International Journal of Physiotherapy and Research,
Int J Physiother Res 2023, Vol 11(5):4628-41. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2023.153

Systemic Review

A Systematic Review on Comparison between Otago Exercise Program and Balance Exercise in Balance and Fall Risk among elderly with Knee Osteoarthritis

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ABSTRACT

Background: Patients with knee osteoarthritis have balance issues and an increased fall risk; nevertheless, it is unclear whether the Otago exercise programme (OEP) or balance exercise will improve balance and reduce fall risk among individuals with knee osteoarthritis. Therefore, there is a need to compare the effectiveness of these exercises in treating knee osteoarthritis. This review aims to investigate the effects of an OEP and balance exercise programme to improve balance and reduce fall risk among the elderly population with knee osteoarthritis (OA).

Methodology: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were used to conduct this systematic review. Four databases (PubMed, Cochrane central register of controlled trails (CENTRAL), Physiotherapy Evidence Database (PEDro), and Science Direct) were searched until September 2022 using predefined terms by two independent reviewers. The methodological quality of the studies was assessed using PEDro. All literature published from each source was selected according to the inclusion and exclusion criteria, and data extraction was performed independently with the outcomes of the Berg balance scale (BBS), time up and go test (TUG), chair stand test (CST), and short falls efficacy scale (SFES I).

RESULT: The literature review studied seven full-text articles that met the selection criteria and PRISMA guidelines. Those articles were reviewed by grouping them into five different sub-groups based on the interventions. The quality of studies ranged from good (5 studies) to fair (2 studies). The improvement in balance and fall risk prevention following OEP and balance training showed mixed results, and the findings from this review may form the basis for a future systematic research program.

CONCLUSION: It is difficult to conclude clear evidence-based recommendations for Otago exercise programmes and balance exercises in improving balance and reducing fall risk among the elderly population with knee OA due to limited availability and weak evidence.

KEYWORDS: Fall risk, community dwelling older adults, elderly population, knee osteoarthritis.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Physiotherapy and Research** ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr
DOI: 10.16965/ijpr.2023.153	**Article Information** Received: 04 Aug 2023 Accepted: 24 Sep 2023 Peer Review: 06 Aug 2023 Published (O): 11 Oct 2023 Revised: 20 Aug 2023 Published (P): 11 Oct 2023

INTRODUCTION

Among older adults, falls and osteoarthritis (OA) are frequently co-present [1,2].

Osteoarthritis is frequently linked to decreased mobility because of pain and muscle weakness and is therefore regarded as a known risk factor for falling. [3,4,5]. Knee OA accounts for roughly four-fifths of all OA cases worldwide [6]. In India, the prevalence of osteoarthritis

ranges from 22% to 39%, making it the second-most prevalent rheumatologic condition. Women are more likely than men to develop OA [7,8].

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The majority of people with knee OA experience the worst degrees of pain, stiffness, and dysfunction, which increases their risk of instability, muscular weakness, impaired coordination, and ultimately falling [9]. Among the elderly, falls and fall-related injuries are the primary cause of morbidity and mortality, which is a significant public health issue [10]. Recent studies have shown that exercise regimens, particularly Otago and balance exercises, can reduce fall rates and improve balance in older people with knee OA [11,12].

The Otago Exercise Program (OEP) is the most thorough fall prevention programme available. The Accident Compensation Corporation in New Zealand uses it; it was developed at Otago Medical School [13,14].

The OEP is a programme that combines walking with strength and balance training [15,16]. Numerous studies, including systematic reviews and meta-analyses, have shown that the OEP is an effective exercise preventative method that enhances physical functioning and reduces falls in individuals with knee OA [10,16,17].

Exercises for maintaining balance are useful and crucial parts of a programme to prevent falls. Numerous studies have shown that adding balance training to regular exercise routines is beneficial for those with knee OA [9,12,18-19]. Authors advise The Time Up and Go Test (TUG) has good measuring qualities in OA patients and other demographics [19].

The TUG test is a helpful technique for assessing older individuals with OA to identify mobility decline and fall risk [20,21].

The TUG and Berg Balance Scale (BBS) tests are the most popular clinical tests for assessing balance in people with knee OA. They are widely used as clinical assessment tools for balance control and are useful for rating balance [22,23]. The chair stand test (CTS) is an important mobility exercise for assessing the balance of older people with symptomatic OA [24].

The Short Falls Efficacy Measure International (Short FES-I) is a reliable and practical tool for measuring elderly people's fear of falling. In clinical practice, the brief FES-I is accurate and practical. It can also benefit elderly people with cognitive impairment [25].

The aim of this study is to compare the efficacy of the Otago exercise programme and Balance exercise in improving balance and lowering fall risk in an elderly population with knee osteoarthritis.

METHODS

A primary literature search was performed using the search engines PEDro (Physiotherapy Evidence Database), Science direct, PUBMED, and Cochrane central register of controlled trails (CENTRAL) at 3rd September 2022. With the articles published between the years 2000 to 2022.

The following were the main search terms: In PEDro (Physiotherapy Evidence Database) and the other forementioned databases. The "OR" operator was used to add similar terms as alternatives to the "population search" term "older adults" (older adults or elderly or elderly adults' Elderly population or community dwelling older adults). For the intervention, the keywords "modified Otago" AND " balance exercise"; "Otago Exercise Program" AND "balance exercise" Balance and fall prevention in older individuals; "modified Otago" and "balancing exercise" were used. "Balance Exercise Program and the Otago Exercise Program. "Otago Exercise Program" AND "balance exercise"; "older adults" AND "balance" and "fall prevention" were the search phrases utilised for comparison. Time up and go test

were used as the search terms for outcome measurements. The Berg balancing scale Search terms connected to "AND" included "older adults" AND "modified Otago" and "balance exercise," as well as "Short FES-I." AND "Chair stand test."The current systematic review was reported according to the PRISMA guidelines (figure 1) [26] and the selected studies were assessed for methodological quality by using Pedro scale. All possibly qualifying papers were acquired in full text, and reference lists from research that qualified were also examined.

Eligibility criteria:

Selection Criteria:

Studies were considered eligible if they met the pursuing criteria:

Study design: full-text randomized controlled trails and pilot randomized controlled trails.

Participants: older adults with knee OA (grade I and II) from both sexes; with above 60 years of age.

Intervention: Otago exercise program and balance exercise program • Outcomes: Berg balance scale (BBS), time up and go test (TUG), chair stand test (CST) and short falls efficacy scale international (Short FES-I).

Language: available English full-text studies

Criteria for exclusion

Studies that have not yet been published

Case reports or series, observational studies, narrative reviews and conference proceedings

Research that looked into outcomes not relevant to our field of study.

Study selection*:* The search engines yielded a total of 94 published articles, eligible for the title and abstract screening. After removing duplicate articles, a total of 70 articles were selected. After the screening of the title and abstract a total of 32 articles were selected, finally 13 articles were excluded with reasons and a total of 7 studies were selected for the review. The PRISMA flow chart is shown in (figure.1).

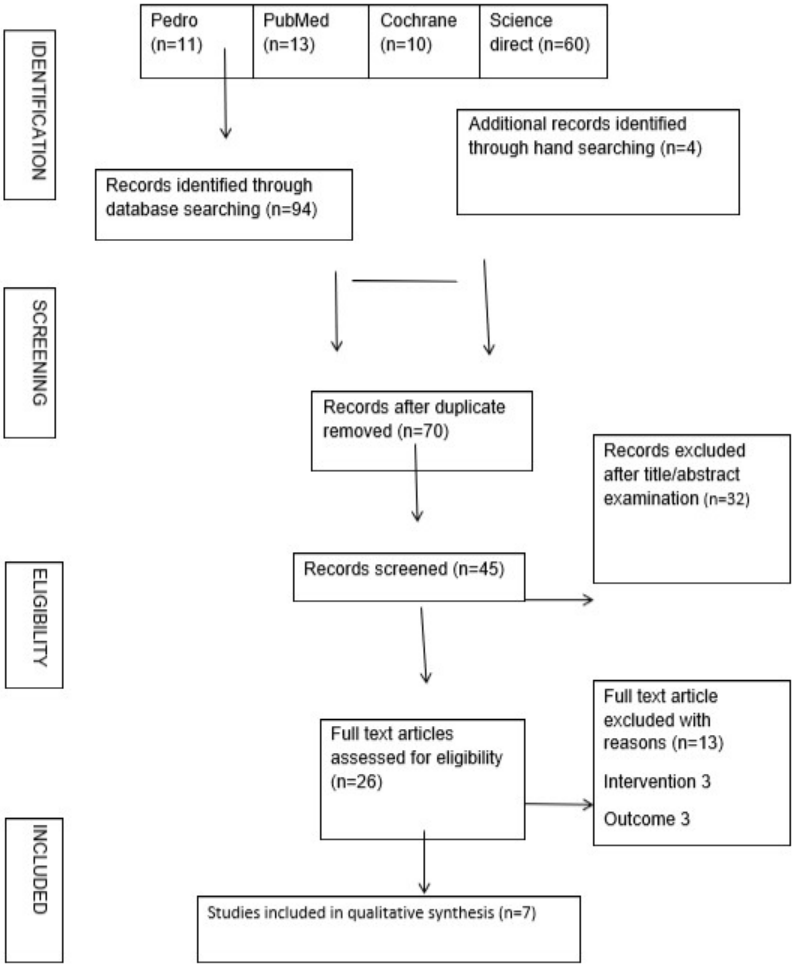

Fig 1: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart

Table 1: Participants, diagnosis, intervention, duration, outcome measures and results

Study	Participants	Intervention	Duration	Outcome measures	Results
Mat S et al (2017) [28].	A Randomized controlled trial with 50 participants with knee OA initially (28 control-22 intervention) after 6 months follow up 41 participants, 24 in the control group and 17 in the intervention group aged ≥65 years with history of two falls or one injurious fall over the past 12 months. Participants with at least mild OA, KL grade 2-4	The participants in the intervention group received a personalised and modified OEP as part of a multifactorial intervention. Control group received general health advice and standard care.	6 months	Postural control: The modified Clinical Test of Sensory Interaction on Balance (m CTSIB) and the Limits of Stability (LOS) Fear of falling: The short-form falls efficacy scale-international (short FES-I) Osteoarthritis symptoms and functional ability: The Knee injury and Osteoarthritis Outcome Score (KOOS)	**Significant**
Mohan Ra RD et al (2021) [29].	A Randomised Control Trial Subjects with knee OA. 36 both male and female were selected. Age 60-70 years divided into two groups; 18 subjects in each group. For 4 weeks and 3 days per week. patient diagnosed with osteoarthritis of knee > six months, pain, knee OA (grading 2-3) Kellgren and Lawrence grading system	Group A of 18 and Group B of 18 subjects. Group A performed Otago exercises and Group B performed Dual task net step exercises for 4 weeks and 3 days per week Protocol for both groups 40min/thrice in a week for 4 weeks	4 weeks and 3 days per week Protocol for both groups 40min/thrice in a week for 4 weeks	Visual analogue scale (VAS) Time Up and Go test (TUG) Berg Balance Scale. (BBS)	**Significant**

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KANCHAN A. KATRE et al (2019) [30]	Randomized clinical trial study design 40 Subjects with bilateral knee osteoarthritis. Bilateral knee osteoarthritis, Complain of knee pain less than 30 minutes of morning.	Randomly assigned into group A (N=20) and group B (N=20). Subjects in Group A received otago exercise program group B strength training program	3 days in a week for 8 weeks (total = 24 sessions), with 40 minutes per session for both groups.	30-sec Chair Stand time up go test (TUG)	**Significant**
Elsheikh MM et al (2020). [31]	A comparative study with 60 Participants with OA knee age: 50 to 67 years. Patients with mild or moderate primary knee osteoarthritis according to the clinical and radiological criteria of ACR	two groups: Group I: (30) Patients trained by strength exercises rehabilitation program and balance training in BSSSD. (bio index stability system) Group II: (30) Patients trained with strength exercises rehabilitation program only	3 sessions per week for 12 weeks	VAS, Ritchie's tenderness scale, morning stiffness, range of motion physical performance (CTS), functional assessment by WOMAC, assessment of postural stability and balance disturbance (postural stability test- fall risk test- limits of stability test)	**Significant**
Jahanjoo F et al (2019). [32]	single-blinded randomized clinical trial with 60 participants (mean age: 56.5±0.90 years) with primary mild or moderate knee OA	Two groups. (n=30) Physiotherapy (PT) group received routine physical therapy (hot pack, ultrasound, TENS, and exercise) while balance training group (BT) (n=30) received conventional physical therapy plus balance training using Biodex balance system (BBS).	10 sessions of one-hour treatment/ 5 weeks	WOMAC TUG VAS, Lequesne index.	**Significant**

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Table 2: PEDro score.

PEDRO SCALE	Mat S et al (2017) [28]	Mohan Ra RD et al (2021) [29]	KANCHAN A. KATRE (2019) [30]	Elsheikh MM et al (2020) [31]	Jahanjoo F et al (2019) [32]	Pazit L al (2017) [33]	UzunkulaoĞlu A et al (2020) [34]
Eligibility criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes
randomly allocated	Yes	Yes	Yes	No	Yes	Yes	Yes
Concealed allocation	No	No	No	No	No	Yes	No
Similar Baseline	Yes	Yes	Yes	Yes	Yes	Yes	Yes
subject blinding	No	No	No	No	No	No	No
Therapist blinding	No	No	No	No	No	No	No
assessors blinding	Yes	Yes	No	No	Yes	No	Yes
Dropouts less than 15 %	No	Yes	Yes	Yes	Yes	Yes	Yes
intention to treat analysis	No	No	Yes	Yes	Yes	No	No
between-group statistical comparisons	Yes	Yes	Yes	No	Yes	Yes	Yes
point measures and variability data	Yes	Yes	No	No	Yes	Yes	Yes
SCORE	5	6	6	4	7	6	6

DATA EXTRACTION

A primary literature search was performed using the search engines Pedro (Physiotherapy Evidence Database), Science direct, PUBMED, and Cochrane central register of controlled trails (CENTRAL), published between the years 2000 to 2022. The key search terms were as follows: The "OR" operator was used to add similar terms as alternatives to the "population search" term "older adults" (older adults or elderly or elderly adults or Elderly population or community dwelling older adults). For the intervention, the keywords "modified Otago" AND "balance exercise"; "Otago Exercise Program" AND "balance exercise" Balance and fall prevention in older individuals; "modified Otago" and "balancing exercise" were used. "Balance Exercise Program and the Otago Exercise Program. "Otago Exercise Program" AND "balance exercise"; "older adults" AND "balance" and "fall prevention" were the search phrases utilised for comparison. Time up and go test were used as the search terms for outcome measurements. The Berg balancing scale Search terms connected to "AND" included "older adults" AND "modified Otago" and "balance exercise," as well as "Short FES-I." AND "Chair stand test. The current systematic review was reported according to the PRISMA guidelines (figure 1) and the selected studies were assessed for methodological quality by using Pedro scale (Table 2).

Methodological quality assessment: The Pedro scale was used to rate the methodological quality of the current systematic review. PEDro is a trustworthy and valid indication of the methodological quality of clinical trials [27]. The PEDro scale criteria of sufficient randomization, allocation concealment, blinding of participants, therapists, and assessor, incomplete outcome data, same baseline, and use of intention-to-treat analysis were used to evaluate the internal validity of the included studies. The items are given a present (1) or absent score (0). The final judgement was made after two reviewers independently evaluated the included studies' methodological quality, and any disagreements were settled with the help of a third reviewer. Each item was classified as "present" or "absent," and the sum of "present" responses was used to determine each study's overall score. Scores range from 0 to 10, with higher numbers indicating higher methodological quality for RCTs. The quality of each study was given a score, which ranged from excellent (score 9–10), good (score 6-8), fair (score 4-5), or poor (score 3) [26].

A systematic error in findings or conclusions is referred to as bias. Biases can go both ways; they can cause an overestimation or underestimation of the actual intervention effect. Biases come in different degrees of severity. In most cases, it is impossible to tell how much biases affected a study's conclusions. Random sequence generation, allocation concealment, selective reporting, other sources of bias, blinding (participants and personnel and outcome assessment), and incomplete outcome data are the domains that represent the risk of bias in the current systematic review.

RESULTS

Literature search: The search strategy revealed 94 articles from the previously mentioned databases as follows: Cochrane central register of controlled trails (CENTRAL) (10), PEDro (11), PubMed (13), and science direct (60). Records after duplicate articles removal were (70). The remaining 32 articles, titles, and abstracts were independently screened by the reviewers. 26 articles were filtered based on full text; as shown in PRISMA (Fig. 1), 13 articles were excluded based on the inclusion and exclusion criteria, or the outcome of interest was absent. The remaining seven studies formed the basis for the current systematic review.

The total sample of the included studies was around 315, and the details of the control group in each of the included studies are mentioned in Table 1, and the methodological quality of the synthesized articles is mentioned using the Pedro score mentioned in Table 2.

Participant characteristics: knee osteoarthritis, elderly population, patients with balance and fall issues [28-34].

Intervention: All studies investigated the effect of different types of exercise for knee osteoarthritis with the interventions are of Otago exercise program and balance exercises for the elderly population with balance issues and fall risk [28-34].

Types of outcomes measured: berg balance scale (BBS), time up and go test (TUG), chair stand test (CST) and short falls efficacy international (SFES I) [28-34].

Measurements of outcome: All studies used the outcome mentioned above to measure the balance and fall risk was measured with the Berg Balance scale (BBS), Time up and go test (TUG), Chair stand test (CST) and Short falls efficacy international (SFES I) [28-34].

Methodological quality level: Table 2 shows how each study scored on the PEDro scale. The mean score of the 7 studies was 5.71. four studies were rated a 6 [29,30,33,34], one study was given a 7 that represents "good" [32]. and another study were given 4 and 5 respectively that represents "fair" quality [28,31].

DISCUSSION

The objective of the current systematic review was to evaluate the quality and strength of the evidence for various types of exercises for older people with knee OA. To this end, systematic approaches were employed to search for and evaluate the studies that were already accessible. The outcomes in this review include the berg balance scale (BBS), time up and go test (TUG), chair sand test (CST), and short falls efficacy worldwide (SFES I). older adults who exercise as part of the Otago programme experience increased mobility and balance and experience fewer falls. Furthermore, it demonstrates how it enhances older persons' functional abilities. [10].

The Otago exercise programme helps older adults by enhancing their lower limb muscle strength, dynamic and static balance ability, gait stability, and posture control, all of which are important for the older adult's ability to maintain their balance and prevent falls. OEP is useful for reducing depression incidence and harm caused by sedentary behaviour in older adults, as well as for helping them overcome their fear of falling [16].

Kinaesthesia and balance training have been shown to have beneficial additive effects on knee OA. They ought to be able to improve the functional capabilities, isokinetic muscular strength, proprioceptive sensibility, and pain threshold in OA patients when used in clinical settings [9].

Exercises that focus on balance have been suggested as being essential for OA patients to prevent falls. According to studies, balance exercises delivered as at-home workout routines seem to be useful in easing symptoms and enhancing quality of life in people with knee OA [12,18].

All studies included in this systematic review met the eligibility criteria as specified and similar baselines as reported, the random allocation of participants, and the results of between-group statistical comparisons were also done for all studies except one [31] and provided measures of variability for at least one outcome. Expect two studies [30, 31]. Four studies [28, 29, 32, 34] had blinded assessors, and a concealed allocation was done for one study [33]. None of the studies had blinded participants or a blinded therapist. All the included studies obtained at least one outcome from more than 85% of the participants initially allocated, except one study [28] and three studies [30–32] that used an intention-to-treat analysis.

When an elderly person has knee OA, increased impairments in balance control may come from a reduction in joint flexion/extension due to discomfort, deformity, or muscular weakness as a result of deteriorating knee OA. People with knee OA has the reduced ability to clear obstacles, issues with centre of gravity transfer, and poor balance recovery are the results of changes in gait patterns and postural stability. While it has been demonstrated that OA can affect one's ability to maintain balance and their walking biomechanics [35]. The likelihood of falling was found to be higher in people with knee osteoarthritis [36].

In the first year following their diagnosis, people with osteoarthritis of the hip or knee are more likely to fall and/or break a bone [37]. Compared to healthy older persons, patients

with severe knee osteoarthritis were more likely to fall. Consequences of severe knee osteoarthritis include pain, stiffness, physical limitations, decreased muscular strength, a patient's quality of life being hampered, and an increased risk of falling [38]. Fall risk is increased in people with knee arthritis. Due to knee discomfort, stiffness, restricted mobility, impaired muscle strength, and lower quality of life, patients are more likely to fall [39].

According to general reports, people with knee OA have weaker lower limb muscles than healthy controls. Reduced hip muscle strength has been highlighted in relation to knee OA more frequently than strength impairments in the quadriceps [40]. Patients with knee OA and self-reported knee instability had a lower risk of falling when their knees could extend and flex fully [41].

Dynamic balance may be compromised by increased muscle weakness, decreased knee joint range of motion, altered postural control, and poor proprioception, which are all neuromuscular abnormalities documented in persons with knee OA that in turn increasing the danger of falling as a result. [42]. As a result of a potential decline in muscle strength and joint position awareness, people with knee OA frequently have increased balance impairment [43].

One risk factor for falls in the population with knee OA is poor balance control, particularly when standing or moving [44]. In OA patients, proprioceptive inaccuracy, knee instability, and muscle weakness may all contribute to poor postural control, and decreased postural control may result in activity restrictions [45].

Affected proprioception, atrophy and muscular weakening, discomfort, stiffness, and restrictions in daily activities and social interaction are some of the clinical signs of osteoarthritis [46].

Proprioception issues lead to a reduction in balance control, also known as postural stability, which increases the chance of falling as a result [47].

Otago exercise programme was used in three studies included in this systematic review by Mat S et al (2017), Mohan Ra RD et al (2021) [29], and KANCHAN A. KATRE (2019) [30]; balance exercises were used in four studies by Elsheikh MM et al (2020) [31], Jahanjoo F et al (2019) [32], Pazit L al (2017) [33] and Uzunkulaolu et al (2020) [34] The time commitment for the Otago exercise programme and balance exercises varied from 4 weeks to 6 months. The studies' findings correspond to the Berg Balance scale (BBS), Time up and go test (TUG), Chair stand test (CST), and Short falls efficacy international tests (SFES I) [28-34].

According to Mat S et al's 2017 research [28] on modified OEP, older fallers with OA, gait, and balance issues benefit from it by increasing postural control, lowering FoF, and without negatively affecting OA symptoms. The reduction in falls was not statistically different or showing any trend, though. Therefore, a longer follow-up period is necessary to determine if the gains in postural control seen in people with OA who use the modified OEP would result in a noticeably lower rate of recurrent falls. The elderly population with knee OA may therefore experience fewer balance problems as a result of this.

Mohan Ra RD et al. (2021) [29] noticed a significant improvement in BBS and TUG scores, enhanced balance, and functional mobility in OEP when compared to dual-task net step exercises. The researchers found that, for improving balance and functional mobility in senior adults living in communities who have knee OA, respectively, Otago exercises are superior to Dual Task Net Step Exercises. The Otago exercise may be more effective than dual task net exercise in enhancing balance and functional mobility in senior persons with knee OA because it combines strength training and balance training.

According to Kanchan A. Katre et al. (2019) [30], significant improvements were found in the OEP group's (30-sec CST) and timed up-go test. This study proved that among people with bilateral knee osteoarthritis, the Otago exercise programme outperformed a strength training programme in terms of reducing the risk of falling and enhancing lower limb strength. One of the main issues with elderly

persons who have knee OA is a loss of lower limb strength. The Otago exercise programme may help to increase lower limb strength while also lowering the chance of falling.

Huei-Ling Chiu et al [48] have suggested that administrating the OEP in a group setting in >30-minute sessions may be the most appropriate and effective exercise protocol for improving balance. According to Elsheikh MM et al. (2020) [31], combining a rehabilitation programme for strength exercises with the BSS-SD bio index stability system (which includes balance exercises and stability training) has more positive effects on treating mild to moderate knee OA than a rehabilitation programme for strength exercises alone. For elderly people with knee OA, balance exercises must be combined with stability training to improve postural stability and lower fall risk.

In 2019, Jahanjoo F. et al [32] found that physical therapy and balance training together reduced pain more effectively and enhanced functional capacities. Therefore, balancing training must be included in order to obtain superior functional capacities.

High speed resistance training and high-speed resistance training plus balancing group were realistic and safe ways to increase physical function and strength, according to Pazit L. al. (2017) [33]. Future large-scale research trials are necessary to explore the impact of effective exercise on reducing falls in individuals with knee OA. Therefore, combining balance training with resistance training helps the senior population with knee OA improve their physical function and strength.

Uzunkulaolu A and colleagues (2020) [34] Age-related osteoarthritis patients can improve their balance function with single-task and dual-task training. Both of these balancing exercises improved balance performance in elderly people with knee OA equally well.

Chao Xie and co. (2020: A systematic review and meta-analysis) This study provides high-quality evidence relating to the effects of Otago exercise on falls and balance in patients with OA, supporting the influence of Otago exercise on falls and balance in OA patients. [49].

Kinaesthesia, balance and agility (KBA) is a form of proprioceptive training. This exercise training is typically designed to improve dynamic joint stability and neuromuscular control using a series of physical activities that challenge the individual's neuromuscular system to maintain balance and coordination among knee OA population [47].

Combining balance exercises to conventional exercises improves the functional ability of OA knee patients more than the conventional exercises alone. Based on the presented findings, exercises which aimed to improve the stability of the knee joint, through training of the neuromuscular and proprioceptive systems, attending to neutral alignment of the knee, and muscle strengthening both are necessary [50]. Balance and functionality in knee OA patients can be significantly improved by adopting a rehabilitation program with an emphasis on balance exercises [47]. Despite the increased risk of falling for individuals with KOA and the benefit of balance training in older adults, information is lacking about utilization of this intervention as a component of physical therapy (PT) for this population [43].

Due to time constraints, there were certain limitations to this review, including the lack of a meta-analysis. There should be further investigation into how different exercise programmes affect fall prevention. The outcomes used in this study are not sufficiently comparable; adequate statistical methods were not applied; and parametric and non-parametric research were also not readily available, which may have resulted in an incomplete meta-analysis. Thus, we limited our investigations. Given the dearth of high-quality studies that have been conducted on specific types of exercise's effects on improving balance and reducing the risk of falls in elderly people with knee OA, the findings of this systematic review should be viewed with caution. In order to adequately demonstrate the effects of various exercise programmes on improving balance and fall prevention in elderly populations with knee osteoarthritis, more research with well-powered studies and a large sample is required. However, this systematic review urges the need for more focused

research on the use of exercises like the Otago exercise programme and balance training not only in improving balance and lowering fall risk in elderly adults with knee OA but also in the prevention of osteoarthritis progression, enhancing lower limb muscle strength, and improving functional capacities. It is also advised that more study be done on the use of exercise training in conjunction with other types of therapy for older people with knee OA who have poor balance and a higher risk of falling.

CONCLUSION

The aim of this systematic review is to close the knowledge gap between clinical practise and research regarding the use of exercise regimens like the Otago exercise programme and balance training in the treatment of knee OA patients who have poor balance and a higher risk of falling. For people with knee OA who have impaired balance and a higher risk of falling, both exercises offer the optimal intervention. Additionally, Otago exercise helps older adults with knee OA maintain their balance and reduces their chance of falling. More high-quality randomised controlled trials are clearly needed to establish strong evidence, as evidence for the benefit of exercise on knee OA in reducing fall risk remains weak.

ABBREVIATIONS

OA: Osteoarthritis;
OEP: Otago Exercise Program;
TUG: Time up and go test;
BBS: Berg balance scale, **CST:** chair sand test;
SFES I: short falls efficacy international,
BBS: Bio index balance system (BBS);
BT: Balance Training;
FSST: The Four Square Step Test;
WOMAC: Western Ontario and McMaster universities osteoarthritis index;
VAS: Visual Analogue Scale;
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analysis;
RCT: Randomized controlled trial;
PEDro: Physiotherapy Evidence Database.

COMPETING INTEREST: Authors declare that they have no competing interests**.**

CONTRIBUTIONS OF AUTHORS

DN and W performed an electronic search and data extraction independently, **PS and M** assessed the methodological quality of included studies where discrepancies between them were resolved by consultation with the author **DN** to reach the final decision. The authors read and approved the final manuscript.

ACKNOWLEDGEMENTS

The authors would like to thank the institution for their valuable support for the development of this research.

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How to cite this article: Divya N, Praveena Shri P, Sai Priyaa M, Meyammai S, Winnie T E, Pavithra R. A Systematic Review on Comparison between Otago Exercise Program and Balance Exercise in Balance and Fall Risk among elderly with Knee Osteoarthritis. Int J Physiother Res 2023;11(5):4628-4641. **DOI:** 10.16965/ijpr.2023.153