, or other significant discomfort. Appropriate safety measures were maintained throughout the intervention.

2.4. Statistical Analysis

Data were analysed using descriptive and inferential statistical methods. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequency and percentage. Baseline demographic characteristics were compared between the two groups using an independent-samples *t*-test for continuous variables and the chi-square test for categorical variables. The 8-week post-intervention BBS and FES scores were compared between groups using analysis of covariance (ANCOVA), with the corresponding baseline score, age, and gender included as covariates. Adjusted mean scores, standard errors (SE), *F*-statistics, *p*-values, and partial eta-squared (η^2) were reported. Statistical significance was considered at $p < 0.05$.

3. RESULTS

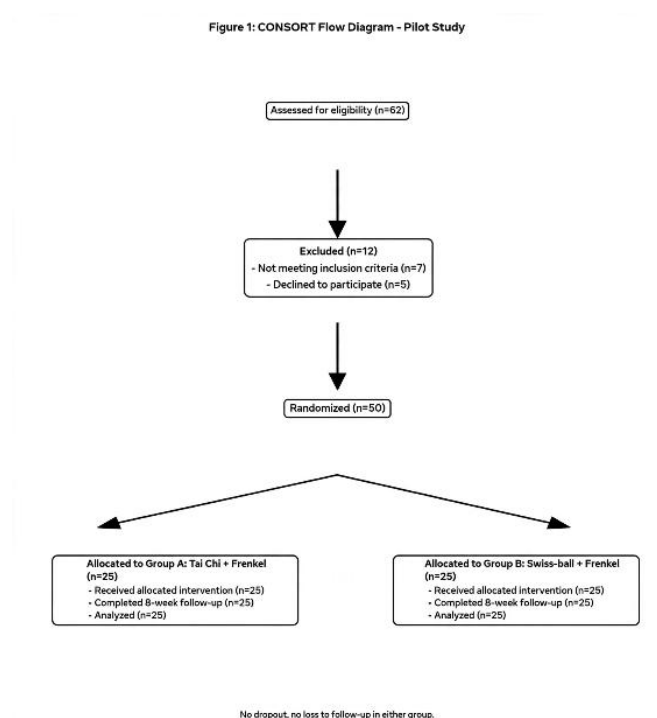


Figure 1 shows the CONSORT flow diagram of participant recruitment and retention.

A total of 62 elderly individuals were assessed for eligibility, of which 12 were excluded (7 did not meet inclusion criteria, 5 declined). Fifty participants were randomized (25 per group) and all completed the 8-week intervention with no dropouts (Figure 1). Group A received Tai-Chi exercises combined with Frenkel coordination exercises, whereas Group B received Swiss-ball exercises combined with Frenkel coordination exercises, administered 5 days per week for 8 weeks. At baseline, no significant between-group differences were observed in age or gender distribution. However, baseline BBS scores were significantly different between groups ($p < 0.001$), whereas baseline FES scores did not differ significantly ($p = 0.281$).

Table 1 Baseline Demographic and Clinical Characteristics

Variable	Group A (n=25)	Group B (n=25)	p-value
Age (years)	63.48 ± 4.32	64.28 ± 4.90	0.536
Male, n (%)	17 (68%)	15 (60%)	0.556
Female, n (%)	8 (32%)	10 (40%)	
BBS pre-test	37.20 ± 1.12	33.80 ± 4.12	<0.001
FES pre-test	79.88 ± 2.54	79.20 ± 1.89	0.281

BBS scores increased from baseline to 8 weeks in both groups, from 37.20 ± 1.12 to 47.16 ± 1.49 in Group A and from 33.80 ± 4.12 to 42.84 ± 3.79 in Group B. Because baseline BBS scores differed significantly between groups, ANCOVA was performed with baseline BBS, age, and gender as covariates. After adjustment, a statistically significant between-group difference was observed in 8-week BBS scores, $F(1,45) = 9.29$, $p = 0.004$, partial $\eta^2 = 0.17$. The adjusted mean BBS score was 45.65 ± 0.28 in Group A and 44.35 ± 0.28 in Group B, indicating significantly better balance performance in Group A.

Table 2 BBS and FES Scores at Baseline, 4 Weeks, and 8 Weeks

Variable	Group	Pre-test	4 Weeks	8 Weeks
BBS	A	37.20 ± 1.12	41.44 ± 1.33	47.16 ± 1.49
	B	33.80 ± 4.12	37.80 ± 4.20	42.84 ± 3.79
FES	A	79.88 ± 2.54	73.12 ± 2.91	66.52 ± 3.15
	B	79.20 ± 1.89	75.40 ± 1.85	69.24 ± 2.03

FES scores decreased from baseline to 8 weeks in both groups, from 79.88 ± 2.54 to 66.52 ± 3.15 in Group A and from 79.20 ± 1.89 to 69.24 ± 2.03 in Group B. ANCOVA was performed with baseline FES, age, and gender as covariates. A statistically significant between-group difference was observed in 8-week FES scores, $F(1,45) = 16.97$, $p < 0.001$, partial $\eta^2 = 0.27$. The adjusted mean FES score was 66.39 ± 0.51 in Group A and 69.37 ± 0.51 in Group B. Assuming that lower FES scores indicate lower fear of falling, these findings indicate a greater reduction in fear of falling in Group A.

Table 3 Between-Group Comparison at 8 Weeks Using ANCOVA

Variable	Group A Adjusted Mean ± SE	Group B Adjusted Mean ± SE	Mean Difference	F(1,45)	p-value	Partial η^2
BBS, 8 Weeks	45.65 ± 0.28	44.35 ± 0.28	1.30	9.29	0.004	0.17
FES, 8 Weeks	66.39 ± 0.51	69.37 ± 0.51	-2.97	16.97	<0.001	0.27

4. DISCUSSION

In this study effects of Tai-Chi exercises combined with Frenkel exercises compared with Swiss-ball exercises combined with Frenkel exercises on balance and fall-related self-efficacy in elderly individuals. Random allocation was done and participants divided into two equal groups and each group received their respective interventions for 8 weeks, 5 days per week. The Berg Balance Scale (BBS) and Fall Efficacy Scale (FES) were used to measure balance and fall-related outcomes at baseline, four weeks, and eight weeks.

Both groups showed consistent progress in their BBS scores during the duration of the exercise. For Group A, their mean BBS score was recorded at 37.20 at the start and 47.16 after 8 weeks, while for Group B, there was an improvement from 33.80 at the start to 42.84. Thus, this result suggest that both exercises led to improvements in the functional balance of the subjects. The possible reason for the improvement in the case of the Tai-Chi and Frenkel combination is probably because of the slow, controlled, and multidirectional nature of movements performed in Tai-Chi, which requires shifting weights, stepping, and postural adjustments. Some recent studies that used systematic reviews and meta-analysis found some benefits of Tai-Chi in terms of balance and physical function among elderly individuals, particularly in BBS and other balance tests [23,24]. The findings in this study are in agreement with Hosseini et al. (2018) in that an 8-week Tai Chi Chuan intervention was effective in improving balance and functional mobility as well as reducing the fear of falls in community-dwelling older adults. [20].

Also, Group B showed improvements in BBS scores, as they increased from 33.80 at baseline to 42.84 after 8 weeks. Swiss ball exercises use an unstable surface that requires postural changes, and might challenge the stability of trunk, proprioception, coordination, and anticipatory postural adjustments. This could explain the improvement in balance after Swiss-ball training. It is known from previous literature that Swiss-ball exercises used for trunk stabilization were effective in improving static and

dynamic balance among elderly individuals. Lee et al. showed significant improvement in several parameters of static and dynamic balance after four-weeks of Swiss-ball exercise.[21]. Previous research has also demonstrated improvements in postural stability and balance following proprioceptive and unstable-surface training in older adults [22].

FES scores decreased progressively in both groups during the intervention. Group A showed a reduction from 79.88 at baseline to 66.52 at 8 weeks, whereas Group B decreased from 79.20 to 69.24. Assuming the scoring direction used in the present study, lower FES scores indicate reduced fear or concern related to falling. The greater reduction observed in Group A may be associated with the balance-related demands of Tai-Chi, which require repeated weight transfer, controlled movement, and postural adaptation. Improved balance ability may consequently enhance confidence during functional activities and reduce concerns related to falling. This finding is consistent with previous evidence indicating that Tai-Chi may improve balance confidence and reduce fear of falling in older adults [23,25].

At 8 weeks, Group A demonstrated a higher observed mean BBS score than Group B (47.16 vs. 42.84) and a lower observed mean FES score (66.52 vs. 69.24). However, interpretation of the between-group BBS findings requires caution because the groups differed significantly in baseline BBS scores (37.20 vs. 33.80, $p < 0.001$). Therefore, the higher unadjusted 8-week BBS score in Group A should not be interpreted solely as an intervention effect. To account for this baseline imbalance, ANCOVA was performed using baseline BBS, age, and gender as covariates. After adjustment, a statistically significant between-group difference remained in 8-week BBS scores, with Group A demonstrating a higher adjusted mean than Group B ($F(1,45) = 9.29$, $p = 0.004$, partial $\eta^2 = 0.17$). This suggests that the advantage of the Tai-Chi plus Frenkel intervention persisted after accounting for baseline BBS and demographic differences, although the baseline imbalance should still be considered when interpreting the magnitude of the treatment effect.

In contrast, baseline FES scores were comparable between the groups ($p = 0.281$). Both groups demonstrated reductions in FES scores over the intervention period, with a greater observed reduction in Group A. After adjustment for baseline FES, age, and gender, ANCOVA demonstrated a statistically significant between-group difference at 8 weeks ($F(1,45) = 16.97$, $p < 0.001$, partial $\eta^2 = 0.27$). The adjusted mean FES score was lower in Group A than in Group B, supporting a greater reduction in fall-related concerns in the Tai-Chi plus Frenkel group.

The common Frenkel exercise component may also have contributed to improvements observed in both groups. Frenkel exercises consist of slow, controlled, and visually guided movements that require accurate limb placement, coordinated movement, and attention to movement execution. These characteristics may facilitate the integration of visual and somatosensory information during movement and contribute to improved coordination and postural control [26]. Since both groups received Frenkel exercises, the improvements observed in both groups may partly reflect the contribution of this common intervention component. The additional between-group differences may therefore be related to the specific characteristics of Tai-Chi and Swiss-ball training.

Overall, both intervention groups demonstrated favourable changes in balance and fall-related outcomes over the 8-week intervention period. The ANCOVA findings further indicated statistically significant between-group differences at 8 weeks after adjustment for baseline scores, age, and gender, with the Tai-Chi plus Frenkel group demonstrating more favourable adjusted outcomes for both BBS and FES. These findings suggest that combining Tai-Chi with Frenkel exercises may provide additional benefits for balance and fall-related self-efficacy compared with Swiss-ball exercises combined with Frenkel exercises in elderly individuals. Nevertheless, the significant baseline imbalance in BBS warrants cautious interpretation of the between-group balance findings. Future studies with larger sample sizes, rigorous allocation procedures, longer follow-up periods, and adequately powered baseline-adjusted analyses are recommended to confirm the observed effects and determine the long-term clinical benefits of these interventions.

5. CONCLUSION

The present study concluded that both Tai-Chi combined with Frenkel exercises and Swiss-ball exercises combined with Frenkel exercises were associated with improvements in balance and fall-related outcomes among elderly individuals following 8 weeks of intervention. However, after adjustment for baseline scores, age, and gender, the Tai-Chi with Frenkel exercise group demonstrated more favourable outcomes in BBS and FES compared with the Swiss-ball with Frenkel exercise group. These findings suggest that Tai-Chi combined with Frenkel exercises may be a beneficial physiotherapy approach for improving balance and reducing fear of falling in elderly individuals.

6. LIMITATIONS

This study has some limitations. The sample size was relatively small, and participants were recruited from a single clinical setting, which may limit generalizability. Participants and therapists could not be blinded because of the nature of the exercise interventions. In addition, the significant baseline imbalance in BBS warrants cautious interpretation of the between-group balance findings. Longer-term follow-up studies with larger samples and rigorous allocation and assessment procedures are warranted.

7. ETHICS APPROVAL

The study received approval from the Institutional Ethics Committee of Mahatma Gandhi Medical College & Hospital, Jaipur, under approval number MGMC & H/IEC/JPR/2023/1265.

8. FUNDING

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9. CONFLICT OF INTEREST

The authors declare that they have no competing interests or conflicts of interest.

REFERENCES

- [1] Youngson R, Robert M. Ageing. In: *Collins Dictionary of Medicine*. Glasgow: HarperCollins; 2004–2005.
- [2] Borha H, Shukla P, Jain K, Kumar S. Elderly population in India. In: *Elderly in India: Profile and Programmes*. New Delhi: Government of India; 2016. p.24.
- [3] World Health Organization. *WHO global report on falls prevention in older age*. Geneva: World Health Organization; 2007.
- [4] Cao ZB, Maeda A, Shima N, Kurata H, Nishizono H. The effect of a 12-week combined exercise intervention program on physical performance and gait kinematics in community-dwelling elderly women. *J Physiol Anthropol*. 2007;26(3):325-332. doi:10.2114/jpa2.26.325.
- [5] Dey S, Nambiar D, Lakshmi JK, et al. Health of the elderly in India: challenges of access and affordability. In: National Research Council (US) Panel on Policy Research and Data Needs to Meet the Challenge of Aging in Asia; Smith JP, Majmundar M, editors. *Aging in Asia: Findings from New and Emerging Data Initiatives*. Washington (DC): National Academies Press (US); 2012. p.15. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK109208/>
- [6] Duffy A. The assessment and management of falls in residential care settings. *Br J Nurs*. 2013;22(5):259-263. doi:10.12968/bjon.2013.22.5.259.
- [7] Chan DK. Falls in nursing homes: challenges from a nursing perspective. *Br J Community Nurs*. 2019;24(1):6-9. doi:10.12968/bjcn.2019.24.1.6.
- [8] Uymaz P. The impact of COVID on elderly falls living in the community. *Int Arch Integr Med*. 2021;8(9):26-31.
- [9] Homann B, Plaschg A, Grundner M, Haubenberger D, Schwerdtfeger AR, Wöber C, et al. The impact of neurological disorders on the risk for falls in the community dwelling elderly: a case-controlled study. *BMJ Open*. 2013;3(11):e003367. doi:10.1136/bmjopen-2013-003367.
- [10] Song J, Wei L, Cheng K, Lin Q, Xia P, Wang X, et al. The effect of modified Tai Chi exercises on the physical function and quality of life in elderly women with knee osteoarthritis. *Front Aging Neurosci*. 2022;14:860762. doi:10.3389/fnagi.2022.860762.
- [11] Chen Y, Qin J, Tao L, Liu Z, Huang J, Liu W, et al. Effects of Tai Chi Chuan on cognitive function in adults 60 years or older with type 2 diabetes and mild cognitive impairment in China: a randomized clinical trial. *JAMA Netw Open*. 2023;6(4):e237004. doi:10.1001/jamanetworkopen.2023.7004.
- [12] Rathi M, Hamdulay N, Palekar TJ, Joshi R, Patel R, Shah R, et al. Effectiveness of Frenkel's balance exercises on elderly people. *Indian J Gerontol*. 2021;35(4):483-494.
- [13] Setyawan R, Setijono H, Kusnanik NW. The effect of floor and Swiss ball exercises using circuit training methods towards balance, strength, flexibility and muscle endurance. *Britain Int Humanit Soc Sci J*. 2021;3(2):384-395. doi:10.33258/biohs.v3i2.469.
- [14] Sherrington C, Fairhall NJ, Wallbank GK, Tiedemann A, Michaleff ZA, Howard K, et al. Exercise for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2019;1(1):CD012424. doi:10.1002/14651858.CD012424.pub2.

- [15] Hopewell S, Adedire O, Copsey BJ, Boniface GJ, Sherrington C, Clemson L, et al. Multifactorial and multiple component interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2018;7(7):CD012221. doi:10.1002/14651858.CD012221.pub2.
- [16] Montero-Odasso M, van der Velde N, Martin FC, Petrovic M, Tan MP, Ryg J, et al. World guidelines for falls prevention and management for older adults: a global initiative. *Age Ageing*. 2022;51(9):afac205. doi:10.1093/ageing/afac205.
- [17] Mhaske GC, Fursule D, Khairnar A. Effect of Tai Chi and stepping exercise for balance training in geriatrics: randomized controlled trial. *Int J Health Sci Res*. 2021;11(6). doi:10.52403/ijhsr.20210625.
- [18] Malhotra A, Gupta N. Different sizes of Swiss ball for balance training in geriatric population. *Physiother Occup Ther J*. 2019;12(4).
- [19] Kumar C. Comparison between Tai Chi and balance-strength training exercise to decrease fear of fall and improving balance and functional mobility in elderly. *J Nov Physiother*. 2017;7:350. doi:10.4172/2165-7025.1000350.
- [20] Hosseini, L., Kargozar, E., Sharifi, F., & Negarandeh, R. (2018). *Tai Chi Chuan can improve balance and reduce fear of falling in community dwelling older adults: A randomized control trial*. *Journal of Exercise Rehabilitation*, 14(6), 1024–1031. <https://doi.org/10.12965/jer.1836488.244>
- [21] Lee CW, Lee KJ, Song CH. The effects of trunk stabilization exercise using a Swiss ball in the absence of visual stimulus on balance in the elderly. *J Phys Ther Sci*. 2016;28(7):2144-2147. doi:10.1589/jpts.28.2144.
- [22] Martínez-Amat A, Hita-Contreras F, Lomas-Vega R, Caballero-Martínez I, Alvarez PJ, Martínez-López E. Effects of 12-week proprioception training program on postural stability, gait, and balance in older adults: a controlled clinical trial. *J Strength Cond Res*. 2013;27(8):2180-2188. doi:10.1519/JSC.0b013e31827da35f.
- [23] Bertolini R, Vercelino R, Ferreira LF, Telles da Rosa LH. Effects of Tai Chi Chuan on older adults' balance: a systematic review with meta-analysis. *J Aging Phys Act*. 2024;33(1):84-97. doi:10.1123/japa.2023-0423.
- [24] Li L, Guo S, Ding B, Zhang J. Effectiveness of Tai Chi exercise on balance, falls, and motor function in older adults: a meta-analysis. *Front Med (Lausanne)*. 2024;11:1486746. doi:10.3389/fmed.2024.1486746.
- [25] Zhang W, Sun J, Feng X, Zhang H, Zhang Y, Zhao M. Effectiveness of Tai Chi exercise on fear of falling and balance in older adults: a meta-analysis. *Geriatr Nurs*. 2023;51:194-201. doi:10.1016/j.gerinurse.2023.03.019.
- [26] Mańko G, Pieniążek M, Tim S, Jekielek M. The effect of Frenkel's stabilization exercises and stabilometric platform in the balance in elderly patients: a randomized clinical trial. *Medicina (Kaunas)*. 2019;55(9):583. doi:10.3390/medicina55090583.
- [27] Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health*. 1992;83 Suppl 2:S7-S11.
- [28] Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. *J Gerontol*. 1990;45(6):P239-P243. doi:10.1093/geronj/45.6.P239.