CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 50-year-old patient with symptomatic knee osteoarthritis and balance deficits, is balance training or therapeutic exercise more effective in improving pain, stiffness, and function as measured by the Western Ontario and McMasters Universities Osteoarthritis Index (WOMAC)?

AUTHOR

Prepared by	Monica Anderson	**Date**	December 1, 2016
Email address	Monica_anderson@med.unc.edu		

CLINICAL SCENARIO

The clinical question for this critically appraised topic was inspired by the protocol established in the 2015 PATH-IN (Physical therapy vs. Internet-Based Exercise Training for Patients with Knee Osteoarthritis) trial.[1] The standardized physical therapy protocol emphasized prescribing patients with knee osteoarthritis home exercise programs which consisted of strengthening, stretching/range of motion, and aerobic exercises. The particular population included in the PATH-IN trial was quite broad, with the primary inclusion criteria being that the participants have a diagnosis of knee OA and that they have joint symptoms in at least one knee most days of the week.[1] The clinical question for this critically appraised topic inquires whether balance training or therapeutic exercise is the most effective treatment strategy for a 50-year-old patient with an identified balance deficit included in the PATH-IN trial.

Currently, there is high-level, quality evidence that therapeutic exercise improves physical function and reduces pain in patients with osteoarthritis. However, there is less availability of evidence to determine the effectiveness of balance training related to patients with symptomatic knee osteoarthritis and balance impairments. Patients with knee OA often experience a loss of proprioception, kinaesthesia sensation, and strength.[2] These commonly occurring deficits may lead to inadequate neuromuscular control and subsequent balance impairments. Therefore, physical therapists would value knowing the answer to this clinical question, as clinicians may tend to emphasize therapeutic exercise, while undervaluing the potential benefits of balance training interventions for this patient population. Knowing the answer to this clinical question would help clinicians discern optimal plans of care for patients with symptomatic knee OA and balance impairments.

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

- ✓ A total of 10 studies were selected that met the inclusion/exclusion criteria, including one systematic review, six randomized controlled trials (RCT), two exploratory follow-ups of randomized controlled trials, and one quasi-experimental trial. Three studies were selected as the "best evidence" related to this clinical question- two RCTs and one systematic review.
- ✓ Evidence from the three highest quality studies convey that:
  - The addition of agility and perturbation training exercises to a typical therapeutic exercise program for knee OA offers slightly better results regarding WOMAC total scores and WOMAC- physical function scores for the first 6-12 months of treatment intervention.

- Within group comparisons of both balance training and strength training programs indicate that both interventions are effective in terms of lowering pain, improving symptoms, regaining function in daily living, improving function in sport and recreation, and improving overall mobility. However, no statistically significant differences in outcomes have been demonstrated between balance training and strength training programs related to pain, symptoms, function in daily living, and function in sport and recreation.
- A pooled analysis of a large body of evidence supports the use of strength training programs as effective interventions for individuals with symptomatic knee OA; however, there is also promising and credible high-level evidence supporting alternative types of exercise to address symptoms of knee OA, including as balance training, Tai Chi, and proprioceptive training.

CLINICAL BOTTOM LINE

Current best evidence suggests that balance training programs and/or therapeutic exercise programs are comparable in terms of effectiveness for individuals with symptomatic knee osteoarthritis. Both interventions have demonstrated to be beneficial in improving WOMAC total score outcomes, KOOS scores, as well the subscale components of both of these outcome measures, including pain, symptoms, and functional mobility in daily life. Balance training interventions may have some additive benefits to a standard exercise program, including an increase in WOMAC total score, and improvements in physical function scores and proprioceptive function. Further research is necessary to examine the effectiveness of these programs in balance impaired populations as well as the effectiveness of these programs in patients with varying stages of knee OA. Therefore, physical therapists should select exercises and home-based programs based on their patient's individual needs, goals, or preferences.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
knee osteoarthritis knee arthritis knee OA degenerative joint disease of knee DJD of knee	balance training balance program balance	therapeutic exercise exercis* rehabilitation physical exercise exercise prescription	WOMAC Western Ontario and McMasters Universities Osteoarthritis Index WOMUOI osteoarthritis index pain relief pain

			stiffness ROM limitation range of motion function functional limitation functional activities physical activities functional mobility

Final search strategy:

For PubMEd

1. "knee osteoarthritis" OR knee osteoarthritis[MeSH Terms] OR "knee arthritis" OR "degenerative joint disease" OR (DJD AND KNEE)
2. balance training OR balance program OR balance[MeSH Terms]
3. “therapeutic exercise” OR exercis* OR rehabilitation OR physical exercise OR “exercise prescription”
4. WOMAC OR “Western Ontario and McMasters Universities Osteoarthritis Index” OR WOMUOI OR “osteoarthritis index”
5. pain OR "pain relief"
6. “range of motion” OR “range of motion limitation”
7. function OR “functional limitation” OR “functional activities” OR “physical activities” OR “functional mobility”
8. #1 AND #2 AND (#4 OR #5 OR #6 OR #7) -- **75 results**
9. #1 AND #3 AND (#4 OR #5 OR #6 OR #7) -- **3286 results**
10. #1 AND #2 AND #3 AND (#4 OR #5 OR #6 OR #7) **combined both interventions (#1 and #2 and #3) and with all outcome measures -- 67 results**

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
PubMed	**67**	
CINAHL	**9**	Same search strategy as PubMed: **-9 results** Interventions searched separately to retrieve more results: OA and Balance with outcomes **-10 results** OA and Exercise with outcomes **-571 results**
PEDro	**10 and 17**	Titles and abstracts searched for: knee osteoarthritis and balance and exercise and WOMAC **-10 results** knee osteoarthritis and balance and WOMAC **-17 results**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Randomized controlled trials, systematic reviews, or meta-analyses • Contains a protocol that included balance training and/or therapeutic exercise for adults with knee osteoarthritis • Published in English • Observed outcomes related to at least one of the following: pain, stiffness and/or function

Exclusion Criteria
• Studies that involved adults with neurological, vestibular, or cardiopulmonary diagnoses • Studies that involved adults with rheumatoid arthritis or other inflammatory joint diseases • Case studies or case series • Abstracts, conferences proceedings, letters to the editor, dissertations, narrative review articles

RESULTS OF SEARCH

A total of 10 relevant studies were located and categorized as shown in the following table (based on Levels of Evidences, Centre for Evidence Based Medicine, 2011) using the PEDro quality assessment rating scale for RCTs, AMSTAR measurement tool (2007) for methodological quality of systematic reviews, and the 1998 Downs and Black checklist (modified power item) for non-randomized studies of health care interventions.

Summary of articles retrieved that met inclusion and exclusion criteria

Author (Year)	Study quality score	Level of Evidence	Study design
Diracoglu (2005)[2]	**PEDro score: 7/11**	**Level 1b**	**Quasi-randomized Controlled Trial**
Diracoglu (2008)[11]	**PEDro score: 4/11**	**Level 2b**	**Long-term follow-up clinical investigation of quasi-randomized controlled trial**
Bennell (2005)[15]	**PEDro score: 9/11**	**Level 1b**	**RCT**
Chaipinyo (2009)[4]	**PEDro score: 8/11**	**Level 1b**	**RCT**
Golightly (2012)[5]	**Amstar score: 6/11**	**Level 1a**	**Comprehensive systematic review of RTCs, systematic reviews, and meta-analyses**
Rogers (2012)[10]	**PEDro score: 6/11**	**Level 1b**	**Single-blind (four arm) factorial RTC**
Duman (2012)[13]	**Pedro score: 4/11**	**Level 1b**	**RCT**
Fitzgerald (2011)[3]	**Pedro score: 9/11**	**Level 1b**	**Prospective, single-blind RCT**
Fitzgerald (2012)[12]	**Pedro score: 7/11**	**Level 2b**	**Exploratory follow-up study of a RTC**
Al-Khlaifat (2016)[16]	**Modified Downs and Black score: 18/29**	**Level 2b**	**Quasi-experimental: repeated pre-test/post-test design**

BEST EVIDENCE

The following 3 studies were identified as the 'best' evidence and selected for critical appraisal. Reasons for selecting these studies were:

- **Fitzgerald 2011[3]:** This prospective, single-blinded RCT has high methodological quality, having a score of 9/11 on the PEDro assessment tool and is classified as level 1b evidence. This study directly addresses my clinical question- utilizing the WOMAC as the primary outcome measure, and comparing balance training interventions (agility and perturbation training) with a standard exercise program in 183 individuals with symptomatic knee OA. Additionally, secondary outcome measures (global rate of change, Get Up and Go Test, and self report measure of pain and instability) were included in the study to assess pain, function, and instability. These outcome tools may provide additional insight into the clinical question at hand that the WOMAC does not specifically address.
- **Chaipinyo 2009[4]:** This RCT had high methodical quality, having a PEDro score of 8/11 and level 1b evidence. This study is very relevant to my clinical question at hand, as it compares a balance training home-based program to a strength training home-based program prescribed by physical therapists. The study of 48 participants had a high follow-up rate, with only a 13% loss. The authors of the study utilized relevant between-group statistical comparisons for all outcome measures, which provides useful information that many of the other studies in the search failed to produce.
- **Golightly 2012[5]:** This study was the only systematic review (level 1a evidence) that met the inclusion and exclusion criteria for my literature search. This comprehensive review evaluates the effectiveness of varying types of exercise programs for OA, only appraising high-level evidence (RCTs, systematic reviews, and meta-analyses) in the literature. Specifically related to my clinical question, this review appraises and summarizes strength training programs, resistance training programs, balance and neuromuscular training programs, and proprioceptive exercise programs on their effectiveness in patients with OA. Full details were provided regarding the search strategy and study selection, and a total of four databases were searched for articles. A large majority of the studies included in this systematic review utilized the WOMAC outcome measure for their interventions, making it relatable to the current clinical question. This review includes systematic reviews and meta-analyses with a significantly higher number of participants/subjects compared to RCTs alone, and therefore gives a larger pool of data to provide a more meaningful effect size.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of "Agility and Perturbation Training Techniques in Exercise Therapy for Reducing Pain and Improving Function in People with Knee Osteoarthritis: A Randomized Clinical Trial" by Fitzgerald GK, Piva SR, Gil AB, Wisniewski SR, et al. (2011)[3]

Aim/Objective of the Study/Systematic Review:
The objective of this study was to evaluate if the inclusion of agility and perturbation exercises has an additive effect on physical function, knee stability, and knee pain in patients with knee OA compared to a standardized knee OA exercise program alone.
Study Design
✓ Prospective, single-blind randomized controlled clinical trial ✓ There was blinding of all assessors who measured outcomes. Treating therapists did not participate in outcome testing procedures or test results. Subjects were blinded to their

specific intervention group, but were aware that they were randomly assigned to 1 of 2 exercise approaches.

- ✓ Block randomization was used to ensure an equal number of participants to the two intervention groups. The intervention assignments occurred in "block sizes" of 2 and 4 individuals per block. Additionally, stratified randomization was utilized by the presence of unilateral or bilateral knee OA.
- ✓ The study statistician created sequentially numbered, sealed envelopes containing the participant intervention assignment and distributed them to the trial coordinator.
- ✓ All therapists were given instruction of the intervention procedures by the principal investigator and were provided a booklet with exercise descriptions and instructions regarding the progression of the exercises to be administered
- ✓ Periodic, random reviews of the subjects' treatment records were performed by the trial coordinator to ensure adherence to standardized protocols.
- ✓ All participants were to complete 12 supervised sessions of their designated program in a 6 to 8-week period. Additionally, therapists instructed participants in home exercises so they would be independent with them by the end of the surprised sessions and complete them during the follow-up time period. Participants were given exercise diary check-lists to record adherence- diaries were returned at each follow-up visit through the 6-month follow-up visit.
- ✓ Outcomes were assessed at baseline, 2-, 6-, and 12-month follow-ups.
- ✓ All outcome analyses were conducted according to the intention-to-treat principle

Setting

- The research for this study was conducted at the Outpatient Department of Physical Therapy at the University of Pittsburgh Medical Center - Center for Sports Medicine in Pittsburgh, Pennsylvania.

Participants

- Subjects were recruited from the Pittsburgh metropolitan area through convenience sampling
- All participants gave written informed consent
- All participants in the study met the 1986 American College of Rheumatology (ACR) clinical criteria for knee OA and had a grade II or greater Kellgren and Lawrence radiographic changes in the tibiofemoral joint.
- Subjects were excluded from the study if they required use of an assistive device, had severe visual problems, reported a history of two or more falls in the past year, or were unable to ambulate 30.5 meters without an assistive device or need of a rest break. Additionally, subjects were excluded if they had a TKA, had uncontrolled hypertension, history of cardiovascular disease, or neurological disorders that affected their lower extremities.
- 231 participants enrolled in the study, 183 participated, and 145 subjects completed the trial. All 183 participants were included in the intention to treat analysis.
- There were no differences between groups for any key demographic variables at baseline

Participants in Agility and Perturbation Group:

- n=91, 15 lost to follow-up

- mean age: 63.3 ± 8.9 years
- 65.9% women
- 42.9% with prior history of knee injury
- 40% with unstable knee instability rating
- 35% with 3-5 years with arthritis, 25% with 5-10 years with arthritis, 22% with >10 years with arthritis
- mean WOMAC total score at baseline: 28.1
- mean WOMAC physical function score at baseline: 19.5
- 14.4% unilateral involvement
- 47% adherent to home exercise sessions (>80%), 32% partially adherent to home exercise sessions (50-80%), 24% not adherent (<50%)

Standard Exercise Group:

- n=92, 23 lost to follow-up
- mean age: 64.6 ± 8.4 years
- 67.4% women
- 38.0% with prior history of knee injury
- 30.4% with unstable knee instability rating
- 22% with 3-5 years with arthritis, 27% with 5-10 years with arthritis, 33% with >10 years with arthritis
- mean WOMAC total score at baseline: 28.1
- mean WOMAC physical function score at baseline: 19.9
- 10.9% unilateral involvement
- 52% adherent to home exercise sessions (>80%), 16% partially adherent to home exercise sessions (50-80%), 28% not adherent (<50%)

Intervention Investigated

Control – Standard Exercise Group

- 12 supervised sessions with physical therapist in a 6 to 8-week period
- Exercise program included:
    - lower-extremity muscle stretching of the quadriceps femoris, hamstrings, and calf muscles
    - strengthening exercises (quad sets, supine straight leg raises, prone hip extensions, seated isometric knee extensions, single-leg leg presses, standing hamstring curls, and standing heel raises)
    - long-sitting knee flexion and extension range of motion
    - treadmill walking
- All lower extremity exercises were performed bilaterally
- To account for the requirement of the increase in contact time with the experimental group (additional time required for the agility and perturbation exercises), the standard exercise group performed an arm-bike exercise activity of the upper extremities for 10-15 minutes
- Duration of the supervised sessions were not described in the article, but it seems apparent that they were standard-length visits of an outpatient physical therapy session
- Home exercise program included:
    - Similar exercises as given during the supervised sessions, however instead of leg press exercises patients completed wall squat exercises. Patients were also given cuff weights to perform the straight leg raises, hip extensions, and hamstring curls at home. For isometric knee extension exercises, patients were given heavy resistance Theraband (gold) and were instructed to perform the exercises with the Theraband attached to a chair.

- Home exercises were instructed to be completed at 2 times per week
- Walking program of at least 30 minutes per day at least 3 days per week

Experimental- Agility and Perturbation Group

- 12 supervised sessions with a physical therapist in a 6 to 8-week period
- Experimental group received the same exercise program as the standard exercise group with the addition of agility and perturbation exercises
- Agility exercises included:
  - Side stepping, braiding, front crossover steps during forward ambulation, back crossover steps during backward ambulation, shuttle walking (forward and backward walking to and from designated markers), and a drill requiring multiple changes in direction at random during walking
- Perturbation exercises included:
  - Balance training on foam surfaces, tilt boards, and rollerboards to induce potentially destabilizing forces. Balance and control emphasized during perturbation exercises.
- Duration of the supervised sessions were not described in the article, but it seems apparent that they were standard-length visits of an outpatient physical therapy session.
- Home exercise program included:
  - Same home exercise program as the standard exercise group, with the addition all agility exercises that were performed during the supervised sessions (with the exception of the therapist directed exercise involving multiple changes in direction)
  - Single leg standing balance exercise on level surfaces and carpeting
  - Home exercises were instructed to be completed at 2 times per week
  - Walking program of at least 30 minutes per day at least 3 days per week

Outcome Measures (Primary and Secondary)

- The primary outcome score of the study was the WOMAC total score and secondary outcome measures included self-reported knee instability, self-reported knee pain, global rating of change (GRC) score, and Get Up and Go Test (GUAG) score.
- Outcome measures and self-report measures were tested at baseline, and at 2, 6, and 12 months following the initial enrollment into the study. Physical performance measures (the GUAG score) were taken at baseline and at the end of 2- and 6-month follow-ups.
- Baseline testing was performed by the trial coordinator, however the authors did not state who performed the follow-up testing, just that the follow-up testing assessors were blinded from participants' group assignments and that the treating therapists were not involved in the testing procedures
- The WOMAC is composed of 24 total items, with 5 of the items related to pain, 2 items related to stiffness, and 17 items related to physical function. Each of the items is rated on a 5-point scale (0- No difficulty, 4-extreme difficulty) and summed up to give a total WOMAC score which can range from 0-96. Based on an 8-point difference in mean between groups (with a common standard deviation of 18 points) on the WOMAC (with a .05 level of significance), the authors calculated that an effect index of 0.44 could be considered a moderate treatment effect between the groups, demonstrating an additive effect of perturbation and agility exercises
- Knee severity was rated on a 0-5 numeric scale based off of the question: "To what degree does giving way, buckling, or shifting of the knee affect your level of daily activity?" with 0 being that the symptom prevents all daily activities and 5 being the participant is not symptomatic. Participants were classified as "unstable" if their instability rating was ≤3 and as "stable" if their rating was ≥4.
- Self-reported knee pain was tested using a 11-point numeric scale with 0 representing "no pain" and 10 representing "worst pain imaginable." Participants were asked to report the worst knee pain they've experience in the 24 hours before testing.

- The GRC is a 15-item scale in which participants rate their change in their knee condition. 1 corresponds to "a very great deal better," 8 corresponds to "about the same," and 15 corresponds to "a very great deal worse"
- The GUAG measured physical function, and involved participants getting up from a standard-height chair and walking as fast as possible along a level distance of 15.2 m. The length of time to complete the task was recorded. The minimum detectable change for this test is 1.2 seconds. Normative data or cut-off scores were not described in the article regarding this test.

Main Findings

- ✓ There was some improvement in both groups from baseline, but the agility and perturbation group had slightly more improvement than the standard exercise group on the WOMAC total score (p=0.05), the physical function score (p=0.04), and the global rating of change (p=0.03).
- ✓ Longitudinal intention-to-treat analysis conveyed that there were no significant differences on outcomes between the two treatment groups at the 12-month follow-up.
- ✓ Raw effect sizes were calculated for WOMAC scores for the two treatment groups as change scores from baseline to the 12-month ITT sample follow up:
    - WOMAC total scores
        - Agility and perturbation group: 4.6 points
            - n=91
        - Standard exercise group: 4.2 points
            - n=92
    - WOMAC physical function scores
        - Agility and perturbation group: 6.3 points
            - n=91
        - Standard exercise group: 4 points
            - n=92
    - None of the differences between means (effect sizes) met the authors criteria of an 8-point minimal difference

- ✓ Percent change in WOMAC scores from baseline to 12-month follow-up:
    - Agility and perturbation group: 29%
        - n=76
    - Standard exercise group: 32%
        - n=66
- ✓ Percent change in WOMAC scores from baseline to 12-month follow-up (ITT Sample):
    - Agility and perturbation group: 16%
        - n=91
    - Standard exercise group: 15%
        - n=92
- ✓ Within group changes from baseline in the WOMAC total and WOMAC physical function scores were significant with (P<.01) for both groups at all follow-up periods
- ✓ Slight improvements were observed within the two groups regarding knee pain improvement (ranging from 0.3-1.0 improvement) and GUAG scores (0.3 to 0.5 second improvement), however the changes were not significant and no differences were found between the two groups
- ✓ No statistical differences were observed regarding adherence to home exercise sessions between the two groups. (P=.63)
- ✓ Slight within-group improvements in the proportion of participants reporting knee instability from baseline were observed.
- ✓ No adverse events were reported

Original Authors' Conclusions

Based on the results of the study, the authors concluded that there does not seem to be a clinically meaningful additive effect of agility and perturbation exercises to a standard exercise program designed for patients with symptomatic knee OA. However, the perturbation and agility group demonstrated better results compared to the standard exercise group in self-reported function (WOMAC total scores and WOMAC physical function score) and global rating of change throughout the first six to twelve months of treatment.

Critical Appraisal

Validity

- PEDro Scale score: 9/11 based on eligibility criteria: Yes; Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: Yes; >85% participant outcomes: Yes; Intention-to-treat analysis: Yes; Between-group comparison: Yes; Point estimates and variability: Yes
- Though the participants and therapists were unable to be blinded in this study, the PEDro score for this study is quite high, indicating that this RCT is likely to have high internal validity and may have sufficient statistical information to provide meaningful data. The methodological quality of this study was high, and it appears the authors strived to make their trial as comprehensive and valid as possible. For example, the authors accounted for the extra 15 minutes of time the perturbation and agility training required, and standardized the time for the standard exercise group with the upper arm bike. Additionally, the researchers assessed for potential covariates and estimated an adequate sample size to produce sufficient power (80%).
- The active control group, in this case the standard exercise group, was quite appropriate for this patient population. The researchers aimed to detect a noticeable difference in the agility and perturbation group to a commonly utilized protocol for symptomatic knee OA. Therefore, this form of control is much more relevant and valuable compared to an inactive or "wait-list" control group.
- To help ensure confounding variables are not influencing the groups, standardization of the interventions was reinforced with periodic random reviews of the participants' treatment records by the principal investigator. Furthermore, the principal investigator reviewed the intervention programs with the therapists every 6 months in person.
- A key limitation in this study is that the initial power analysis conveyed that a sample size of 168 participants (84 subjects per group) was necessary to yield 80% power to detect a difference of 8 in the mean WOMAC scores at the 12-month follow-up. However, only 145 participants completed the study, which may have decreased the overall power of the trial.
- As noted in the exclusion criteria, participants who demonstrated significant balance deficits did not participate in this study (i.e. those who use assistive devices, reported a history of two or more falls in the past year, or were unable to ambulate 30.5 meters without an assistive device or need of a rest break). This may have biased the results of the study, as falls-risk subjects may have demonstrated a stronger effect from the agility and perturbation interventions.
- Though the authors of the study clarified that follow-up testing assessors were blinded of the participants' group assignments and that the treating therapists were not involved in the testing procedures, they failed to state who performed the outcome testing at the follow-ups.
- The duration of the exercise interventions was never explicitly stated, though it can be assumed that all study participants received the same number of hours of therapy. However, exercise duration may have an influential impact on outcomes, as a patient is

likely to make more gains in outcomes through longer treatment sessions, compared to shorter sessions.

- Bias may have been present in the exercise diaries provided to assess home exercise program adherence. The researchers state they aimed to eliminate potential bias of participants forging their diaries by offering a small monetary award if participants returned their exercise diaries at follow-up visits- regardless of whether the exercise diary checklist was completed or not. However, inaccurate information very well may have still been provided.

Interpretation of Results

- The results of this study suggest that there is no significant additive effect of agility and perturbation training to a standardized exercise program for patients with symptomatic knee OA after 12 months. However, the findings of the data demonstrate that the addition of agility and perturbation exercises may offer slightly more improvements compared to a standardized exercise program alone, regarding WOMAC total scores, physical function scores, and the GRC scores in the first six months of treatment.
- The authors state in their discussion: "A 17% to 22% change in WOMAC scores from baseline has been reported to be clinically meaningful." (p. 462) Based off of this assumption, the results of this study were clinically meaningful for the WOMAC scores at the 12-month follow up for both groups. Therefore, either intervention may be clinically meaningful and effective in improving functional status in patients with symptomatic knee OA. However, knee pain and GUAG outcomes did not produce clinically meaningful effects for either groups, as the changes were too minimal to justify the interventions.
- The effect size calculated from the total WOMAC scores for the two treatment groups from baseline to the 12-month-follow up demonstrated a 4.6-point improvement in the agility and perturbation group and a 4.2-point improvement for the standard exercise group. The difference (.4) between these two effect sizes is quite small, and based off of previous clinical reasoning, not very meaningful. Within both of the groups, the the difference is an improvement of approximately 4 points from baseline. However, the minimally clinically important difference (MCID) for the WOMAC is 7.9 points with a 95% CI.[6] Therefore, the effect size from this study within both groups falls short of clinically relevant.

(2) Description and appraisal of "No difference between home-based strength training and home-based balance training on pain in patients with knee osteoarthritis: a randomised trial" by Chaipinyo K and Karoonsupcharoen O. (2009)[4]

Aim/Objective of the Study/Systematic Review:

The aim of this study was to compare the efficacy of a four-week balance training home exercise program to a four-week conventional strength training home exercise program in decreasing pain in elderly patients with knee joint osteoarthritis.

Study Design

- Randomized controlled equivalency trial
- Participants were randomly assigned to one of the two intervention groups using a randomized sequence concealed in envelopes
- A priori power analysis was used to determine the number of participants needed to fulfil the pain subscale of the KOOS, with a sample size of 40 providing an 80% probability of detecting a 10-point effect of balance training of the pain subscale
- Participants and physical therapists prescribing the exercises were not blinded to group allocation
- There was blinding of the assessor who measured outcome measures and performed the data analysis
- After randomization, baseline outcome measures were collected and participants were either prescribed a balance training or strength training home-based exercise program to complete for four weeks
- Advice or revisions were distributed to the patients after the first two weeks of the home exercise program as necessary. No outcome measures were recorded at this period.
- After four weeks of the home exercise program, outcome measures were collected.

Setting

- All research for this study was conducted at the Srinakharinwirot University Physical Therapy Clinic in Bangkok, Thailand. The authors of this study disclose that this clinic is a physical therapy service and clinical practice teaching center for undergraduate physical therapy students.

Participants

- Subjects were recruited through convenience sampling
- All participants in the study were ≥ 50 years of age and met the 1986 American College of Rheumatology clinical criteria for knee osteoarthritis
- Subjects were excluded from the study if they had a history of cardiovascular disease, Parkinsonism, osteoporosis, limitations in knee motion that prevented them from comfortably positioning their knee for knee strength measurement; were unable to walk 15 meters; and had been receiving intra-articular injections or physical therapy intervention for their knee during the preceding six months.
- 50 individuals with knee osteoarthritis enrolled in the study, with 48 participants eligible for the trial. 42 participants finished the four week trial.
- The six subjects were lost to follow-up for the following reasons:
    - Other illnesses (n=4)
    - Personal reason (n=1)
    - Uncontactable (n=1)

- There were no clinically-important differences between the two intervention groups at baseline

Participants in Balance Training Group

- n= 24, 0 lost to follow up
- mean age: 62 ± 6 years
- mean weight: 60 ± 11 kg
- 38% men
- mean BMI: 25 ± 4 kg/m^2
- 42% right side knee osteoarthritis

Participants in Strength Training Group

- n= 24, 6 lost to follow up
- mean age: 70 ± 6 years
- mean weight: 57 ± 9 kg
- 8% men
- mean BMI: 25 ± 3 kg/m^2
- 46% right side knee osteoarthritis

Intervention Investigated

Conventional Strength Training Group

- Home exercise program consisted of:
    - 30 repetitions of isometric knee extension in sitting for each leg, 5 days per week.
        - Subjects performed 10 repetitions/set for 3 sets and take a rest between each set as long as necessary before starting the next set
    - Patients were instructed to begin exercises with knee flexed to 90 degrees, and then maximally extend their knee and hold a maximum isometric contraction for 5 seconds within a pain free range
- The home exercise program was prescribed by two physical therapists at a University clinic. Photographic details of the home exercise program were distributed to each participant, and all subsequent exercise sessions were performed at home.
- Participants were given a log book to record the numbers of days the exercises were performed per week

Balance Training Group

- Home exercise program included a sequence of:
    - Stepping forward and backward with left leg 30 times
    - Bilateral minisquat 10 times
    - Stepping forward and backward with right leg 30 times
    - Bilateral mini squat 10 times
    - Stepping sideward to the left 30 times
    - Bilateral minisquat 10 times
    - Stepping sideward to the right 30 times
- Bilateral mini squats were instructed to be performed within pain free range (approximately 15-30 degrees of knee flexion)
- Exercises were performed 5 days per week
- The home exercise program was prescribed by two physical therapists at a University clinic. Photographic details of the home exercise program were distributed to each participant, and all subsequent exercise sessions were performed at home.

- Participants were given a log book to record the numbers of days the exercises were performed per week

Outcome Measures (Primary and Secondary)

- The primary outcome score of the study was pain measured from the subscale of the Knee injury and Osteoarthritis Outcome Score (KOOS).
- Secondary outcome measures included:
    - The other subscales of the KOOS which comprise: other symptoms, function in daily living, function in sport and recreation, knee-related quality of life
    - Strength
    - Mobility
- The KOOS in a self-report measurement tool which assesses a patients' perception about their knee and associated problems. This modified version of the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index consists of 41 questions arranged into 5 subscales.
- The five subscales of the KOOS include: pain, other symptoms, function in daily living, function in sport and recreation, and knee related quality of life. 5 Likert boxes are the standardized answer options given, and each question is assigned a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each subscale.
- Knee flexor strength and extensor strength were measured using an isokinetic dynamometer. The participants were verbally encouraged to exert a maximal effort forces the four different conditions: extensors and flexors, involved and uninvolved knees. The highest torque developed throughout the range of motion was averaged over five repetitions and recorded.
- Mobility was measured by the time measured to complete the following activities:
    - Walking along a level unobstructed corridor for 15 meters
    - Rising from a chair and walking 15 meters (Get up and Go)
    - Walking up 11 stairs
    - Walking down 11 stairs

Main Findings

- ✓ Independent t-tests were used to compare the between-group difference after 4 weeks of the home exercise training
- ✓ Paired t-tests were used to compare the within-group difference from baseline to 4 weeks to asses the level of improvement for all the participants.
- ✓ Level of significance was set at $p<0.05$
- ✓ No significant differences between groups for pain was found
    - Mean difference was -3 points out of 100 with a 95% CI from -10 to 5
- ✓ There was a between-group difference in the Knee injury and Osteoarthritis Outcome Score for knee-related quality of life, where the strength group showed improvements, but the balance group did not
    - Mean difference -17 points out of 100 with a 95% CI from -28 to -5
- ✓ There was no significant difference between groups for strength
- ✓ The only between-group difference in mobility was the time taken to walk downstairs, where the strength group improved by 2 seconds more than the balance group
    - 95% CI from 0 to 3
- ✓ When the two intervention groups were observed together there were statistically-significant differences in all outcomes except extensor strength of the uninvolved knee.
    - The five subscales of the KOOS increased by an average of 11 points out of 100
    - Mobility improved in totally by 4 seconds, with a 95% CI from 2 to 6

- Extensor strength of the involved knee increased by 4 Nm, with a 95% CI from 0 to 8
- Mean difference for extensor strength of uninvolved knee was 3 Nm, with a 95% CI from -1 to 7

Original Authors' Conclusions

Based on the results of the study, the authors conclude that there is no significant difference between the two intervention groups in decreasing pain or improving strength. However, when observed together, both balance training and strength training programs demonstrated to be effective interventions in terms of lowering pain, improving symptoms, regaining function in daily living, improving function in sport and recreation, increasing knee extensor strength, and improving overall mobility. Due to the comparable effects of both the balance training and strength training programs, the authors support the use of either program as home-based exercise for older adults with knee osteoarthritis.

Critical Appraisal

Validity

- ✓ PEDro Scale score: 8/11 based on eligibility criteria: Yes; Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: Yes; >85% participant outcomes: Yes; Intention-to-treat analysis: No; Between-group comparison: Yes; Point estimates and variability: Yes
- ✓ This study's high PEDro score indicates that this RCT is likely to have high internal validity and may have sufficient statistical information to provide meaningful data.
- ✓ Though the participants and the therapists were not blinded during the study, the authors strived to reduce bias through means of blinding the outcome assessor and data analyst. However, the authors did not disclose who specifically undertook outcome measures and data analysis or their exact qualifications.
- ✓ An important strength of this study is that 42 participants completed the four-week trial, increasing the study's overall power. This sample size satisfies the requirements of the priori power analysis to determine the number of participants needed to fulfil the pain subscale of the KOOS.
    - sample size of 40 provides an 80% probability of detecting a 10-point effect of balance training of the pain subscale
- ✓ A key strength of this study is its high external validity, as the interventions required minimal equipment and could be easily completed in generalized environments and situations- outside of a research setting.
- ✓ The design of the home exercise programs may have the following limitations:
    - The exercises included in the programs are rather generic and monotonous. Therefore the exercises may be unlikely to engage the patients. Research has conveyed that knee osteoarthritis patients are less likely to adhere to an exercise program if they do not find the intervention to be enjoyable or tailored to their individual needs.[7]
    - If participants in the study had balance deficits or a fear of falling, they may not have adequately challenged themselves during the home-based balance exercises. Therefore, they may not have been able to promote optimal neuromuscular re-education and noticeable effects with treatment.
- ✓ Bias may have been present in the exercise log book provided to the participants to record the number of days the exercises were performed per week. Participants may have documented inaccurate information or forged their exercises to represent adherence to the program.
- ✓ A limitation of this study is that an intention-to-treat analysis was not completed for the six participants who did not complete the trial. This is of particular interest for this study, as all six of the participants who did not complete the four-week trial were from the strength

training group. Therefore, biased comparisons may have been made between the intervention groups. <<Great point>>

- ✓ This study was an equivalency trial, which lacked a control group with no intervention. The strength of this study may have been enhanced if a control group with no intervention was incorporated to enhance the effectiveness of the two training programs.
- ✓ This study was completed in a relatively short duration of four weeks. A longer duration for the interventions may be necessary to observe a greater effect in outcomes. Additionally, a follow-up may be necessary to control for any improvements or progressions of symptoms over time.

Interpretation of Results

- The results of this study suggest that a home-based balance training program or a strength training program have comparable effects on pain and strength in older adults with knee osteoarthritis. However, when both groups were considered together for all outcome measures, statistically significant improvements were found for all measures, except extensor strength of the uninvolved knee. After the four-weeks, mean difference within both groups demonstrated improvements in pain, symptoms, regaining function in daily living, improving function in sport and recreation, increasing knee extensor strength, and improving overall mobility (all within 95% CI). Based off of these findings, the use of balance training and/or strengthening programs for home-based exercise may be effective interventions for older adults with knee osteoarthritis.
    - When evaluating the mean extent of improvement for both groups considered together, related to the outcomes in the KOOS subscales, only the symptoms and and knee-related quality of life subscales met the minimal detectable change estimates established by Roos et al.[8] However, the mean score for function in daily living subscale was only one point away (9, 95% CI) from the Roos et al. estimate of 10 points.

- As previously noted, home-programs that are engaging and tailored to an individual's may prove to be more successful and demonstrate large effects over time. When prescribing a home-based balance program, clinicians should also screen patients for a perceived fear of falling or balance impairments, as they may be less likely to challenge themselves at home without the reassurance of a nearby clinician.

- Of interest, there was one between-group difference for the interventions in the Knee injury and Osteoarthritis Outcome Score (KOOS) for the knee-related quality of life subscale. The strength group demonstrated significant improvements compared to the balance group regarding this outcome (a 17-point mean difference). However, it should be noted that the six dropouts in the study were from the strength training group, and likely had higher baseline knee-related quality of life scores (as the mean knee-related quality of life dropped significantly after the 6 baseline scores were removed). Therefore, it cannot be confidently concluded that a strengthening program is more effective in improving knee-related quality of life.

- One other between-group difference was observed for one of the mobility measurements (time to descend 11 stairs), with the strength group improving 2 seconds more than the balance group after four weeks. However, a 2-second difference is unlikely to be a functionally meaningful change for individuals, therefore clinicians should use their clinical reasoning and acknowledge their patient's goals when determining home-based exercise programs for their patients.

(3) Description and appraisal of "A comprehensive review of the effectiveness of different exercise programs for patients with osteoarthritis" by Golightly YM, Allen KD, and Caine DJ. (2012)[5]

Aim/Objective of the Study/Systematic Review:

The objective of this review was to discuss the effectiveness of varying exercise programs for symptomatic osteoarthritis based on a comprehensive review of the literature.

Study Design

- ✓ Comprehensive review focusing primarily on RCTs
- ✓ Search strategy
  - Search of publications from the past 15 years
    - January 1997-July 2012
  - Four databases were utilized:
    - Pubmed/Medline
    - The Cochrane Library
    - Physiotherapy Evidence Database
    - The Cumulative Index to Nursing and Allied Health Literature
  - Terms searched included:
    - Osteoarthritis, exercise, exercise program, effectiveness, and treatment outcome
  - Titles and abstracts for identified articles were reviewed by two of the authors (Golightly and Caine)
  - Inclusion criteria for the systematic review:
    - Specific to osteoarthritis
    - Clearly defined exercise program
    - Examined the effectiveness of the program
    - English-language RCTs and systematic reviews of exercise programs
  - Exclusion criteria for the systematic review:
    - Pharmacological and surgical intervention studies for OA
- ✓ The initial search strategy yielded 443 possible articles for review
  - 72 duplicate studies and 332 articles that did not meet the inclusion criteria after review were excluded
- ✓ 39 articles were included in the systematic review

Setting

- The settings for the studies included in this systematic review varied, but were predominantly outpatient facility-based, home-based, or both. Specific geographic setting information related to the studies included in this systematic review was not disclosed.

Participants

- Most studies in the systematic review included patients included patients with mild-to moderate OA, and were generally older adults with a great proportion of women
- No comparisons of the effectiveness of exercise programs on age or sex were reported
- 39 Randomized controlled trials, meta-analyses, and systematic reviews were included in the study with the following studies reviewed for each type of exercise program:
  - Mixed Land-Based Exercise Programs

        - 3 meta-analyses
    - Strength Training Programs
        - 2 meta-analyses
        - 1 systematic review
        - 8 RCTs
    - Balance and Neuromuscular Training Programs
        - 1 meta-analysis
        - 1 systematic review
        - 5 RCTs
    - Water-Based Programs
        - 2 meta-analyses
    - Mixed Water-Based and Land-Based Programs
        - 2 systematic reviews

- The systematic review included the following studies related to <u>balance and neuromuscular training programs</u>:

    - 1 systematic review that included 9 RCTs that examined the effectives of exercise on balance with women with OA
        - 833 total participants
        - Exercise interventions included:
            - Aerobic and strength training, Tai Chi, hydrotherapy, vibrating platform exercise, balance exercises, and educational programs
            - Duration for trials ranged from 4 weeks to 18 months

    - 1 meta-analysis of 7 RCTs comparing a proprioceptive exercise program with a nonproprioceptive exercise program or a nontreatment control for adults with OA
            - 560 total participants with a mean age of 63
            - All proprioceptive exercises were weight-bearing and based on functional activities
                - Stepping, standing, walking, or balancing
        - Nonproprioceptive exercise programs were lower extremity exercises
        - Duration of the programs ranged from 4-8 weeks

- The systematic review included the following studies related to <u>strength training exercise programs</u>:

    - 1 systematic review with 6 RCTs emphasizing progressive resistance training (PRT) in older adults
        - total of 503 participants with hip or knee OA
        - PRT was performed 2-3 timers per week at a high intensity
    - 1 meta-analysis with 7 trials of patients with knee OA and 1 trial with patients with hip and knee OA, that observed the effectiveness of PRT in older adults
        - 907 total participants
        - interventions included:
            - moderate- to high-intensity programs that included 1-9 exercises
            - frequency ranged 3-5 times per week
            - duration ranged from from 6-72 weeks
    - 1 meta-analysis consisting of 21 RCTS that researched the effectiveness of PRT programs in adults with OA
        - 2325 patients with a primary diagnosis of OA
        - Exercise types included:
            - Isometric, isotonic, isokinetic, concentric, concentric/eccentric/ dynamic
            - Alone or with other exercises such as stretching and ROM

Intervention Investigated

Balance and Neuromuscular Training Programs

- 1 systematic review that included 9 RCTs that examined the effectives of exercise on balance with women with OA
  - 833 total participants
  - Exercise interventions included:
    - Aerobic and strength training, Tai Chi, hydrotherapy, vibrating platform exercise, balance exercises, and educational programs
    - Duration for trials ranged from 4 weeks to 18 months

- 1 meta-analysis of 7 RCTs comparing a proprioceptive exercise program with a non-proprioceptive exercise program or a non-treatment control for adults with OA
    - 560 total participants with a mean age of 63
    - All proprioceptive exercises were weight-bearing and based on functional activities
      - Stepping, standing, walking, or balancing
    - Non-proprioceptive exercise programs were lower extremity exercises
    - Duration of the programs ranged from 4-8 weeks

Strength Training Programs

- 1 systematic review with 6 RCTs emphasizing progressive resistance training (PRT) in older adults
  - total of 503 participants with hip or knee OA
  - PRT was performed 2-3 timers per week at a high intensity
- 1 meta-analysis with 7 trials of patients with knee OA and 1 trial with patients with hip and knee OA, that observed the effectiveness of PRT in older adults
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    - Isometric, isotonic, isokinetic, concentric, concentric/eccentric/ dynamic
    - Alone or with other exercises such as stretching and ROM

Outcome Measures (Primary and Secondary)

- This systematic review did not observe one specific primary outcome measure. The studies included in this systematic review examined various outcome measures related to differing therapeutic interventions. For the purposes of this CAT, only the outcomes measures

utilized in the strength training and balance and neuromuscular training programs are summarized, with an emphasis on outcome measures observing pain, stiffness, and function.

- Outcome measures observed with strength training programs:
    - Pain, WOMAC, WOMAC subscales, strength, range of motion, physical disability questionnaire, knee pain questionnaire, quality of life, performance based tasks (distanced walked for the 6-minute walk test, lifting and carrying 10 pounds, and time to get in and out of a car).

- Outcome measures observed with balance and neuromuscular training programs:
    - Pain, WOMAC, WOMAC subscales, balance, joint position sense-related measurement, timed walk over uneven ground, joint position angulation error and joint position sense, balance functional performance tests (Berg Balance Scale, timed get-up-and-go test, chair stand test, 6-minute walk test)

Main Findings

Strength Training Programs

- ✓ An included systematic review by Liu and Latham found that participants with OA reported a deduction in pain following progressive resistive training 2-3 times per week at a high intensity (SMD, -0.30, 95% CI, -0.487 to -0.13)
    - Mean age for the studies included was ≥60 years
- ✓ An included meta-analysis by Latham and Liu conveyed findings that moderate-to high-intensity progressive resistive training programs that included 1-9 exercises (3-5 times per week) reduced pain (SMD, -0.35;95% CI, -0.52 to -0.18), improved function (SMD 0.33, 95% CI, 0.18 to 0.49), and improved leg extensor strength (SMD, 0.33;95% CI, 0.12-0.54) compared to non-strength training control groups.
    - One of the studies included, FAST, had a resistance training group which consisted of a 3-month facility based program meeting 3 times per week to perform 2 sets of 12 repetitions of 9 exercises, followed by a 15-month home-based program
    - The resistant group in FAST demonstrated reduced mean scores on the physical disability questionnaire (p=0.003), the knee pain questionnaire (p=0.02), and improved performance on physical function tasks such as the 6-minute walk test (p=0.02), faster time lifting and carrying 10 lbs (p=0.001), and faster time to get in and out of a car (p=0.003).
- ✓ An included meta-analysis by Pelland et al. found that strengthening exercises improved pain, range of motion, strength, and functional status in patients with OA. Exercises included concentric, eccentric, isometric, isokinetic resistance, and whole body functional strengthening.
- ✓ A RCT of 142 individuals with knee OA demonstrated that a home-based quadriceps strengthening program may be as effective as the use of NSAIDS for improving pain, stiffness, physical function, and quality of life outcomes during an 8-week intervention period.
    - The exercise intervention involved 20 repetitions of a slow knee extension movement performed 4 times daily
- ✓ Findings from a RCT of 389 overweight and obese men and women demonstrated significant improvements in knee pain on WOMAC scores in knee strengthening exercise groups compared to those in non-exercise groups (mean difference, -0.91; 95% CI, -1.66 to -0.17).
- ✓ A RCT of 102 participants with mile-to-moderate OA demonstrated that high-resistance exercise was more time efficient and had a larger effect size compared to low-resistance exercise related to pain, function, walking time, and muscle torque improvements at follow-up.

Balance and Neuromuscular Training Programs

- ✓ Results from a systematic review by Silva et al. demonstrated that balance in women with knee OA improved following exercise programs (lasting 4 weeks to 18 months) that included aerobic exercise and strength training, Tai Chi, hydrotherapy, vibrating platform exercise, balance exercises, and educational programs.
- ✓ Two included RCTs by Trans et al. and Avelar et al. demonstrated positive findings regarding the use of vibration training with exercise to promote muscular power and proprioception
- ✓ Findings from several RCTs on the effects Tai Chi programs have demonstrated that Tai Chi may improve function in women with OA
    - Results from a 24-week Tai Chi program indicated that Tai Chi had statistically significant effect compared to a control group for Chinese women with knee OA:
        - total WOMAC score (6.18 vs. 1.71); WOMAC pain (1.36 vs. 0.07); stiffness (0.66 vs 0.05), and function subscales (6.17 vs 1.72); the 6-minute walk distance (32.43 vs 16.76 m); and the stair climb time (2.27 vs. 0.27 sec)
- ✓ Proprioceptive exercise programs have also demonstrated to be successful intervention techniques for individuals with knee OA.
    - An included meta-analysis by Smith et al. conveyed that proprioceptive exercises significantly improved functional outcomes compared with a non-treatment control ($p<0.02$).
        - Mean difference in WOMAC physical function score, -12.19;95% CI, -15.67 to -8.71).
        - However, outcomes were similar between proprioceptive and non-proprioceptive programs (consisting of lower extremity exercises) with the exception that the outcomes were better for the proprioceptive programs for joint positon sense-related measurements (timed to walk over uneven ground ($p=0.03$) and joint position angulation error ($p<0.01$).
        - All proprioceptive exercises were weight-bearing and based on functional activities

Original Authors' Conclusions

Based on the information obtained through the comprhensive review, the authors conclude that the evidence supports progressive strengthening exercise for reducing pain and improving physical function in patients with mild-to-moderate OA of the knee. Though the authors note, "the effects are generally comparable with estimates reported for simple analgesics and NSAIDS for the treatment of knee pain" (p. 62). The authors also recognize that there is a limited, but promising, amount of evidence available supporting alternative types of exercise for symptomatic knee OA, such as balance training, Tai Chi, and proprioceptive training.

Critical Appraisal

Validity

- AMSTAR score 6/11 based on:
    - Was an "a priori' design provided? No
    - Was there duplicate study selection and data extraction? Yes
    - Was a comprehensive literature search performed? Yes
    - Was the status of publication used as an inclusion criterion? No
    - Was a list of studies (included and excluded) provided? No
    - Were the characteristics of the included studies provided? Yes

- Was there scientific quality of the included studies assessed and documented? Yes
- Was the scientific quality of the included studies used appropriately in formulating conclusions? Yes
- Were the methods used to combine the finds of studies appropriate? Not applicable
- Was the likelihood of publication bias assessed? No
- Was the conflict of interest included? Yes

- The level of evidence for this study is strong, as it is a comprehensive review that evaluates the effectiveness of varying types of exercise programs for OA- only appraising high-level evidence (RTCs, systematic reviews, and meta-analyses) in the literature.
- The systematic review includes systematic reviews and meta-analyses with a significantly higher number of participants/subjects compared to RTCs alone. Therefore, the larger pool of participants provides a larger pool of data to offer a more meaningful effect size regarding exercise interventions for symptomatic knee OA.
- Full details were provided regarding the search strategy and study selection in this systematic review, thereby limiting methodological bias. Another strength of this systematic review, is that a total of four databases were included in the search strategy, ensuring a comprehensive collection of the latest research on this topic.
- One weakness of this systematic review is that the authors did not disclose if they utilized the use of valid assessment tools to analyse the methodological quality of each study included in the review. The authors noted that they considered studies for their quality of evidence, but did not specifically state how they made this assessment. Without a credible assessment of the studies included, the information summarized may vary in clinical relevance, quality, and validity. However, as previously mentioned, the authors only appraised high-level evidence for their review.
- As noted in the AMSTAR review of this study, the authors did not clarify if the research questions and inclusion criteria was established before the review commenced. Although a list of references is provided at the end of the article, a full list of included and excluded studies was not presented in the review.

Interpretation of Results

- A large body of high-level evidence (one systematic review and two meta-analyses) supports the use of strength training programs as effective interventions for individuals with symptomatic knee OA. Moderate- to high- intensity progressive resistance training (PRT) programs have demonstrated to be effective in reducing pain, improving function, and improving lower extremity strength, compared to non-strength training groups. Effective strengthening programs for patients with symptomatic knee OA may incorporate isometric, isotonic, isokinetic, concentric, or dynamic movements. PRT can be successfully implemented into exercise programs for older adults. Additionally, high-resistance strengthening exercise may be a time-efficient exercise for this patient population, as it has demonstrated a larger effect size for pain, function, walking time, and muscle torque compared to low-resistance strengthening.

- The summary of the Silva et al. study included in the systematic review suggests that exercise programs may improve balance in women with knee OA, regardless of the specific program intervention. The authors noted that the Silva et al. study included 8 RCTs in which the exercise programs varied and included interventions such as aerobic and strength training, Tai Chi, vibrating platform exercise, and balance exercises- most of which demonstrated balance improvements after completion.

- Evidence from numerous RTCs have supported the use of Tai Chi in individuals with symptomatic OA to promote balance, flexibility and strength, while improving function status and reducing pain and stiffness. When clinicians are considering balance training interventions for knee OA patients, they should consider the inclusion of Tai Chi exercises to promote optimal outcomes.

- A meta-analysis included in the study provides compelling and high-level evidence insight into the benefits for proprioceptive exercise programs to improve functional outcomes in individuals with knee OA. Compared to a non-treatment control, proprioceptive exercises demonstrated to be effective in improving WOMAC physical function score, with a clinically meaningful difference of 12.1 points (95% CI, -15.67 to -8.71). A study Pua et al. has estimated that the minimal detectable change score for the WOMAC-PF to be 9.1 points for patients with symptomatic osteoarthritis.[9] When compared to non-proprioceptive programs consisting of lower extremity exercises, the functional outcomes were similar (mean difference in WOMAC physical function score, 0.59; 95% CI, 2.12 to 3.29), suggesting that traditional therapeutic exercise and proprioceptive exercise are comparatively effective in improving function in knee OA patients. One exception where proprioceptive exercise demonstrated better outcomes compared to traditional lower extremity exercises was joint position sense-related measurements (time to walk over uneven ground ($p=0.03$) and joint position angulation error ($p<0.01$).

EVIDENCE SYNTHESIS AND IMPLICATIONS

Implications for Practice

A majority of the evidence reviewed for this topic was conclusive in that balance training interventions do not have clinically superior outcomes compared to traditional therapeutic exercise intervention, related to improving WOMAC measures for individuals with symptomatic knee osteoarthritis (OA). Many studies have conveyed that there may or may not be a benefit of balance training intervention to patients with knee OA, as the effectiveness of balance training programs have demonstrated to be comparable to strengthening programs in terms of outcomes.[3,4,10] Specifically related to home-based programs, the literature suggests that a balance training program or a strength training program have proportionate positive effects related to reducing pain and stiffness and improving strength and physical function in patients with knee OA.[4,10] Furthermore, a four-armed RTC by Rogers et al. found that a combined strengthening and balance home exercise program had comparable outcomes related to pain, stiffness and improving physical function on WOMAC subscales, compared either a balance or strengthening program alone.[10] Therefore, therapists should use their clinical judgment to determine which intervention program would be most beneficial and appropriate for a patient with symptomatic knee OA.

Of note, several studies have also demonstrated some additive effects of balance training interventions to standard exercise programs for individuals with knee OA, though the clinical relevance of these effects vary.[2,3,5,11] The addition of agility and perturbation exercises may offer slightly more improvements compared to standardized exercise program alone, regarding WOMAC total scores, physical function scores and global rating of change within the first 6-12 months of treatment intervention.[3] Similarly, high-quality evidence by Diracoglu et al. (Pedro score of 7/11) has demonstrated that the addition of kinaesthesia and balance exercises to a strength training program can significantly improve physical function on the WOMAC- physical function subscale in symptomatic knee OA patients.[2] Furthermore, proprioceptive exercise (which include balance components) may be more effective compared to traditional lower extremity exercise in promoting

joint position sense when walking over uneven ground and overall proprioceptive function.[5] Interestingly, there may also be an additive of any exercise program (aerobic, strength training, or balance training) on improving balance in women with knee OA.[5]

There is a substantial quantity of evidence supporting strengthening exercise for reducing pain and improving physical function in patients with mild-to moderate knee OA.[5] Effective strengthening programs for patients with symptomatic knee OA may incorporate isometric, isotonic, isokinetic, concentric, or dynamic movements and are likely to demonstrate the larger effect when performed against high resistance.[5] However, the body of high-level evidence supporting balance interventions such as balance exercise, Tai Chi, and proprioceptive training is also meaningful and clinically relevant.[5]

Psychometric and perceived stability are also factors that should be addressed when working with patients with symptomatic knee OA, as Fitzgeralad et al. conveyed addressing factors such as self-reported knee instability and fear of physical activity and are necessary to demonstrate a meaningful treatment response (20% improvement in numerical knee pain rating scale and the WOMAC physical function scale) in individuals with knee OA.[12]

Therefore, use of balance training programs and/or therapeutic exercise programs may be effective interventions for individuals with symptomatic knee osteoarthritis. Both interventions have demonstrated to be beneficial in improving WOMAC total score outcomes, as well the subscale components as well. Therapists should select exercises and home-programs programs based on the patient's individual goals or preferences, as patients with knee OA are more like to adhere to an exercise program if they find the intervention to be tailored to their specific needs.[7]

Implications for Future Research

Further research is necessary to determine if the addition of balance training interventions to a standard OA exercise program can improve treatment effects (specifically pain, stiffness, and function) in patients who are a falls risk or have balance impairments, as patients with significant balance impairments were often excluded from the studies reviewed in this appraisal. This particular need is relevant to the clinically-based question, as the patient in this scenario has identified balance deficits. Some of the studies reviewed in this CAT have had contradictory findings related to long-term outcomes after balance or therapeutic intervention programs.[11,12] Therefore, additional research is necessary to determine the lasting effects of the additive benefits of balance training to standard OA exercise program. This information is clinically necessary, as knee osteoarthritis is often a life-long chronic condition.[13,14] Research is also needed to determine the effectiveness of balance training interventions on varying stages of knee OA, as there is likely to be a decline in balance and proprioception due to increased articular damage and decreased quantity of joint mechanoreceptors that corresponds with the aging process.[13]

REFERENCES

1. Williams QI, Gunn AH, Beaulieu JE, Benas BC, et al. Physical therapy vs. internet-based exercise training (PATH-IN) for patients with knee osteoarthritis: study protocol of a randomized controlled trial. *BMC Musculoskeletal Disorders*. 2015; 16:264. Doi: 10.1186/s12891-015-0725-9
2. Diracoglu D, Aydin R, Baskent A, Celik A. Effects of kinesthesia and balance exercises in knee osteoarthritis. *Journal of Clinical Rheumatology*. 2005;11(6):303-310. Doi: 10.1097/01.rhu.0000191213.37853.3d.
3. Fitzgerald GK, Piva SR, Gil AB, Wisniewski SR, et al. Agility and perturbation training techniques in exercise therapy for reducing pain and improving function in people with knee osteoarthritis: a randomized clinical trial. *Physical Therapy*. 2011; 91(4):452-469. Doi: 10.2522/ptj.20100188.
4. Chaipinyo K, Karoonsupcharoen O. No difference between home-based strength training and home-based balance training on pain in patients with knee osteoarthritis: a randomised trial. *Australian Journal of Physiotherapy*. 2009;55:25-30. Doi: 10.1016/S0004-9514(09)70057-1.
5. Golightly YM, Allen KD, Caine DJ. A comprehensive review of the effectiveness of different exercise programs for patients with osteoarthritis. *The Physician and Sportsmedicine*.2012;40(4):52-65. Doi: 10.3810/psm.2012.11.1988.
6. Tubach F, Ravaud P, Baron G, Falissard B, et al. Evaluation of clinically relevant changes in patient reported outcomes in knee and hip osteoarthritis: the minimal clinically important improvement. *Ann Rheum Dis*. 2005; 64(1):29-33.
7. Lee FI, Lee TD, So WK. Effects of a tailor-made exercise program on exercise adherence and health outcomes in patients with knee osteoarthritis: a mixed-methods pilot study. Clinical Investigations in Aging. 2016;11:1391-1402.
8. Roos et al. The Knee Injury and Osteoarthritis Outcome Score (KOOS) scoring. JOSPT. 1998;78:88-96.
9. Pua YH, Cowan SM, Wrigley TV, Bennell KL. The lower extremity functional scale could be an alternative to the Western Ontario and McMaster Universities Osteoarthritis Index physical function scale. Journal of Clinical Epidemiology. 2009; 62(10):1103-1111.
10. Rogers MW, Tamulevicus N, Semple SJ, Krkeljas Z. Efficacy of home-based kinesthesia, balance and agility exercise training among persons with symptomatic knee osteoarthritis. *Journal of Sports Science and Medicine*. 2012;11(4):751-758. Available at: https://www.ncbi.nlm.nih.gov/pubmed/24150088. Accessed October 2, 2016.
11. Diracoglu D, Baskent A, Celik A, Issever H, Aydin R. Long-term effects of kinesthesia/balance and strengthening exercises on patients with knee osteoarthritis: A one-year follow-up study. *Journal of Back and Musculoskeletal Rehabilitation*. 2008;21:253-262. Doi: 10.3233/BMR-2008-21406.
12. Fitzgerald GK, White DK, Piva SR. Associations for change in physical and psychological factors and treatment response following exercise in knee osteoarthritis: an exploratory study. *Arthritis Care & Research*. 2012;62(11):1673-1680. Doi: 10.1002/acr.21751.
13. Duman I, Taskaynatan MA, Hohur H, Tan AK. Assessment of the impact of proprioceptive exercises on balance and proprioception in patients with advanced knee osteoarthritis. *Rheumatol Int*. 2012; 32:3793-3798. Doi: 10.1007/s00296-011-2272-5.
14. Jamtvedt G, Dahm KT, Christie A, Moe RH, et al. Physical therapy interventions for patients with osteoarthritis of the knee: an overview of systematic reviews. *Physical Therapy*. 2008;88(1):123-138. Doi: 10.2522/ptj.20070043
15. Bennell KL, Hinman RS, Matcalf BR, Buchbinder R, et al. Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial. *Ann Rheum Dis*. 2005;64:906-912. Doi: 10.1136/ard.2004.026526.
16. Al-Khlaifat L, Herrington LC, Tyson SF, Hammond A, Jones RK. The effectiveness of an exercise programme on dynamic balance in patients with medial knee osteoarthritis: a pilot study. *The Knee*. 2016;23:849-856. Doi: 10.1016/j.knee.2016.05.006.