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Systematic review

The addition of structured lifestyle modifications to a traditional exercise program for the management of patients with knee osteoarthritis: A systematic review and meta-analysis of randomised trials

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ABSTRACT

Background: Guidelines recommend exercise for the management of knee osteoarthritis (OA), however, recently it has been suggested that including additional lifestyle modifications with a traditional exercise program may elicit greater benefits than exercise alone.

Objectives: To investigate the influence of the addition of lifestyle modifications to a traditional exercise program, with respect to functional outcomes and quality of life among individuals with knee OA.

Design: Systematic review and meta-analysis.

Methods: Four databases were searched to identify randomised controlled trials comparing an exercise program, which included the addition of lifestyle modifications, to an exercise program alone in individuals with knee OA. Methodological quality of included studies was assessed via the PEDro scale. Results synthesis through meta-analysis using a random effects model was conducted to determine the pooled effect on eligible outcomes and a GRADE approach was utilised to rate the certainty of evidence.

Results: Meta-analysis of seven studies showed the inclusion of lifestyle modifications to an exercise program can further decrease pain intensity (SMD -0.68 [95% CI -1.26 to −0.10]), improve joint stiffness (MD -0.69 [95% CI -1.21, −0.17]) and increase physical function (MD -1.26 s ([95% CI -1.34, −1.17]) at six-months. Individual results showed improvements in quality of life with the addition of lifestyle modifications, however, this was not demonstrated through meta-analysis.

Conclusion: This systematic review supports the inclusion of additional lifestyle modifications to a traditional exercise program, for pain intensity, joint stiffness and physical function for individuals with knee OA.

Trial registration: PROSPERO registration number: CRD42021279594.

1. Background

Individuals with knee osteoarthritis (OA) often present with pain and disability, resulting in impaired function and leading to poorer quality of life (Bennell and Hinman, 2011; Hawker et al.; Vitaloni et al.). The subsequent decrease in physical activity may also contribute to muscle weakness and increase the risk of systemic disease development, resulting in further disability (Bennell and Hinman, 2011; Fransen et al., 2015; Stewart). Given the growing ageing population combined with rising obesity rates, an increase in knee OA prevalence has also been projected (Bennell and Hinman, 2011; Cross et al.; Woolf and Pfleger; Ackerman et al.), placing an ever-increasing financial burden on healthcare systems (Cross et al.; Mahendira et al.; Chen et al., 1941). With no known cure for knee OA, current non-operative management focuses on relieving pain and reducing symptoms along with improving physical function and capacity (DeRogatis et al.; Smink et al.). Exercise is often a preferred conservative treatment amongst clinicians as it is non-invasive, easily accessible and has minimal adverse effect risk (Cross et al.). With the aim of increasing an individual's physical activity level and muscle strength, there is high-quality evidence to support that an exercise program can reduce pain and disability associated with knee OA (Bennell and Hinman, 2011; Fransen et al., 2015; Smink et al.; Bannuru et al., 2019). The subsequent improvement in quality of life, pain and function may also delay the need for surgical intervention

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(Husted et al.).

To date, most studies exploring the efficacy of traditional exercise in managing knee OA have focused primarily on elements of lower limb strength and conditioning (Bennell and Hinman, 2011; Juhl et al., 2014; Li et al., 2016; Roddy et al., 2005; Tanaka et al., 2013). This includes the comparison between open and closed kinetic chain, concentric and/or eccentric, weight-bearing versus non-weight-bearing and aerobic exercises. Additionally, balance and joint proprioception, in the form of neuromuscular training have also been investigated. Whilst evidence surrounding the efficacy of exercise for short-term benefits is well established, there is also growing support for including lifestyle modifications and mind-body exercises into traditional exercise programs to enhance long-term effects (Mihalko et al., 2019; Ye et al., 2014). In line with national medical association guidelines (Bannuru et al., 2019; Fernandes et al., 2013; Kolasinski et al., 2019; RACGP, 2018; Bruyère et al.), some of the recommendations for lifestyle modifications other than traditional exercise include disease education, self-care and pain coping strategies, dietary and weight loss programs, tai chi, yoga, and workshops targeting goal setting, motivation, and lifestyle advice (Bennell and Hinman, 2011; Kolasinski et al., 2019; Kuru Çolak et al.; Deepeshwar et al., 2018; Brierley et al., 2021). The subsequent changes to lifestyle habits and behaviours may increase overall physical activity levels and prevent the development, or progression, of comorbidities (Dunlop et al., 2011; Gay et al., 2016). This could improve long-term morbidity and mortality in populations who are more at risk of metabolic and cardiovascular disease (Dunlop et al., 2011; Gay et al., 2016). However, it should be noted that the provision of additional lifestyle modification interventions to a traditional exercise program will likely be associated with increased costs to the patient and health care provider and therefore the benefits of the inclusion of these should be examined (Mazzei et al., 2021).

Although past reviews have reported on the efficacy of land-based exercises for knee OA, there appears to be no systematic review examining the addition of other lifestyle modifications to exercise for the management of knee OA (Fransen et al., 2015; Anwer et al., 2001). Given the current recommendations for incorporating additional lifestyle modifications along with traditional exercise in conservative knee OA management, the purpose of this review is to explore the available research to determine if there is an evidence base for this. Therefore, this review aims to investigate the influence of the addition of lifestyle modifications to an exercise program, compared to a traditional exercise program in isolation, with respect to outcomes of pain, function, and quality of life for individuals with knee OA.

2. Methods

2.1. Data sources and search strategy

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis PRISMA statement (Page et al., 2021), and the study protocol was prospectively registered in PROSPERO (CRD42021279594).

A population, intervention, control, outcomes (PICO) framework was used to refine the clinical question and inform the search and eligibility criteria. A baseline search strategy was created for the PubMed database, and modified for CINAHL, SPORTDiscus, and PEDro databases using SR-Accelerator Polyglot software (Clark et al.a, b) (Appendix A). Key terms in the search strategy were as follows: exercise, rehabilitation, physiotherapy, physical therapy, and knee osteoarthritis. Databases were electronically searched from inception to September 11, 2022 to identify eligible studies.

2.2. Study eligibility

Studies meeting the PICO (population, intervention/exposure, comparison, and outcome) criteria were included in this review:.

1. Population: Adults >18 years of age with clinically diagnosed unilateral or bilateral knee OA
2. Intervention: A management program including the addition of other lifestyle modifications to a traditional exercise program.
3. Comparison: Traditional exercise program alone.
4. Outcomes of interest: At least one of the following was required, pain intensity, quality of life, physical function, such as mobility and ability to perform functional tasks.

Exclusion criteria: (1) If the population of interest was that of a chronic cardiovascular, neurological, or metabolic disease condition in addition to diagnosed knee OA, post-surgical population, (2) the publication was not available in full text.

2.3. Selection and data collection process

After the removal of duplicates, two authors (AK, LS) independently carried out a title and abstract screen, followed by a full-text screen using SR-Accelerator Screenatron software (Clark et al.a, b) to identify studies that met the predefined eligibility criteria. Any disagreements on final study inclusion were resolved through consensus discussion with a third author (WH). Population characteristics, intervention protocol/time frame, eligibility criteria, outcome measures and results of individual studies were extracted independently by two authors (AK, LS) and recorded in a table adapted from the Cochrane Handbook for Systematic Reviews of Interventions (Table 1) (Cumpston et al.).

2.4. Assessment of methodological quality

Assessment of methodological quality within the selected studies was carried out independently by two authors (AK, LS) using the PEDro scale (Moseley et al., 2002). The PEDro scale is designed to assess the internal validity and risk of bias of a clinical trial (Moseley et al., 2002). Encompassing 11 yes or no check-point items, studies are scored out of 10 (item 1 is not included in the calculation). Studies with a score higher than 6 were considered to have a good methodological quality, whilst studies that receive a score of 4–6 points and 0–3 points were considered to have a fair, and poor methodological quality, respectively (Moseley et al., 2002). After the methodological quality of each study was scored independently, the Kappa coefficient of inter-rater reliability was calculated (IBM SPSS Statistics, Version 27.0. Armonk, NY: IBM Corp) to assess the agreement between the two reviewers (Landis et al.). Where there was disagreement on an individual item, a third author (WH) adjudicated to achieve consensus.

2.5. Synthesis methods

Individual study results were described through narrative and tabular synthesis. Meta-analysis statistical analyses were completed using Review Manager software (RevMan, Version 5.4; The Cochrane Collaboration, 2020), to report on the overall effectiveness of the intervention on outcomes from eligible studies. Studies were eligible for quantitative synthesis through meta-analysis if an outcome measure was present across two or more of the included studies, utilised similar time points for assessment, and reported the changes within-group mean differences (MD) and standard deviations (SD). If the SD was not provided, then it was determined from reported means and confidence intervals from the outcome results utilizing a RevMan calculator. As the effect of the intervention between studies was deemed to be variable concerning intervention dosage and type, a random-effects model was applied. The heterogeneity of study outcomes was determined via the I^2 index, I^2 values from 75 to 100% were seen as having considerable heterogeneity (Cochrane Handbook for Systematic Reviews of Interventions, Version 6.3, 2002). Values were considered statistically significant where $p < 0.05$. In cases where it was not possible to undertake meta-analysis such as in instances where only one study

Table 1
Study demographics.

Author, Year, Country	Title	Control No of participants Sex (M/F) Mean age (years)	Experimental No of participants Sex (M/F) Mean age (years)			PEDRO Score (/10)
			Group 1	Group 2	Group 3	
Alfieri et al., 2020, Brazil	Efficacy of an exercise program combined with lifestyle education in patients with knee osteoarthritis	17 5/12 64.4	22 3/19 63.7			6
Bennell et al., 2016, Aus	Physical therapist-delivered pain coping skills training and exercise for knee osteoarthritis: randomised controlled trial	75 44/30 62.7	74 45/29 63	73 44/29 64.6		7
Bennell et al., 2017, Aus	Telephone coaching to enhance a home-based physical activity program for knee OA: A randomised clinical trial	84 27/57 63.4	84 35/49 61.1			8
Bennell et al., 2020, Aus	Behaviour changes text messages for home exercise adherence in knee osteoarthritis: Randomised Trial	54 15/39 62.9	56 21/35 61.7			9
Bokaeian et al., 2021, Iran	Effects of an exercise therapy targeting knee kinetics on pain, function, and gait kinetics in patients with knee OA: An RCT	18 4/14 56.7	22 6/16 54.9	19 4/15 57		7
Chen, 2019, China	Benefits of a transtheoretical model-based program on exercise adherence in older adults with knee OA: An RCT	72 4/68 68.71	89 8/81 67.09			6
Farr et al., 2010, USA	Progressive resistance training improves overall physical activity levels in patients with early OA of the knee: An RCT	57 16/41 55.8	52 14/38 55.5	62 13/49 54.2		5
Focht et al., 2014	Group-mediated physical activity promotion and mobility in sedentary patients with knee OA: results from the IMPACT-Pilot trial	40 9/31 63.6	40 4/36 63.4			6
Jenkinson et al., 2009	Effects of dietary intervention and quadriceps strengthening exercises on pain and function in overweight people with knee pain: RCT	76 3/73 61.5	122 43/79 61.7	82 26/56 61.1	109 36/73 61.1	7
Keefe et al., 2004, USA	Effects of spouse-assisted coping skills training and exercise training in patients with osteoarthritic knee pain: An RCT	18 7/11 57.56	18 9/9 60	16 10/6 60.25	20 7/13 60.20	3
Messier et al., 2004, USA	Exercise and dietary weight loss in overweight and obese older adults with knee OA	78 25/53 69	82 33/49 68	80 18/51 69	76 18/51 76	8
Mihalko, 2018, USA	Effects of intensive diet and exercise on self-efficacy in overweight and obese adults with knee OA: the IDEA RCT	150 42/108 65.5	152 44/108 65.8	152 43/109 65.4		6
Rejeski et al., 2002, USA	Obese, older adults with knee OA: weight loss, exercise, and quality of life	68 22/46 68.59	69 18/51 68.09	73 19/54 68.09	68 18/50 5.62	6
Veenhof et al., 2006, Netherlands	Effectiveness of Behavioural Graded Activity in Patients With Osteoarthritis of the Hip and/or Knee: A Randomized Clinical Trial	103 22/81 64.5	97 24/73 65.1			7
Wang et al., 2016, China	Comparative Effectiveness of Tai Chi Versus Physical Therapy for Knee Osteoarthritis:A Randomized Trial	98 30/68 60.1	106 31/75 60.3			7
Wang et al., 2020, China	The effect of transtheoretical model-lead intervention for knee osteoarthritis in older adults: a cluster randomized trial	86 10/93 68.81	103 4/82 67.38			7

M Male, *F* Female, *RCT* Randomised controlled trial.

reported on an outcome, data was extracted into tables and individual results were presented.

2.6. Certainty of evidence

To assess the certainty of the evidence for each meta-analysis result, the Grading of Recommendation Assessment, Development, and Evaluation (GRADE) approach was utilised (Schünemann et al., 2019; Guyatt et al., 2008). The ratings for the certainty of evidence were performed independently by two authors (AK, LS) and any disagreements were resolved through discussion with a third author (WH). The certainty of the evidence for each meta-analysis result was graded high (Fransen et al., 2015), medium (Vitaloni et al.), low (Hawker et al.) or very low certainty (Bennell and Hinman, 2011) (Schünemann et al., 2019; Guyatt et al., 2008). As the design for all included studies were randomized controlled trials each outcome began with a high-certainty rating. Studies were then downgraded one place if there was (Bennell and Hinman, 2011) Risk of bias or limitations in the detailed design and implementation (PEDro 50%) (Hawker et al.), Unexplained heterogeneity or inconsistency of results ($I^2 = >50\%$) (Vitaloni et al.), Indirectness of evidence (Fransen et al., 2015) Imprecision of results (5% CI > 0.8 MD) or (Stewart) High probability of publication bias (Schünemann et al., 2019; Guyatt et al., 2008).

3. Results

3.1. Study selection

The initial search yielded 5879 studies, and after the removal of duplicates, 3845 remained. Following the title and abstract screen, 51 studies were further screened in full text, leaving a final 16 studies included in this review (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Jenkinson et al., 2009; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Rejeski et al., 2002; Bokaeian et al., 2021). The complete study screening and selection process is shown in Fig. 1. Flow diagram of included studies.

3.2. Methodological quality appraisal

PEDro scores for the methodical quality of individual studies are reported in Table 1, with an average PEDro score of 7/10 across all studies (mean = 6.56, SD = 1.32), indicating overall good methodological quality. Nine studies (Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Jenkinson et al., 2009; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020) had a good methodology, receiving a score greater than six, whilst six studies (Mihalko et al., 2019; Alfieri et al., 2020; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Rejeski et al., 2002) had a fair methodology, receiving a score between 4 and 6. One study (Keefe et al., 2004) had a score of three, indicating that the methodological quality was poor. Apart from one study (Focht et al., 2014), intervention groups were concealed and randomly allocated across the studies. Whilst all studies had easily identifiable eligibility criteria, a baseline comparison between participants was only reported in ten studies (Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Jenkinson et al., 2009; Messier et al., 2004; Wang et al., 2016, 2020). Nil studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Jenkinson et al., 2009; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Rejeski et al., 2002; Bokaeian et al., 2021) blinded their therapist or assessors. The Kappa coefficient of inter-rater reliability for this review was 0.88, which can be interpreted as almost perfect (Landis et al.). All studies final agreed score for each PEDro item is reported in Appendix B.

3.3. Study characteristics

This review included 3113 participants with a mean age range of 54–76 years. Allocation of participants was similar between groups, with 1094 individuals assigned to an exercise-only group, whilst 1176

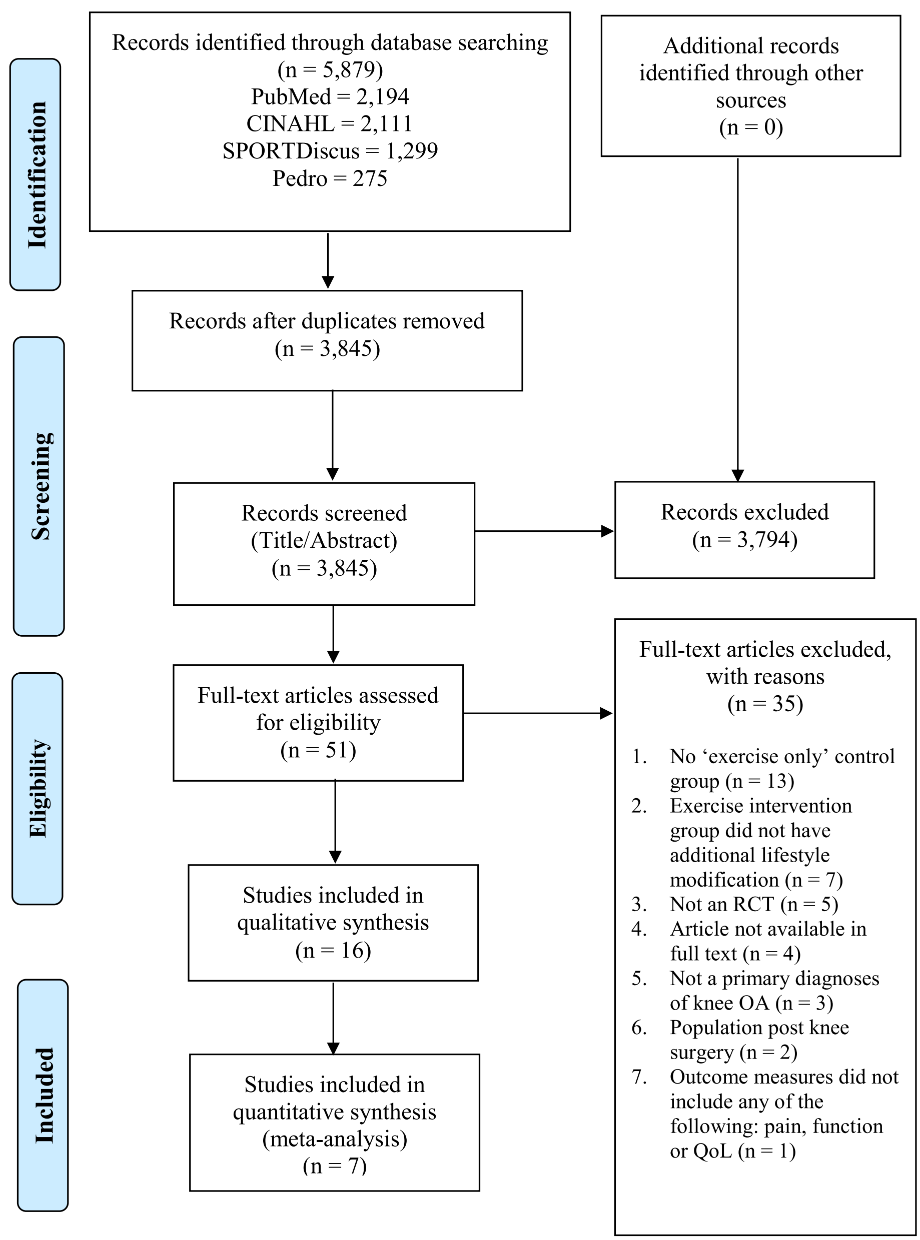


Fig. 1. Flow diagram of included studies.

were assigned to an exercise program with the inclusion of additional lifestyle modifications. All studies included both males and females and of those studies, all reported a higher female population (83.5%) than males. The participant inclusion criteria across all studies required participants to be diagnosed with knee OA and have radiographic evidence of the disease for at least 3–6 months. All studies excluded individuals who had suffered recent knee trauma, presented with a neuromuscular disorder or were seeking adjunct non-exercise forms of treatment. Participant inclusion criteria concerning disease severity were determined by radiographic or criterion-based evidence and the requirements for baseline physical activity levels varied between studies. Full participant eligibility for studies is reported in Appendix C.

3.4. Study interventions

The lifestyle modifications utilised across studies can be broadly categorised into advice and education, dietary modifications, and mind-body exercises. Reported in nine (Alfieri et al., 2020; Bennell et al., 2017, 2020; Farr et al., 2010; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2020; Rejeski et al., 2002) and 11 (Alfieri et al., 2020; Bennell et al., 2016, 2017; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Jenkinson et al., 2009; Keefe et al., 2004; Messier et al., 2004; Wang et al., 2020; Rejeski et al., 2002) studies respectively, healthy lifestyle guidance on physical activity and minimising harmful activities such as alcohol consumption, alongside disease education were the most frequent form of advice and education to be integrated with an exercise program. Pain coping skills and stress management were utilised across nine studies (Bennell et al., 2016, 2017; Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Keefe et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020) and goal setting and self-motivation strategies aimed towards weight loss and increasing physical activity levels were utilised in five (Bennell et al., 2017, 2020; Focht et al., 2014; Keefe et al., 2004; Veenhof et al., 2006). Four studies (Bennell et al., 2020; Chen et al., 2020; Veenhof et al., 2006; Wang et al., 2016) included adherence monitoring and six studies (Mihalko et al., 2019; Alfieri et al., 2020; Farr et al., 2010; Jenkinson et al., 2009; Messier et al., 2004; Rejeski et al., 2002) included dietary modifications, which consisted of meal plans, weight-loss programs, and advice on healthy recipes. Mind-body exercises, such as yoga and tai chi, were seen in two studies (Wang et al., 2016; Bokaeian et al., 2021).

A second intervention group, consisting of lifestyle modifications in isolation, were reported in six studies (Mihalko et al., 2019; Farr et al., 2010; Jenkinson et al., 2009; Messier et al., 2004; Rejeski et al., 2002; Bokaeian et al., 2021), however, are not included in the results of this review due to not meeting the eligibility criteria of having an exercise component in the protocol. With respect to exercise programs included in this review, all studies investigated an exercise protocol with some form of lower body strength and conditioning component and two (Chen et al., 2020; Farr et al., 2010) of the 16 studies also incorporated neuromuscular training into their intervention. Across all studies, the average duration per exercise session was greater than 20 min, however, intervention timeframes varied between 4 and 78 weeks. Regarding sample size, the average population consisted of 194 participants, although three studies had less than 100 participants. Full study demographics and methodology of included studies are reported in Tables 1 and 2, respectively.

3.5. Outcomes assessed

Several outcome measures were utilised to assess pain intensity, joint stiffness, quality of life, and self-reported or objective physical function, as shown in Table 2. Summarised results of individual studies are reported in Table 3, with the results of all individual studies reported in full in Appendix D. The results of those studies eligible for pooled synthesis are presented in forest plot Fig. 2a–d. Due to the different outcome measures utilised to assess pain intensity, the standardized mean difference has been used to express the size of the intervention effect, for all other categories the mean difference has been reported. Lifestyle modifications that were included in the meta-analyses consisted of disease education, lifestyle advice, pain coping strategies, stress management, exercise adherence, goal setting, meal plan, weight loss and healthy recipes.

Patient-reported outcome measures (PROM) were used to assess pain intensity. This included the Western Ontario and McMaster Universities Arthritis Index (WOMAC) – Pain subscale, which was utilised in ten studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2017; Chen et al., 2020; Farr et al., 2010; Jenkinson et al., 2009; Veenhof et al., 2006; Wang et al., 2016, 2020; Bokaeian et al., 2021), whilst the remaining studies utilised a Numerical Rating Scale (NRS) (Bennell et al., 2017, 2020), Visual Analogue Scale (VAS) (Alfieri et al., 2020; Bennell et al., 2016; Veenhof et al., 2006; Bokaeian et al., 2021) and Knee Injury and Osteoarthritis Outcome Score (KOOS) – pain subscale (Bennell et al., 2020). Nine studies (Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Jenkinson et al., 2009; Keefe et al., 2004; Veenhof et al., 2006; Wang et al., 2016; Rejeski et al., 2002) measured quality of life, including sleep quality, self-efficacy and coping abilities, via administered questionnaires, such as SF-36, AQOL and Arthritis self-efficacy scale. An overall individual's self-reported functional capabilities were measured using the WOMAC – Function subscale, which was utilised in seven studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017; Jenkinson et al., 2009; Veenhof et al., 2006; Wang et al., 2016), as well as the KOOS-function subscale (Bennell et al., 2020). Objective physical function was measured across ten studies (Mihalko et al., 2019; Bennell et al., 2016; Chen et al., 2020; Focht et al., 2014; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Bokaeian et al., 2021). Assessments included timed up-and-go (TUG), quadriceps strength, stair climb ability and various forms of walking tests examining gait speed and distance travelled. Moderate and vigorous physical activity level was recorded in two studies (Farr et al., 2010; Focht et al., 2014). Regarding knee joint stiffness the WOMAC – Stiffness subscale was utilised in three studies (Alfieri et al., 2020; Chen et al., 2020; Wang et al., 2016).

3.6. Pain intensity

All studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Farr et al., 2010; Jenkinson et al., 2009; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Bokaeian et al., 2021) measuring pain reported significant improvements post-intervention within all groups, of which, six studies (Chen et al., 2020; Keefe et al., 2004; Messier et al., 2004; Wang et al., 2016, 2020; Bokaeian et al., 2021) reported improvements to be greater following the inclusion of lifestyle modifications compared to exercise in isolation. In contrast, pain improvements were seen within the exercise in isolation group for only one study (Farr et al., 2010). Pooled analysis of seven studies (Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2020) ($n = 966$) for pain intensity (Fig. 2a) at varying time points between 12 weeks and six months demonstrated a reduction in pain scores (SMD -0.68 [95% CI -1.26 to −0.10]; $I^2 = 95\%$), favouring the inclusion of additional lifestyle modifications to a traditional exercise program.

3.7. Joint stiffness

Significant improvements within both groups were reported amongst all studies (Alfieri et al., 2020; Chen et al., 2020; Wang et al., 2016, 2020) that assessed joint stiffness, however, three studies (Chen et al., 2020; Wang et al., 2016, 2020) reported benefits to be greater with the inclusion of lifestyle modifications compared to exercise alone. Among the two eligible studies (Chen et al., 2020; Wang et al., 2020) ($n = 350$), this was further supported by a pooled analysis of the WOMAC - Stiffness subscale (Fig. 2b), which demonstrated a point difference of MD -0.69

Table 2
Study methodology.

Author, Year	Lifestyle modifications included	Intervention duration (Weeks)	Functional Outcome Measure(s)	Measurement tool	Assessment timing (weeks)
Alfieri et al., 2020	Disease education Lifestyle advice Pain coping strategies Healthy recipes	8	1. Pain 2. Self-reported function 3. Joint stiffness 4. QoL 5. Pain tolerance	1a. VAS 1 b. WOMAC Pain 2. WOMAC function 3. WOMAC joint stiffness 4. FANTASTICO 5. Pressure pain tolerance threshold – PPT	Baseline 8
Bennell et al., 2016	Disease education Pain-coping strategies Stress management	12	1. Pain 2. Self-reported function 3. QoL 4. Physical function	1. VAS 2. WOMAC function 3. Coping strategy questionnaire – Pain coping 4a. Quadricep strength 4 b. 30s STS 4c. 20 m step-test	Baseline 12 32 52
Bennell et al., 2017	Disease education Lifestyle advice Pain coping strategies Stress management Goal setting	24	1. Pain 2. Self-reported function 3. QoL	1a. NRS 1 b. WOMAC – pain 2. WOMAC – function 3. AQoL	Baseline 36 52 72
Bennell et al., 2020	Lifestyle advice Goal setting Exercise adherence	24	1. Pain 2. Self-reported function 3. QoL	1a. NRS 1 b. KOOS pain 2. KOOS function 3a. KOOs QoL 3 b. AQoL	Baseline 24
Bokaeian et al., 2021	Yoga	4	1. Pain 2. Physical function 3. Gait biomechanics	1a. VAS 1b. WOMAC pain 2.2 m walk-test (distance) 3, 2 m walk-test (gait speed)	Baseline 4 8
Chen, 2019	Disease education Pain coping strategies Stress management Exercise adherence	24	1. Pain 2. joint stiffness 3. Physical function	1a. NRS 1b. WOMAC Pain 2. WOMAC stiffness 3a. 5× STS 3. TUG	Baseline 12 24
Farr et al., 2010	Disease education Lifestyle advice Pain coping skills Stress management Healthy recipes	36	1. Pain 2. Physical activity level	1. WOMAC pain 2a. Moderate PA level 2 b. Vigorous PA level	Baseline 12 36
Focht et al., 2014	Disease education Pain coping strategies Stress management Goal setting	12	1. Physical function 2. Physical activity level	1.400-m walk time 2. Total weekly PA time	Baseline 12 52
Jenkinson et al., 2009	Disease education Meal Plan Weight-loss Healthy recipes	104	1. Pain 2. Self-reported unction 3. QoL	1. WOMAC – Pain 2. WOMAC – function 3. SF-36	Baseline 24 52 104
Keefe et al., 2004	Lifestyle advice Pain coping strategies Goal setting	12	1. Physical function 3. QoL	1. VO2K 2a. The Arthritis Self-Efficacy Scale 2 b. Coping strategy questionnaire	Baseline 12
Messier et al., 2004	Disease education Lifestyle advice Meal plan Weight-loss Healthy recipes	72	1. Pain 2. Physical function	1. WOMAC Pain 2a. 6 min walk-test 2 b. Stair climb	Baseline 24 72
Mihalko, 2018	Meal plans Calorie restriction	72	1. Pain 2. Physical function 3. Self-reported function	1. WOMAC pain 2a. 6 min walk-test 2b. Gait speed 3. WOMAC function	Baseline 24 72
Rejeski et al., 2002	Disease education Lifestyle advice Meal plans Weight-loss	72	1. QoL	1a. SF-36 mental health 1b. SF-36 physical health 1c. SF-36 satisfaction w/function 1d. SF-36 satisfaction w/appearance	Baseline 24 72
Veenhof et al., 2006	Disease education Lifestyle advice Pain coping strategies Stress management Goal setting Adherence monitoring	65	1. Pain 2. Self-reported function 3. Physical function 4. QoL	1a. VAS 1b. WOMAC Pain 2. WOMAC Function 3.5 m walk test 4. SF-36	Baseline 13 39 65
Wang et al., 2016	Stress monitoring Adherence monitoring Tai Chi	12	1. Pain 2. Self-reported function 3. Physical function 4. QoL 5. Joint stiffness	1a. WOMAC pain 1b. NSAID consumption 1c. Analgesic consumption 2. WOMAC function 3a. 6 min walk test	Baseline 12 24 52

(*continued on next page*)

Table 2 (*continued*)

Author, Year	Lifestyle modifications included	Intervention duration (Weeks)	Functional Outcome Measure(s)	Measurement tool	Assessment timing (weeks)
				3b. 20 m walk test 4a. Patient Global Assessment score 4b. Beck Depression inventory-II 4c. SF-36 4d. Arthritis self-efficacy scale 5. WOMAC stiffness	
Wang et al., 2020	Disease education Lifestyle advice Pain coping strategies Stress management	24	1. Pain 2. Joint stiffness 3. Physical function	1. WOMAC pain 2. WOMAC stiffness 3a. Five-times-sit-to-stand-test (FTSST) 3b. Timed up and go (TUG)	Baseline 24 48

AQoL Assessment of Quality of Life, *KOOS* Knee Injury and Osteoarthritis Outcome Score, *NRS* Numerical rating scale, *PPT* Pain pressure threshold, *PA* Physical activity, *QoL* Quality of life, *STS* Sit-to-stand, *TUG* Timed up-and-go, *VAS* Visual Analogue Scale, *WOMAC* Western Ontario and McMaster Universities Osteoarthritis, *NSAID* Non-steroidal anti-inflammatory drug.

Table 3
Results of individual studies.

Outcome measures					
Author, Year	*Pain*	*Self-reported function*	*Objective Physical function*	*Joint stiffness*	*Quality of life*
Alfieri et al., 2020	=	=	=	=	=
Bennell et al., 2016	✓	✓	✓	NA	=
Bennell et al., 2017	=	=	NA	NA	=
Bennell et al., 2020	=	=	NA	NA	✓
Bokaeian et al., 2021	✓	NA	=	NA	✓
Chen, 2019	✓	NA	✓	✓	✓
Farr et al., 2010	x	NA	NA	NA	NA
Focht et al., 2014	NA	NA	=	NA	NA
Jenkinson et al., 2009	=	=	NA	NA	✓
Keefe et al., 2004	✓	NA	✓	NA	✓
Messier et al., 2004	✓	NA	✓	NA	NA
Mihalko, 2018	=	=	✓	NA	✓
Rejeski et al., 2002	NA	NA	NA	NA	✓
Veenhof et al., 2006	=	=	✓	NA	=
Wang et al., 2016	✓	✓	=	✓	=
Wang et al., 2020	✓	NA	✓	✓	NA

✓favours exercise with lifestyle modifications over exercise alone; = no additional benefits seen with the inclusion of lifestyle modifications to exercise; ***X*** favours exercise in isolation over exercise with the inclusion of lifestyle modifications, *NA* not assessed.

([95% CI -1.21, −0.17]; $I^2 = 0\%$) at six months, indicating that the addition of lifestyle modifications had a significant positive effect on joint stiffness.

3.8. Quality of life

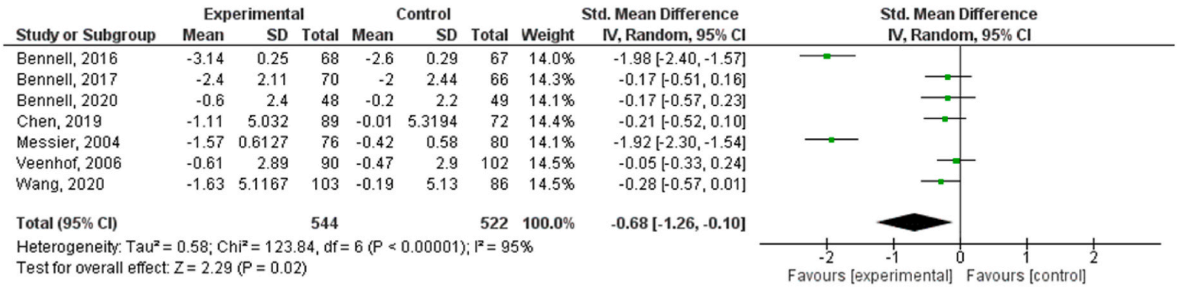
All studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Chen et al., 2020; Jenkinson et al., 2009; Keefe et al., 2004; Veenhof et al., 2006; Wang et al., 2016; Rejeski et al., 2002; Bokaeian et al., 2021) measuring quality of life demonstrated significant improvements post-intervention within the control and experimental groups, of which, seven (Mihalko et al., 2019; Chen et al., 2020; Jenkinson et al., 2009; Keefe et al., 2004; Rejeski et al., 2002; Bokaeian et al., 2021) reported improvements to be greater following the inclusion of lifestyle modifications compared to exercise alone. However, pooled analysis of the two eligible studies (Bennell et al., 2017, 2020) (n = 233) seen in Fig. 2c demonstrated nil additional benefits of including lifestyle modifications with exercise in an individual's self-reported QoL (MD -0.10 ([95% CI -0.24, 0.04]; $I^2 = 0\%$) at six months.

3.9. Physical function

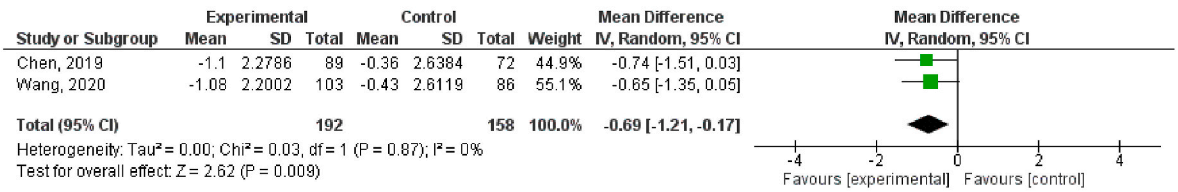
With the exception of three studies (Focht et al., 2014; Wang et al., 2016; Bokaeian et al., 2021), all studies (Mihalko et al., 2019; Bennell et al., 2016; Chen et al., 2020; Focht et al., 2014; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Bokaeian et al., 2021) measuring self-reported and objective physical function reported significant improvements in favour of the addition of lifestyle modifications to exercise alone post-intervention. For the two studies (Chen et al., 2020; Wang et al., 2020) eligible for pooled analysis (n = 350) (Fig. 2d), overall improvements in timed up-and-go speed were (MD -1.26 s ([95% CI -1.34, −1.17]; $I^2 = 0\%$) at six months, which indicates that the inclusion of lifestyle modifications had a significant positive effect on objective physical function and walk speed. Significant improvements within the control and experimental groups were reported consistently throughout all studies (Mihalko et al., 2019; Alfieri et al., 2020; Bennell et al., 2016, 2017, 2020; Jenkinson et al., 2009; Veenhof et al., 2006; Wang et al., 2016) measuring self-reported function. As assessed by changes in self-reported outcome measure scores, improvements favouring the inclusion of lifestyle modifications compared to exercise alone were seen in two studies (Bennell et al., 2016; Wang et al., 2016).

3.10. Grading the evidence

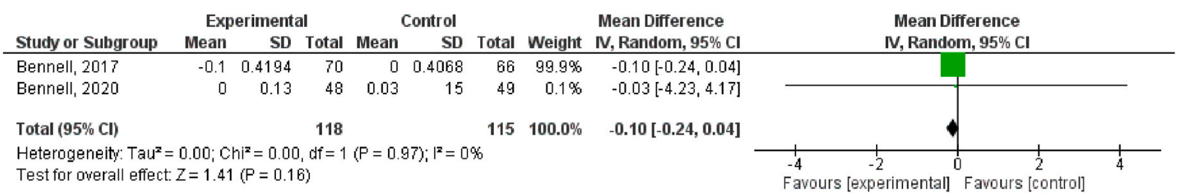
The GRADE certainty of evidence rating and rationale for each meta-analysis result is detailed in Appendix E. A high certainty of evidence was retained for reduction in knee joint stiffness favouring the addition of lifestyle modifications (MD -0.69 [95% CI -1.21, −0.17]; $I^2 = 0\%$). For the improvements seen in physical function with the addition of lifestyle modifications (MD -1.26 s ([95% CI -1.34, −1.17]; $I^2 = 0\%$).) we found a moderate certainty of evidence (downgraded one point for imprecision). For the decrease in pain intensity with the addition of lifestyle modifications (SMD -0.68 [95% CI -1.26 to −0.10]; $I^2 = 95\%$).) we found a low certainty of evidence (downgraded by three points for evidence of indirectness, inconsistency, and imprecision). Finally, a moderate certainty of evidence for the nil additional benefits seen when including lifestyle modifications for quality of life improvements (MD -0.10 ([95% CI -0.24, 0.04]; $I^2 = 0\%$).) as this result was downgraded one point for indirectness.



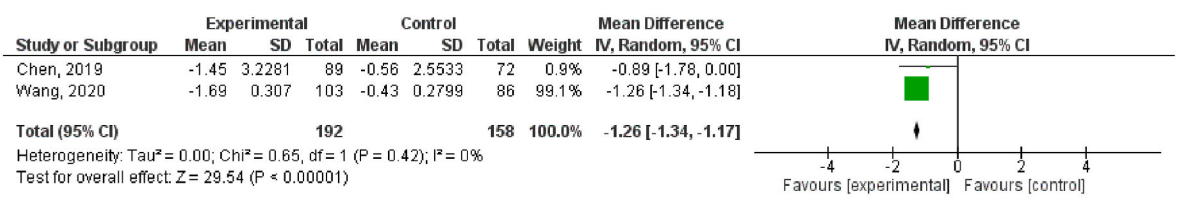
a. Pain intensity at 6-12 weeks – VAS, WOMAC Pain, NRS (41-44, 49, 50, 52)



b. Knee joint stiffness at 6 months – WOMAC stiffness score (44, 52)



c. Quality of life at 6 months – AQoL score (42, 43)



d. Objective Physical function at 6 months – Timed up and go speed (44, 52)

Fig. 2. (a-d). Meta-analysis results for eligible outcomes (*$p < 0.05$).

4. Discussion

Guidelines from professional medical organisations (Bannuru et al., 2019; Fernandes et al., 2013; Kolasinski et al., 2019; RACGP, 2018; Bruyère et al.) recommend that non-surgical, non-pharmacological interventions should consist of exercise with the inclusion of other lifestyle modifications in the treatment of individuals with knee OA. There is likely a positive interaction between exercise and lifestyle modifications meaning the combined effects of both treatments are greater than their individual effects, indicating potential synergy. The findings of this systematic review and meta-analysis support the addition of lifestyle modifications to a traditional exercise program in the management of knee OA, of which advice & education consisting of disease management and self-care strategies, were found to be the most effective in reducing pain and improving function.

In line with past evidence, findings from this review have demonstrated that the inclusion of lifestyle modifications can lead to greater reductions in self-reported pain compared to exercise in isolation (Chen et al., 2020; Keefe et al., 2004; Messier et al., 2004; Wang et al., 2016, 2020; Bokaeian et al., 2021). Increasing understanding and tolerance towards pain through educational workshops consisting of pain-coping strategies and stress management would appear to reduce pain intensity in individuals diagnosed with knee OA (Keefe et al.; Keefe et al., 1990; Lee et al., 2017). This was evident in the Alfieri et al. (2020) study, which reported a greater increase in pain pressure threshold across lower-limb muscles following the inclusion of an 8-week pain coping strategy workshop, compared to an isolated exercise program. It has also been suggested that pain reductions following the inclusion of lifestyle modifications may also be stemmed from improved gait mechanics (Bliddal et al., 2014; Robson et al.). Subsequent to weight loss, reductions in joint loading force during heel strike may also reduce pain and prevent further degeneration of the articular cartilage within the knee joint. This was evident among studies (Jenkinson et al., 2009; Messier et al., 2004) with dietary modifications consisting of a weight loss program, meal plans and dietary advice, which reported significant pain reductions following an 8–12-week protocol. Moreover, given the relationship between inflammation and pain, a decrease in inflammatory biomarkers associated with weight loss, such as CRPM and IL-6, could also be associated with reducing pain (Loeser et al., 2017).

Although pain reductions favouring the inclusion of lifestyle modifications were demonstrated in our pooled analysis (Fig. 2a.), the minimally clinically important differences for pain intensity could not be determined due to the variation in outcome measures included. Therefore, it is possible that the pain reductions following the inclusion of lifestyle modifications compared to exercise alone, although significant, may not necessarily translate to clinical meaningfulness. Given the small number of studies currently eligible for meta-analysis in this review, contributions from future research may confer clinical meaningfulness for pain-related outcomes.

Improvements in self-reported and objective physical function favouring the inclusion of lifestyle modifications were reported across ten studies (Mihalko et al., 2019; Bennell et al., 2016; Chen et al., 2020; Focht et al., 2014; Keefe et al., 2004; Messier et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020; Bokaeian et al., 2021). Given the findings of studies (Chen et al., 2020; Focht et al., 2014; Keefe et al., 2004; Veenhof et al., 2006; Wang et al., 2016, 2020) that incorporated interventions consisting of disease education, lifestyle advice, and goal setting, it could be suggested that additional functional improvements are associated with alterations to exercise habits. Consequential of an increase in awareness surrounding the benefits of exercise, this was evident in four studies (Chen et al., 2020; Farr et al., 2010; Focht et al., 2014; Veenhof et al., 2006), which reported significant increases in exercise adherence and physical activity level, and therefore, physical function. This positive correlation between physical activity levels and functional outcomes is further supported by past literature (Kraus et al.; Chang et al.; Escalante et al.), which reported improvements in 6-min walk tests and stair climb time following interventions involving various land based and aquatic exercises.

Consistent with our pooled analysis results on self-reported pain (Fig. 2a), improvements in physical function may also be attributed to greater pain tolerance (Moss et al.). This was supported by the results of our pooled analysis for physical function (Fig. 2d), where a minimum clinically important difference in speed for the TUG outcome was seen in favour of the intervention group (Alghadir et al.). Furthermore, considering the correlation between self-efficacy and functional status (Kuru Çolak et al.; Maly et al.), it could be argued that an increase in self-efficacy level following telephone coaching sessions that revolve around self-motivation and goal setting could augment functional gains. This was evident in Bennell's et al. (2017) study, which reported additional improvements in self-reported and objective physical function following a six-month protocol. Increased energy levels consequent of improved sleep quality due to greater pain tolerance and stress management following the inclusion of lifestyle modifications, may have also contributed to the additional functional benefits seen (Sariyildiz et al.).

Mind-body exercises, such as yoga and tai-chi, can be a complement to traditional exercise options for individuals with knee OA. Unlike previous research (Fransen et al., 2015), which found yoga to be less beneficial and effective compared to traditional exercise protocols, a study included in this review reported improvements in pain and function following 4-weeks of yoga to be superior compared to exercise in isolation (Bokaeian et al., 2021). This could potentially be explained by the multi-factorial effects of reductions in joint stiffness, stress and anxiety associated with yoga (Cheung et al.; Haaz and Bartlett). Despite the findings reported in the Wang et al. (2016) study, there is still a body of strong evidence supporting the inclusion of tai-chi in the management of knee OA (Ye et al., 2014; Wang et al., 2009). Consequent to central nervous system factors, including the activation of neuroendocrine and autonomic functioning systems, as well as directing neuro-chemical and analgesic pathways, tai-chi can regulate inflammatory responses, and thus, can reportedly also reduce pain (Ye et al., 2014).

There were several strengths to this review, which included the wide range of lifestyle modifications utilised, the overall good methodological quality rating of included studies, as well as, a moderate to high certainty of evidence rating for most meta-analysis outcomes. However, some limitations should also be noted, one of which was the clinical heterogeneity across the included studies, attributed to varying intervention design characteristics which restricted pooled synthesis of results to seven eligible studies. The assessment time points and follow-up periods also varied which meant conclusions on the influence of lifestyle modifications to an exercise program in the longer term were not possible. With respect to heterogeneity within the meta-analysis studies, a random effects model of analysis was applied in an attempt to mitigate any intervention protocol differences, and despite the study design variations, positive effects were seen across the majority of outcomes eligible for meta-analysis. An example of this, was although QoL outcomes significantly favoured the addition of lifestyle modifications over exercise alone in seven out of 12 studies, only two studies met the eligibility criteria for meta-analysis, which may explain the lack of significance found for this result.

A further possible limitation of this review was that 10 studies utilised home exercise programs (HEP) in their study design. With no gold standard to measure exercise adherence and under-reporting of this, accurate measurement of exercise adherence to a HEP remains a challenge. Finally, whilst lifestyle modifications have been linked to various mental health benefits that are unrelated to OA-induced impairments (Lasikiewicz et al., 2014; Janssen et al.; Sheehan et al.), most studies included in this review have only measured the effects of lifestyle modifications in the form of physical benefits, with only a few reporting on psychological variables. Therefore, the mental health benefits of lifestyle modification may have been underestimated.

5. Conclusion

The results of this systematic review and meta-analysis provide support to guidelines suggesting the inclusion of additional lifestyle modifications to a traditional exercise program for improvements in pain intensity, stiffness and physical function amongst individuals with knee OA. Individual results showed improvements in quality of life with the addition of lifestyle modifications, however, this was not demonstrated in the pooled analysis. Although greater benefits were seen with the addition of lifestyle modifications in 12 out of the 16 studies, heterogeneity of individual study methodology limited eligibility for meta-analysis. For those studies included in meta-analyses, the addition of lifestyle modifications (disease education, lifestyle advice, pain-coping, self-management strategies and adherence monitoring) to a traditional exercise program had the most positive impact on outcomes. Future research should compare the effectiveness of the different lifestyle modification types reported in this review, in conjunction with exercise for the management of knee OA, along with further exploration of the associated mental health benefits.

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Authors' contributions

Authors (L.S, A.K) have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted. Authors (C.V, W.H) have made substantial contributions the following: (1) the conception and design of the study and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Availability of data and materials'

The data that support the findings of this study are available on request from the corresponding author [L.S]. The data are not publicly available due to being stored in a secured cloud-based server.

Declaration of competing interest

The authors declare that they have no competing interests.

Abbreviations

AQoL	Assessment of Quality of Life
F	Female
OA	osteoarthritis
KOOS	Knee Injury Osteoarthritis Outcome Score
GRADE	Grading of Recommendation Assessment, Development, and Evaluation
M	Male
NA	Not assessed
NRS	Numerical Pain Rating Scale
NSAID	Non-steroidal anti-inflammatory drug
PA	Physical Activity
PPT	Pain Pressure Threshold
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROMs	Patient reported outcome measures
QoL	Quality of life
RCT	Randomised controlled trial
SD	Standard Deviation
STS	Sit-to-stand
TUG	Timed up and go
VAS	Visual analogue scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2023.102858.

Appendix A. Database search strategies

Database	Search strategy
PubMed	(osteoarthr*[Title/Abstract] OR degenerative [Title/Abstract]) AND (knee*[Title/Abstract]) AND (exercis*[Title/Abstract] OR physiotherap*[Title/Abstract] OR "physical therap*" OR rehab*[Title/Abstract]) AND ("randomized controlled trial" [Publication Type] OR "controlled clinical trial" [Publication Type] OR randomized [Title/Abstract] OR placebo [Title/Abstract] OR randomly [Title/Abstract] OR trial [Title/Abstract] OR groups [Title/Abstract] OR multi.modal [All Fields]) AND "humans" [MeSH Terms:noexp])
CINAHL	((TI osteoarthr* OR AB osteoarthr*) OR (TI degenerative OR AB degenerative)) AND ((TI knee* OR AB knee*)) AND ((TI exercis* OR AB exercis*) OR (TI physiotherap* OR AB physiotherap*) OR "physical therap*" AND ("randomized controlled trial [Publication Type]" OR "controlled clinical trial [Publication Type]" OR (TI randomized OR AB randomized) OR (TI placebo OR AB placebo) OR (TI randomly OR AB randomly) OR (TI trial OR AB trial) OR (TI groups OR AB groups) OR multi.modal)
SPORTDiscus	((TI osteoarthr* OR AB osteoarthr*) OR (TI degenerative OR AB degenerative)) AND ((TI knee* OR AB knee*)) AND ((TI exercis* OR AB exercis*) OR (TI physiotherap* OR AB physiotherap*) OR "physical therap*" AND ("randomized controlled trial [Publication Type]" OR "controlled clinical trial [Publication Type]" OR (TI randomized OR AB randomized) OR (TI placebo OR AB placebo) OR (TI randomly OR AB randomly) OR (TI trial OR AB trial) OR (TI groups OR AB groups) OR multi.modal)
Pedro	Knee AND osteoarthritis AND exercise AND treatment

Appendix B. Pedro critical appraisal score

PEDro Critical Appraisal Scale											
Author (yr)	Q1	Q2	Q3	Q4	Q5	Q6	Q6	Q7	Q8	Q9	Q10	PEDRO SCORE
Alfieri et al., 2020	Y	Y	Y	N	Y	N	N	Y	N	Y	Y	6/10
Bennell et al., 2016	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	7/10
Bennell et al., 2017	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	8/10
Bennell et al., 2020	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	9/10
Bokaeian et al., 2021	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	7/10
Chen 2019	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	6/10
Farr												

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(*continued*)

PEDro Critical Appraisal Scale												
Author (yr)	Q1	Q2	Q3	Q4	Q5	Q6	Q6	Q7	Q8	Q9	Q10	PEDRO SCORE
2010	Y	Y	Y	Y	Y	N	N	N	N	N	Y	5/10
Focht et al., 2014	Y	N	Y	Y	Y	N	N	Y	N	Y	Y	6/10
Jenkinson et al., 2009	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	7/10
Keefe et al., 2004	Y	Y	Y	N	N	N	N	N	N	N	Y	3/10
Messier et al., 2004	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	8/10
Mihalko 2018	Y	Y	Y	N	Y	N	N	Y	Y	N	Y	6/10
Rejeski et al., 2002	Y	Y	Y	N	Y	N	N	Y	N	Y	Y	6/10
Veenhof et al., 2006	Y	Y	Y	N	Y	N	N	Y	Y	Y	Y	7/10
Wang et al., 2016	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	7/10
Wang et al., 2020	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	7/10

Appendix C. Participant inclusion and exclusion criteria within the included studies

Author, Year	Inclusion Criteria	Exclusion Criteria
Alfieri et al., 2020	• Older than 50 years of age presented clinical and radiographic diagnosis of unilateral or bilateral knee OA • Kellgren-Lawrence grading scale 1 to 4 • Pain perception equal to or above 4 cm in visual analogue scale (VAS)	• Patients with any other chronic diseases such as fibromyalgia, rheumatoid arthritis, neurologic or cardiac diseases and uncontrolled hypertension
Bennell et al., 2016	• Ages over 50 years • knee OA fulfilling the American College of Rheumatology criteria • knee pain for 3+ months • Average pain during previous week of 40+ on 100-mm visual analogue scale (VAS) • Moderate difficulty with daily activities (WOMAC)	• Systemic arthritic condition • Self-reported history of serious mental illness; neurological • Knee surgery within the past 6 months or total joint replacement • Awaiting or planning any back or lower limb surgery • Current or past oral or intra-articular corticosteroid use • Physiotherapy, chiropractic or acupuncture treatment or exercises specifically for the knee • Walking exercise; participating in a regular exercise • Participating in or previous participation in a formal PCST program • Inability to walk unaided
Bennell et al., 2017	• Age >50 years • Average knee pain >4 on an 11-point numeric rating scale • American College of Rheumatology clinical criteria for knee OA • Classification as sedentary or insufficiently physically active according to the Active Australia Survey	• Inability to safely participate in moderate-intensity exercise • Undertaking regular lower-extremity strengthening exercises or receiving nondrug management for knee pain from a health professional • Knee surgery or intraarticular corticosteroid injection • Systemic arthritic conditions or current or past • Other condition affecting lower-extremity function • Unable to use/access a telephone • Score of >21 (Depression, Anxiety and Stress Scale)
Bennell et al., 2020	• Aged ≥50 years • Knee pain on most days of the past month • Knee pain for ≥3 months • Average overall pain severity ≥4 (NRS) • Tibiofemoral osteophytes on x-ray • Obesity (BMI ≥30 kg/m^2) • Own a mobile phone with text messaging	• Lateral ≥ medial joint space narrowing on x-ray • Knee surgery/joint injection • Current or past oral corticosteroids use • Systemic arthritic conditions • Other condition affecting lower limb function • Participation in knee strengthening or neuromuscular/functional exercise • Unable to walk unaided
Bokaeian et al., 2021	• 45–76 years of age • Knee pain of 30 or greater on the 100-mm visual analogue scale (VAS) • Unilateral or bilateral tibiofemoral joint OA of grades 2–3 (Kellgren–Lawrence grading system) • History of pain for more than a month, and ability to walk without assistive devices	• Systemic arthritis, diabetes, neuromuscular diseases • Injection in the lower-extremity joints • Hip or knee replacement • Recent trauma to the knee joint • Body mass index >35 • History of lower-extremity surgery
Chen, 2019	• ≥60 years old • Experiencing knee pain on most days within the past month • Knee pain between 3 and 7 (NRS) • Intact cognitive functioning (Short Portable Mental Status Questionnaire)	• Joint replacement or arthroscopic surgery on the affected side of the knee • Other health issues that could induce adverse events • Already having other regular exercise habits
Farr et al., 2010	• Age between 35 and 68 years • Pain on 4 or more days of the week in one or both knees for at least 4 months during the previous year • Less than 5 years' symptom duration • Radiographic status of grade II OA (and no higher) in at least one knee (Kellgren and Lawrence) • Disability due to knee OA (WOMAC)	NR
Focht et al., 2014	• 0 min/week of structured exercise during the prior 6 months • Self-reported difficulty in simple functional tasks • Radiographic evidence of Kellgren-Lawrence scale stage II or III (mild to moderate) tibiofemoral OA • Willingness to participate in our study protocol.	• Serious medical conditions • Inability to walk unaided • Physician-documented radiographic evidence of knee joint varus or valgus malalignment • OA severity >3 on the Kellgren-Lawrence scale
Jenkinson et al., 2009	• All men and women aged 45 and over with a body mass index (BMI) of ≥28.0 • Knee pain	• Rheumatoid arthritis • Intra-articular injection • Total knee replacement

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(*continued*)

Author, Year	Inclusion Criteria	Exclusion Criteria
Keefe et al., 2004	NR	• Comorbid medical conditions that could affect their health status over the course of the trial
Messier et al., 2004	• Age 60 years • Body mass index 28 kg/m^2 • Persistent knee pain • Sedentary activity pattern • Self- reported difficulty in daily functional tasks • Radiographic evidence of grade I–III tibiofemoral or patellofemoral OA	• Comorbid medical conditions that could affect their health status/ability to take part in trial • Mini-Mental State Examination score of 24 • Inability to walk un-aided • Inability to complete the protocol, in the opinion of the clinical staff, because of frailty, illness, or other reasons
Mihalko, 2018	• Grade II–III (mild to moderate) radiographic tibiofemoral OA or tibiofemoral plus patellofemoral OA • Persistent knee pain • 27.0 ≤ BMI ≤41 kg/m^2 • Sedentary lifestyle (less than 30 min of formal exercise per week)	• Significant comorbid disease that prevented safe participation in an exercise program • Significant cognitive impairment or depression
Rejeski, 2010	• 60+ years • BMI 28+ • Persistent knee pain • Sedentary activity pattern • Self-reported difficulty in performing functional activities • Radiographic evidence of tibio-femoral osteoarthritis • Willingness to undergo testing and intervention procedures	• Comorbidity that prevented safe participation in an exercise program • Mini-Mental score 24+ • Inability to walk unaided • Inability to complete the protocol, in the opinion of the clinical staff, because of frailty, illness, or other reasons.
Veenhof et al., 2006	• OA of the hip or knee according to the clinical criteria of the American College of Rheumatology (ACR)	• Indication for hip or knee replacement within 1 year • Contraindication for exercise therapy • Low level of physical function
Wang et al., 2016	• Age ≥40 years • American College of Rheumatology criteria for symptomatic KOA • Radiographic evidence of KOA • Score of 40 or greater on at least 1 of 5 questions in the WOMAC pain subscale range	• Had undertaken Tai Chi or PT in the past year • Presenting with serious medical conditions • Use of articular injections in the past 3 or 6 months • History of knee surgery
Wang et al., 2020	• Age ≥60 years • Persistent knee pain (3–7/11 in NPRS) • Intact cognitive functioning (Short Portable Mental Status Questionnaire)	• History of knee surgery • Severe deformity of the lower limbs (e.g., knee varus or valgus) • Comorbidity that could induce adverse events during trial

Appendix D. Results of Individual Studies

Author, Year	Functional Outcome Measure(s)	Results			
		Timepoint	Control Mean ± SD	Intervention Mean ± SD	
Alfieri et al., 2020	(Bennell and Hinman, 2011) VAS (Hawker et al.) WOMAC Pain (Vitaloni et al.) WOMAC function (Fransen et al., 2015) WOMAC joint stiffness (Stewart) FANTASTICO	1a. Baseline 1b. 8/52 2a. Baseline 2b. 8/52 3a. Baseline 3b. 8/52 4a. Baseline 4b. 8/52 5a. Baseline 5b. 8/52	1a. 6.7 ± 1.6 1b. 5.5 ± 2.3 2a. 48.1 ± 18.6 2b. 43.5 ± 21.1 3a. 38.7 ± 19.2 3b. 35.2 ± 18.6 4a. 37.7 ± 21.9 4b. 478.0 ± 19.1 5a. 66.3 ± 7.8 5b. 74.2 ± 9.7	1a. 6.8 ± 1.9 1b. 4.7 ± 3.4 2a. 55.2 ± 26.1 2b. 41.8 ± 28 3a. 42.1 ± 28.0 3b. 38.4 ± 30.9 4a. 45.4 ± 28.5 4b. 43.7 ± 29.3 5a. 72/6 ± 11.3 5b. 77.3 ± 11.4	
Bennell et al., 2016	(Bennell and Hinman, 2011) VAS (0–100) (Hawker et al.) WOMAC function (0–68) (Vitaloni et al.) Coping strategy questionnaire – Pain coping (0–163) (Fransen et al., 2015) Quadricep strength (NM) (Stewart) 30s STS (Cross et al.) 20 m walk-test (m/s)	1a. Baseline 1b. 12/52 1c. 32/52 1d. 52/52 2a. Baseline 2b. 12/52 2c. 32/52 2d. 52/52 3a. Baseline 3b. 12/52 3c. 32/52 3d. 52/52 4a. Baseline 4b. 12/52	1a. 59.1 ± 12/4 1b.31.8 ± 22.3 1c. 36 ± 24.6 1d. 34/5 ± 23.8 2a. 34.3 ± 7.2 2b. 19.2 ± 10.1 2c. 21.4 ± 12.0 2d. 18.1 ± 11.2 3a. 63.6 ± 26.3 3b. 59.9 ± 26.6 3c. 59.2 ± 24.4 3d. 62.5 ± 26.0 4a. 1.13 ± 0.49 4b. 1.28 ± 0.52 4c. N/A 4d. 1.34 ± 0.52 5a.9.0 ± 2.6 5 b. 11.1 ± 3.0	Intervention A (PCST) 1a. 58.7 ± 12.6 1b. 33.2 ± 22.3 1c. 35.7 ± 23.9 1d. 34/8 ± 21.2 2a. 35.0 ± 7.4 2b. 23.5 ± 10.6 2c. 23.4 ± 12.2 2d. 21.3 ± 9.8 3a. 69.5 ± 23.7 3b. 82.9 ± 26.2 3c. 78.5 ± 24.8 3d. 79.7 ± 25.9 4a. 1.00 ± 0.45 4b. 1.08 ± 0.49 4c. N/A 4d. 1.10 ± 0.44	Intervention B (Ex + PCST) 1a. 58.4 ± 12.8 1b. 26.4 ± 18.4 1c. 28.2 ± 21.6 1d. 31.7 ± 22.6 2a. 35.7 ± 7.3 2b. 15.4 ± 9.2 2c. 17.5 ± 10.8 2d. 16 ± 10.3 3a. 65.8 ± 25.7 3b. 82.8 ± 27.0 3c. 80.1 ± 26.6 3d. 81.4 +- 26.3 4a. 0.99 ± 0.43 4b. 1.13 ± 0.48 4c. N/A 4d. 1.23 ± 0.44

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Author, Year	Functional Outcome Measure(s)	Results Timepoint	Control Mean ± SD	Intervention Mean ± SD	
		4c. 32/52 4d. 52/52 5a. Baseline 5b. 12/52 5c. 32/52 5d. 52/52 6a. Baseline 6b. 12/52 6c. 32/52 6d. 52/52	5c. N/A 5 d. 11.6 ± 2.8 6a. 1.54 ± 0.35 6 b. 1.73 ± 0.34 6c. N/A 6d 1.74 ± 0.37	5a. 8.2 ± 3.0 5b. 9.0 ± 3.3 5c. N/A 5d. 9.6 ± 3.5 6a.1.51 ± 0.30 6b. 1.58 ± 0.33 6c. N/A 6d. 1.63 ± 0.39	5a. 8.8 ± 2.4 5b. 10.6 ± 3.o 5c. N/A 5d. 11.1 ± 2.3 6a. 1.53 ± 0.20 6b. 1.58 ± 0.33 6c. N/A 6d. 1.78 ± 0.36
Bennell et al., 2017	(Bennell and Hinman, 2011) NRS (0–10) (Hawker et al.) WOMAC Pain (Vitaloni et al.) WOMAC function (Fransen et al., 2015) AQoL	1a. Baseline 1b. 6/12 1c. 12/12 1d. 18/12 2a. Baseline 2b. 6/12 2c. 12/12 2 d. 18/12 3a. Baseline 3b. 6/12 3c. 12/12 3d. 18/12 4a. Baseline 4b. 6/12 4c. 12/12 4d. 18/12	1a. 5.8 ± 2.5 1b. 3.8 ± 2.3 1c. 3.7 ± 2.2 1d. 4.1 ± 28.8 2a. 8.5 ± 2.9 2b. 5.7 ± 3.6 2c. 5.4 ± 3.4 2 d. 4.3 ± 3.5 3a. 30.3 ± 10.1 3b. 18.2 ± 11.7 3c. 17.4 ± 11.9 3d. 16.4 ± 11.7 4a. 0.7 ± 0.1 4b. 0.8 ± 0.1 4c. 0.8 ± 0.1 4d. 0.8 ± 0.2.	1a. 5.6 ± 1.4 1b. 3.1 ± 2.2 1c. 3.2 ± 2.4 1d. 3.6 ± 2.4 2a. 8.1 ± 2.7 2b. 4.2 ± 3.0 2c. 4.3 ± 3.3 4.4 ± 3.4 3a. 27.3 ± 11.1 3b. 14.7 ± 10.6 3c. 13.3 ± 10.5 3d. 12.2 ± 10.5 4a. 0.7 ± 0.1 4b. 0.8 ± 0.1 4c. 0.8 ± 0.2 4d. 0.8 ± 0.1	
Bennell et al., 2020	(Bennell and Hinman, 2011) NRS (0–10) (Hawker et al.) KOOS pain (0–100) (Vitaloni et al.) KOOS function (0–100) (Fransen et al., 2015) KOOs QoL (0–100) (Stewart) AQoL (−0.04 – 1.0)	1a. Baseline 1b. 24/52 2a. Baseline 2b. 24/52 3a. Baseline 3b. 24/52 4a. Baseline 4b. 24/52 5a. Baseline 5b. 24/52	1a 3.8 ± 2.4 1b. 4.0 ± 2.3 2a. 63.2 ± 19.8 2b. 64.4 ± 20.1 3a. 70.6 ± 20.7 3b. 70.0 ± 21.1 4a. 47.9 ± 21.7 4b. 47.8 ± 23.0 5a. 0.81 ± 0.12 5b. 0.78 ± 0.15	1a 3.5 ± 2.1 1b. 4.1 ± 2.2 2a. 64.3 ± 14.9 2b. 64.9 ± 17.3 3a. 72.2 ± 15.6 3b. 72.4 ± 17.6 4a. 44.4 ± 19.9 4b. 46.1 + .0 22.0 5a. 0.76 ± 0.18 5b. 0.77 ± 0.15	
Bokaeian et al., 2021	1) VAS (0–100) (Hawker et al.) WOMAC pain (Vitaloni et al.) 2MWT (distance - m) (Fransen et al., 2015) 2MWT (gait speed – m/s)	1a. Baseline 1b. 1/12 1c. 2/12 2a. Baseline 2b. 1/12 2c. 2/12 3a. Baseline 3b. 1/12 3c. 2/12 4a. Baseline 4b. 1/12 4c. 2/12	1a. 69.3 ± 13.7 1b. 41.2 ± 29.9 1c. 44.4 ± 26.6 2a. 17.4 ± 3.6 2b. 7.9 ± 4.6 2c. 10.5 ± 3.9 3a. 120.4 ± 21.9 3b. 138.1 ± 14.5 3c. 136 ± 16.7 4a. 0.84 ± 0.12 4b. 0.8 ± 0.2 4c. 0.86 ± 0.09	1a. 78.1 ± 18.4 1b. 35.3 +/8.7 1c. 39.8 ± 36 2a. 16.2 ± 4.1 2b. 6.9 ± 6 2c 6.4 ± 4.7 3a. 12 ± 20.9 3b. 144.8 ± 26.1 3c. 136.2 ± 25.1 4a. 0.88 ± 0.1 4b. 0.9 ± 0.09 4c. 0.87 ± 0.1	
Chen, 2019	(Bennell and Hinman, 2011) NRS (0–10) (Hawker et al.) WOMAC (Vitaloni et al.) 5× STS (s) (Fransen et al., 2015) TUG (s)	1a. Baseline 1b. 12/52 1c. 24/52 2a. Baseline 2b. 12/52 2c. 24/52 3a. Baseline	1a. 22.64 ± 19.34 1b. 23/47 ± 17.11 1c. 22.71 ± 19.57 2a. 24.13 ± 26.73 2b. 22.92 ± 22.0 2c. 19.62 ± 19.88 3a. 12.12 ± 4.41 3b. 12.11 ± 3.81 3c. 11.34 ± 3.66 4a. 9.12 ± 2.02	1a. 21.69 ± 19.97 1b. 16.85 ± 15.09 1c. 16.18 ± 15.94 2a. 24.16 ± 26.10 2b. 19.10 ± 20.91 2c. 10.41 ± 12.52 3a. 11.98 ± 5.34 3b. 11.19 ± 4.07 3c. 9.61 ± 2.43 4a. 8.91 ± 3.03	

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Author, Year	Functional Outcome Measure(s)	Results			
		Timepoint	Control Mean ± SD	Intervention Mean ± SD	
		3b. 12/52 3c. 24/52 4a. Baseline 4b. 12/52 4c. 24/52	4b. 8.92 ± 1.88 4c. 8.56 ± 1.7	4b. 8.45 ± 2.0 4c. 7.46 ± 1.26	
Farr et al., 2010		(Bennell and Hinman, 2011) WOMAC pain (Hawker et al.) Moderate physical activity level – 3–6 METs (Vitaloni et al.) Vigorous physical activity level - >6 METS	1a. Baseline 1b. 3/12 1c. 9/12 2a. Baseline 2b. 3/12 2c. 9/12 3a. Baseline 3b. 3/12 3c. 9/12	1a. 84.3 ± 70.1 1b. 47.6 ± 50.9 1c. 48.6 ± 61.3 2a. 24.6 ± 17.8 2b. 27.9 ± 19.4 2c. 26.1 ± 17.7 3a. 0.8 ± 2.6 3b. 2.1 ± 4.9 3c. 1.6 ± 4.2	1a. 81.9 ± 67.3 1b. 67.1 ± 68.8 1c. 56.2 ± 75.3 2a. 27.9 ± 18.3 2b. 32.1 ± 17.1 2c. 30.1 ± 15.0 3a. 1 ± 2 3b. 1.6 ± 2.5 3c. 1.9 ± 3.7
Focht et al., 2014	(Bennell and Hinman, 2011) Function – 400 m walk time (s) (Hawker et al.) Physical activity level	1a. Baseline 1b. 3/12 1c. 12/12 2a. Baseline 2b. 3/12 2c. 12/12	1a. 385.8 ± 120.4 1b. 382.3 ± 112.2 1c. 419.4 ± 196.9 2a. 352.5 ± 299.5 2b. 299.1 ± 179.2 2c. 278.3 ± 179.2	1a. 357.6 ± 98.5 1b. 347 ± 95.6 1c. 351.3 ± 95.5 2a. 351 ± 196.8 2b. 410.3 ± 246.4 2c. 404.5 ± 251.8	
Keefe et al., 2004	(Bennell and Hinman, 2011) Coping strategies questionnaire (Hawker et al.) VO2K (Vitaloni et al.) The Arthritis Self-Efficacy Scale	1a. Baseline 1b. 12/52 2a. Baseline 2b. 12/52 3a. Baseline 3b. 12/52	1a. 49.35 ± 26.61 1b. 47.44 ± 20.29 2a. 21.37 ± 5.74 2b. 24.35 ± 5.97 3a. 215.42 ± 36.95 3b. 220.46 ± 44.66	Intervention A (PCST) 1a. 69.36 ± 26.33 1b. 78.18 ± 23.96 2a. 20.36 ± 6.77 2b. 20.40 ± 7.21 3a. 201.93 ± 45.69 3b. 234.13 ± 37.43	Intervention B (PCST + Ex) 1a. 55.19 ± 32.27 1b. 73.76 ± 25.78 2a. 20.42 ± 5.48 2b. 24.03 ± 5.88 3a. 196.68 ± 41.68 3b. 238.71 ± 31.61
Messier et al., 2004	(Bennell and Hinman, 2011) WOMAC Pain – change in score, 0-20 (Hawker et al.) 6MWT (m) (Vitaloni et al.) Stair climb	1a. Baseline 1b. 6/12 1c. 18/12 2a. Baseline 2b. 6/12 2c. 18/12 3a. Baseline 3b. 6/12 3c. 18/12	1a. 6.64 ± 0.39 1b. 6.22 ± 0.45 1c. 6.24 ± 0.47 2a. 424.15 ± 11.42 2b. 465.04 ± 12.13 2c. 472.73 ± 13.12 3a. 10.52 ± 0.66 3b. 8.87 ± 0.73 3c. 8.89 ± 0.78	Intervention A (D) 1a. 6.58 ± 0.40 1b. 5.10 ± 0.43 1c. 5.5 1 ± 0.45 2a. 425.98 ± 10.89 2b. 433.68 ± 11.94 2c. 435.63 ± 12.88 3a. 9.74 ± 0.65 3b. 9.88 ± 0.70 3c. 8.43 ± 0.78	Intervention B (D + Ex) 1a. 7.27 ± 0.41 1b. 5.47 ± 0.47 1c. 5.07 ± 0.47 2a. 416.65 ± 11.34 2b. 482.37 ± 12.65 2c. 477.76 ± 13.12 3a. 10.99 ± 0.67 3b. 8.83 ± 0.78 3c. 8.45 ± 0.81
Rejeski, 2010	1. SF-36 mental health 2. SF-36 physical health 3. SF-36 satisfaction w/function 4. SF-36 satisfaction w/appearance	1a. Baseline 1b. 6/12 1c. 18/12 2a. Baseline 2b. 6/12 2c. 18/12 3a. Baseline 3b. 6/12 3c. 18/12	1a. 54.28 ± 1.0 1b. 52.85 ± 1.26 1c. 54.06 ± 0.81 2a. 34.50 ± 1.14 2b. 37.14 ± 1.25 2c. 37.61 ± 0.85 3a. −1.09 ± 0.18 3 b. −0.13 ± 0.20 3c. −0.09 ± 0.16 4a. −1.31 ± 0.13 4b. −0.93 ± 0.19 4c. −0.96 ± 0.16	Intervention A (D) 1a. 52.69 ± 1.04 1b. 53.89 ± 0.97 1c. 54.39 ± 0.78 2a. 35.17 ± 1.05 2b. 38.20 ± 1.13 2c. 38.15 ± 0.81 3a. −0.99 ± 0.19	Intervention B (D + Ex) 1a. 52.85 ± 1.31 1b. 53.31 ± 0.99 1c. 53.84 ± 0.82 2a. 35.39 ± 1.28 2b. 40.57 ± 1.33 2c. 40.31 ± 0.86 3a. −1.04 ± 0.17 3b. −.39 ± 0.22 3c. 0.38 ± 0.17 4a. −1.78 ± 0.19

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Author, Year	Functional Outcome Measure(s)	Results		
		Timepoint	Control Mean ± SD	Intervention Mean ± SD
		4a. Baseline 4b. 6/12 4c. 18/12		3b. −0.24 ± 0.18 3c. −0.30 ± 0.16 4a. −1.94 ± 0.15 4b. −0.81 ± 0.18 4c. −0.70 ± 0.15 4b. −0.44 ± 0.21 4c. −0.46 ± 0.16
Veenhof et al., 2006	(Bennell and Hinman, 2011) VAS: 0–10 (change to baseline) (Hawker et al.) WOMAC Pain: 0–20 (change to baseline) (Vitaloni et al.) WOMAC Function: 0–68 (change to baseline) (Fransen et al., 2015) 5 m walk test: S (change to baseline) (Stewart) SF-36: 0–100 (change to baseline)	1a. Baseline 1b. 13/52 1c. 39/52 1d. 65/52 2a. Baseline 2b. 13/52 2c. 39/52 2d. 65/52 3a. Baseline 3b. 13/52 3c. 39/52 3d. 65/52 4a. Baseline 4b. 13/52 4c. 39/52 4d. 65/52 5a. Baseline 5b. 13/52 5c. 39/52 5d. 65/52	1a. 3.7 ± 2.5 1b. −0.47 (−1, 0.1) 1c. 0.62 (0, 1.2) 1d. −0.58 (−1.1,-0.3) 2a. 8.7 ± 3.1 2b. −2.20 (−2.9, −1.5) 2c. −1 (−1.8, −0.2) 2d. −3.2 (−3.9, −2.5) 3a. 29.1 ± 9.9 3b. −5.21 (−6.9, −3.5) 3c. −5.22 (−7.4, −3.0) 3d. 7.29 (9.3, 5.2) 4a. 4.8 ± 1.5 4b. −0.19 (−0.4, 0) 4c. No data 4d. −0.13 (−0.3, −0.04) 5a. 45.2 ± 41.7 5b. 15.2 (5.1, 25.2) 5c. 9.2 (−1.4, 19.9) 5d. 17.8 (6, 29.5)	1a. 4.3 _ ± 2.8 1b. −0.61 (−1.2, 0.005) 1c. −0.15 (−0.8, −0.5) 1d. −1.01 (−1.7, −0.3) 2a. 9.1 ± 3.3 2b. −2.35 (−3, −1.7) 2c. −2.30 (−3.3, −1.3) 2d. −3.90 (−4.7, −3.1) 3a. 28.7 ± 12.5 3b. −5.98 (8.0, −4.0] 3c. −6.94 (−9.6, −4.3) 3d. 7.35 (10.4, 4.3) 4a. 4.8 ± 1.2 4b. −0.41 (−0.6, −0.2) 4c. No data 4d. −0.44 (−0.7, −0.2) 5a. 4- ± 4.7 5b. 14.1 (4.9, 23.3) 5c. 12.1 (1.6, 22.5) 5d. 8 (−3.7, 19.7)
Wang et al., 2016[§]	1. WOMAC pain (0–500, mm) 2. WOMAC physical function (0–1700, mm) 3. WOMAC stiffness (0–200, mm) 4. Patient Global Assessment score (0–10 cm) 5. Beck Depression inventory-II (0–63) 6. SF-36 physical (0–100) 7. SF-36 mental (0–100) 8. Arthritis self-efficacy scale (Bennell and Hinman, 2011; Hawker et al.; Vitaloni et al.; Fransen et al., 2015; Stewart; Cross et al.; Woolf and Pfleger; Ackerman et al. Mahendira et al.; Chen et al., 1941) 9.6 min walk test (m) 10.20 m walk test (s) 11. NSAID consumption	1b. 12/52 1c. 24/52 1d. 1 year 2b. 12/52 2c. 24/52 2d. 1 year 3b. 12/52 3c. 24/52 3d. 1 year 4b. 12/52 4c. 24/52 4d. 1 year 5b. 12/52 5c. 24/52 5d. 1 year 6b. 12/52 6c. 24/52 6d. 1 year 7b. 12/52 7c. 24/52 7d. 1 year 8a. Baseline 8b. 12/52 8c. 24/52 8d. 1 year 9b. 12/52 9c. 24/52 9d. 1 year 10b. 12/52 10c. 24/52 10d. 1 year 11b. 12/52	1b. −143.0 (−167.4 to −118.6) 1c. −124.3 (−150.0 to −98.5) 1d. −121.0 (−150.0 to −91.9) 2b. −494.2 (−585.3 to −403.2) 2c. −455.7 (−543.1 to −368.4) 2d. −444.0 (−541.3 to −346.7) 3b. −494.2 (−585.3 to −403.2) 3c. −455.7 (−543.1 to −368.4) 3d. −444.0 (−541.3 to −346.7) 4b. −2.24 (−2.78 to −1.71) 4c. −1.73 (−2.29 to −1.17) 4d. −1.31 (−1.96 to −0.66) 5b. 0.5 (−1.0 to 2.0) 5c. 0.2 (−1.3 to 1.7) 5d. −0.003 (−1.6 to 1.6) 6b. 3.1 (1.4–4.8) 6c. 3.4 (1.4–5.5) 6d. 4.3 (2.3–6.4) 7b. −0.03 (−1.7 to 1.7) 7c. −0.7 (−2.7 to 1.4)	1b. −167.2 (−190.4 to −144.9) 1c. −158.6 (−182.9 to −134.3) 1d. −138.8 (−166.7 to −110.8) 2b. −608.3 (−695.3 to −521.4) 2c. −586.8 (−669.5 to −504.1) 2d. −532.3 (−625.9 to −438.7) 3b. −494.2 (−585.3 to −403.2) 3c. −455.7 (−543.1 to −368.4) 3d. −444.0 (−541.3 to −346.7) 4b. −2.96 (−3.46 to −2.45) 4c. −2.40 (−2.93 to −1.88) 4d. −1.84 (−2.48 to −1.21) 5b. −2.2 (−3.7 to −0.9) 5c. −1.7 (−3.1 to −0.4) 5d. −1.1 (−2.7 to 0.5) 6b. 6.3 (4.6–7.9) 6c. 7.1 (5.1–9.0) 6d 6.3 (4.4–8.3) 7b. 1.6 (−0.1 to 3.2) 7c. 0.4 (−1.5 to 2.2) 7d. −0.1 (−1.9 to 1.8) 8b. 1.3 (0.8–1.8) 8c. 0.9 (0.4–1.4) 8d. 1.0 (0.5–1.5) 9b. 28.6 (17.9–39.2) 9c. 28.9 (16.6–41.2) 9d. 27.1 (12.2–42.0) 10b. −1.6 (−2.4 to −0.8) 10c. −2.4 (−3.4 to −1.3) 10d. −2.4 (−3.5 to −1.4) 11b. 0.39 (0.18–0.87) 11c. 0.17 (0.07–0.40) 11d. 0.39 (0.17–0.92)

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Author, Year	Functional Outcome Measure(s)	Results Timepoint	 Control Mean ± SD	 Intervention Mean ± SD	
		11c. 24/52 11d. 1 year	7d. −1.5 (−3.4 to 0.4) 8b. 0.8 (0.3–1.4) 8c. 0.9 (0.4–1.4) 8d. 0.7 (0.2–1.2) 9b. 26.1 (14.9–37.4) 9c. 24.5 (11.5–37.5) 9d. 22.8 (7.0–38.6) 10b. −1.1 (−2.0 to −0.2) 10c. −1.2 (−2.2 to −0.1) 10d. −1.0 (−2.1 to 0.2) 11b. 0.54 (0.24–1.21) 11c. 0.61 (0.26–1.42) 11d. 0.75 (0.32–1.77)		
Wang et al., 2020		1. WOMAC pain 2. WOMAC stiffness 3. FTSST 4. TUG	1a. Baseline 1b. 24/52 1c. 48/52 2a. Baseline 2b. 24/52 2c. 48/52 3a. Baseline 3b. 24/52 3c. 48/52 4a. Baseline 4b. 24/52 4c. 48/52	1a. 24.42 ± 19.65 1b. 23.47 ± 17.11 1c. 19.64 ± 16.83 2a. 25.00 ± 25.37 2b. 19.62 ± 19.88 2c. 17.57 ± 21.36 3a. 12.27 ± 4.29 3b. 11.34 ± 3.66 3c. 11.06 ± 2.79 4a. 2.03 ± 0.22 4b. 1.60 ± 0.19 4c. 1.22 ± 0.15	1a. 24.37 ± 20.31 1b. 16.18 ± 15.94 1c. 13.62 ± 11.28 2a. 24.03 ± 24.73 2b. 10.53 ± 12.49 2c. 9.77 ± 14.19 3a. 12.03 ± 5.09 3b. 9.61 ± 2.43 3c. 10.29 ± 3.70 4a. 2.95 ± 0.29 4b. 1.26 ± 0.13 4c. 1.11 ± 0.12

Ex Exercise, *VAS* Visual Analogue Scale, *WOMAC* Western Ontario and McMaster Universities Osteoarthritis, *STS* Sit-to-stand, *PCST* Pain Coping Strategy Training, *NRS* Numerical rating scale, *AQoL* Assessment of Quality of Life, *KOOS* Knee Injury and Osteoarthritis Outcome Score, 2MWT 2-m Walk Test, *STS* Sit-to-stand, *TUG* Timed up-and-go, *D* Diet, 6MWT 6-min Walk Test, *QoL* Quality of life, *NSAID* Non-steroidal anti-inflammatory drug, *BGA* Behaviour Graded Activity, *FTSST* Five-time Sit-to-Stand.

**Jenkinson et al. (2009) and Mihalko et al. (2018) were not included in this table as numerical results data was no published in full.

[§] Wang et al. (2016) did not report baseline values in numerical form.

Appendix E. GRADE rating for certainty of evidence

Meta-analysis outcome	Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Rating
Pain intensity SMD -0.61; 95% CI. −1.12 to −0.10; I^2 = 95%	0	−1[§]	−1*	−1[†]	0	−3
Knee joint stiffness at 6 months – WOMAC stiffness) MD -0.69; 95% CI. −1.21 to −0.17; I^2 = 0%	0	0	0	0	0	0
Quality of Life at 6 months (AQoL) MD -0.10; 95% CI. −0.24 to 0.04; I^2 = 0%	0	0	−1*	0	0	−1
Physical function at 6 months (TUG) MD -1.26 s; 95% CI. −1.34 to −1.17; I^2 = 0%	0	0	0	−1[†]	0	−1

GRADE Grade of Recommendation, Assessment Development and Evaluation; *0* Not downgraded.

*Downgraded 1 place because of unexplained indirectness.

[†] Downgraded 1 place because of wide CI.

[§]**Downgraded 1 place for evidence of unexplained inconsistency (I^2 = >50%).**

[‡] Funnell plots not completed due to <10 studies included in meta-analysis.

References

Ackerman IA-O, Bohensky MA, Zomer E, Tacey M, Gorelik A, Brand CA, et al. The Projected Burden of Primary Total Knee and Hip Replacement for Osteoarthritis in Australia to the Year 2030. (1471-2474 Electronic))..

Alfieri, F.M., Lima, A.R.S., Salgueiro, M., Andrade, E.A., Battistella, L.R., Silva, N., 2020. Efficacy of an exercise program combined with lifestyle education in patients with knee osteoarthritis. Acta Reumatol Port 45 (3), 201–206.

Alghadir A, Anwer S, Brismée JM. The Reliability and Minimal Detectable Change of Timed up and Go Test in Individuals with Grade 1-3 Knee Osteoarthritis. (1471-2474 Electronic))..

Anwer, S., Alghadir, A., Brismeé, J.-M., 2001. Effect of home exercise program in patients with knee osteoarthritis: a systematic review and meta-analysis. J. Geriatr. Phys. Ther. 39 (1), 38–48, 2016.

Bannuru, R.R., Osani, M.C., Vaysbrot, E.E., Arden, N.K., Bennell, K., Bierma-Zeinstra, S. M.A., et al., 2019. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage 27 (11), 1578–1589.

Bennell, K.L., Hinman, R.S., 2011. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. J. Sci. Med. Sport 14 (1), 4–9.

Bennell, K.L., Ahamed, Y., Jull, G., Bryant, C., Hunt, M.A., Forbes, A.B., et al., 2016. Physical therapist-delivered pain coping skills training and exercise for knee osteoarthritis: randomized controlled trial. Arthritis Care Res. 68 (5), 590–602.

Bennell, K.L., Campbell, P.K., Egerton, T., Metcalf, B., Kasza, J., Forbes, A., et al., 2017. Telephone coaching to enhance a home-based physical activity program for knee osteoarthritis: a randomized clinical trial. Arthritis Care Res. 69 (1), 84–94.

Bennell, K., Nelligan, R.K., Schwartz, S., Kasza, J., Kimp, A., Crofts, S.J., et al., 2020. Behavior change text messages for home exercise adherence in knee osteoarthritis: randomized trial. J. Med. Internet Res. 22 (9), e21749.

Bliddal, H., Leeds, A.R., Christensen, R., 2014. Osteoarthritis, obesity and weight loss: evidence, hypotheses and horizons - a scoping review. Obes. Rev. 15 (7), 578–586.

Bokaeian, H.R., Esfandiarpour, F., Zahednejad, S., Mohammadi, H.K., Farahmand, F., 2021. Effects of an exercise therapy targeting knee kinetics on pain, function, and gait kinetics in patients with knee osteoarthritis: a randomized clinical trial. Adapt. Phys. Act. Q. (APAQ) 38 (3), 377–395.

Brierley, M.-E.E., Thompson, E.M., Albertella, L., Fontenelle, L.F., 2021. Lifestyle interventions in the treatment of obsessive-compulsive and related disorders: a systematic review. Psychosom. Med. 83 (8), 817–833.

Bruyère O, Honvo G, Veronese N, Arden NK, Branco J, Curtis EM, et al. An Updated Algorithm Recommendation for the Management of Knee Osteoarthritis from the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO). (1532-866X (Electronic)..

Chang WA-O, Chen SA-O, Lee CA-O, Lin HY, Lai PA-O. The Effects of Tai Chi Chuan on Improving Mind-Body Health for Knee Osteoarthritis Patients: A Systematic Review and Meta-Analysis. 1741-427X (Print))..

Chen, F., Su, W., Bedenbaugh, A.V., Oruc, A., 1941. Health Care Resource Utilization and Burden of Disease in a U.S. Medicare Population with a Principal Diagnosis of Osteoarthritis of the Knee. -837X (Electronic)).

Chen, H., Wang, Y., Liu, C., Lu, H., Liu, N., Yu, F., et al., 2020. Benefits of a transtheoretical model-based program on exercise adherence in older adults with knee osteoarthritis: a cluster randomized controlled trial. J. Adv. Nurs. 76 (7), 1765–1779.

Cheung C, Park J Fau - Wyman JF, Wyman JF. Effects of Yoga on Symptoms, Physical Function, and Psychosocial Outcomes in Adults with Osteoarthritis: A Focused Review. (1537-7385 Electronic))..

Clark JM, Sanders S, Carter M, Honeyman D, Cleo G, Auld Y, et al. Improving the Translation of Search Strategies Using the Polyglot Search Translator: a Randomized Controlled Trial. (1558-9439 Electronic))..

Clark J, Glasziou P, Del Mar C, Bannach-Brown A, Stehlik P, Scott AM. A Full Systematic Review Was Completed in 2 Weeks Using Automation Tools: a Case Study. (878-5921 (Electronic))..

Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The Global Burden of Hip and Knee Osteoarthritis: Estimates from the Global Burden of Disease 2010 Study. (1468-2060 Electronic))..

Cumpston M, Li T Fau - Page MJ, Page Mj Fau - Chandler J, Chandler J Fau - Welch VA, Welch Va Fau - Higgins JP, Higgins Jp Fau - Thomas J, et al. Updated Guidance for Trusted Systematic Reviews: a New Edition of the Cochrane Handbook for Systematic Reviews of Interventions (1469-493X (Electronic))..

Deepeshwar, S., Tanwar, M., Kavuri, V., Budhi, R.B., 2018. Effect of yoga based lifestyle intervention on patients with knee osteoarthritis: a randomized controlled trial. Front. Psychiatr. 9, 180.

DeRogatis M, Anis HK, Sodhi N, Ehiorobo JO, Chughtai M, Bhave A, et al. Non-operative Treatment Options for Knee Osteoarthritis. (2305-5839 Print))..

Dunlop, D.D., Song, J., Semanik, P.A., Sharma, L., Chang, R.W., 2011. Physical activity levels and functional performance in the osteoarthritis initiative: a graded relationship. Arthritis Rheum. 63 (1), 127–136.

Escalante Y, García-Hermoso A Fau - Saavedra JM, Saavedra JM. Effects of Exercise on Functional Aerobic Capacity in Lower Limb Osteoarthritis: a Systematic Review. 1878-1861 (Electronic))..

Farr, J.N., Going, S.B., McKnight, P.E., Kasle, S., Cussler, E.C., Cornett, M., 2010. Progressive resistance training improves overall physical activity levels in patients with early osteoarthritis of the knee: a randomized controlled trial. Phys. Ther. 90 (3), 356–366.

Fernandes, L., Hagen, K.B., Bijlsma, J.W., Andreassen, O., Christensen, P., Conaghan, P. G., et al., 2013. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Ann. Rheum. Dis. 72 (7), 1125–1135.

Focht, B.C., Garver, M.J., Devor, S.T., Dials, J., Lucas, A.R., Emery, C.F., et al., 2014. Group-mediated physical activity promotion and mobility in sedentary patients with knee osteoarthritis: results from the IMPACT-pilot trial. J. Rheumatol. 41 (10), 2068–2077.

Fransen, M., McConnell, S., Harmer, A.R., Van der Esch, M., Simic, M., Bennell, K.L., 2015. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br. J. Sports Med. 49 (24), 1554–1557.

Gay, C., Chabaud, A., Guilley, E., Coudeyre, E., 2016. Educating patients about the benefits of physical activity and exercise for their hip and knee osteoarthritis. Systematic literature review. Annals of Physical and Rehabilitation Medicine 59 (3), 174–183.

Guyatt, G.H., Oxman, A.D., Vist, G.E., Kunz, R., Falck-Ytter, Y., Alonso-Coello, P., et al., 2008. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. Bmj 336 (7650), 924–926.

Haaz S, Bartlett SJ. Yoga for Arthritis: a Scoping Review. (1558-3163 (Electronic)..

Hawker GA, Stewart L Fau - French MR, French Mr Fau - Cibere J, Cibere J Fau - Jordan JM, Jordan Jm Fau - March L, March L Fau - Suarez-Almazor M, et al. Understanding the Pain Experience in Hip and Knee Osteoarthritis–an OARSI/OMERACT Initiative. (1063-4584 (Print)..

Husted RS, Troelsen A, Husted H, Grønfeldt BM, Thorborg K, Kallemose T, et al. Knee-extensor Strength, Symptoms, and Need for Surgery after Two, Four, or Six Exercise Sessions/week Using a Home-Based One-Exercise Program: a Randomized Dose-Response Trial of Knee-Extensor Resistance Exercise in Patients Eligible for Knee Replacement (The QUADX-1 Trial). (1522-9653 Electronic))..

Janssen MA-O, Heerkens Y, Kuijer W, van der Heijden B, Engels J. Effects of Mindfulness-Based Stress Reduction on Employees' Mental Health: A Systematic Review. (1932-6203 Electronic))..

Jenkinson, C.M., Doherty, M., Avery, A.J., Read, A., Taylor, M.A., Sach, T.H., et al., 2009. Effects of dietary intervention and quadriceps strengthening exercises on pain and function in overweight people with knee pain: randomised controlled trial. Bmj 339, b3170.

Juhl, C., Christensen, R., Roos, E.M., Zhang, W., Lund, H., 2014. Impact of exercise type and dose on pain and disability in knee osteoarthritis: a systematic review and meta-regression analysis of randomized controlled trials. Arthritis Rheumatol. 66 (3), 622–636.

Keefe Fj Fau - Caldwell DS, Caldwell Ds Fau - Queen KT, Queen Kt Fau - Gil KM, Gil Km Fau - Martinez S, Martinez S Fau - Crisson JE, Crisson Je Fau - Ogden W, et al. Pain Coping Strategies in Osteoarthritis Patients. (022-006X (Print))..

Keefe, F.J., Caldwell, D.S., Williams, D.A., Gil, K.M., Mitchell, D., Robertson, C., et al., 1990. Pain coping skills training in the management of osteoarthritic knee pain: a comparative study. Behav. Ther. 21 (1), 49–62.

Keefe, F.J., Blumenthal, J., Baucom, D., Affleck, G., Waugh, R., Caldwell, D.S., et al., 2004. Effects of spouse-assisted coping skills training and exercise training in patients with osteoarthritic knee pain: a randomized controlled study. Pain 110 (3), 539–549.

Kolasinski, S.L., Neogi, T., Hochberg, M.C., Oatis, C., Guyatt, G., Block, J., et al., 2019. American college of rheumatology/arthritis foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis Care Res. 72 (2), 149–162, 2020.

Kraus VB, Sprow K, Powell KE, Buchner D, Bloodgood B, Piercy K, et al. Effects of Physical Activity in Knee and Hip Osteoarthritis: A Systematic Umbrella Review. (530-0315 (Electronic))..

Kuru Çolak T, Kavlak B, Aydoğdu O, Şahin E, Acar G, Demirbüken İ, et al. The Effects of Therapeutic Exercises on Pain, Muscle Strength, Functional Capacity, Balance and Hemodynamic Parameters in Knee Osteoarthritis Patients: a Randomized Controlled Study of Supervised versus Home Exercises. 1437-160X (Electronic))..

Landis JrFau - Koch GG, Koch GG. The Measurement of Observer Agreement for Categorical Data. (f006-341X (Print))..

Lasikiewicz, N., Myrissa, K., Hoyland, A., Lawton, C.L., 2014. Psychological benefits of weight loss following behavioural and/or dietary weight loss interventions. A systematic research review. Appetite 72, 123–137.

Lee, A.C., Harvey, W.F., Price, L.L., Morgan, L.P.K., Morgan, N.L., Wang, C., 2017. Mindfulness is associated with psychological health and moderates pain in knee osteoarthritis. Osteoarthritis Cartilage 25 (6), 824–831.

Li, Y., Su, Y., Chen, S., Zhang, Y., Zhang, Z., Liu, C., et al., 2016. The effects of resistance exercise in patients with knee osteoarthritis: a systematic review and meta-analysis. Clin. Rehabil. 30 (10), 947–959.

Loeser, R.F., Beavers, D.P., Bay-Jensen, A.C., Karsdal, M.A., Nicklas, B.J., Guermazi, A., et al., 2017. Effects of dietary weight loss with and without exercise on interstitial matrix turnover and tissue inflammation biomarkers in adults with knee osteoarthritis: the Intensive Diet and Exercise for Arthritis trial (IDEA). Osteoarthritis Cartilage 25 (11), 1822–1828.

Mahendira L, Jones C, Papachristos A, Waddell J, Rubin LA-O. Comparative Clinical and Cost Analysis between Surgical and Non-surgical Intervention for Knee Osteoarthritis. (1432-5195 Electronic))..

Maly MR, Costigan Pa Fau - Olney SJ, Olney SJ. Determinants of Self Efficacy for Physical Tasks in People with Knee Osteoarthritis. (0004-3591 (Print))..

Mazzei, D.R., Ademola, A., Abbott, J.H., Sajobi, T., Hildebrand, K., Marshall, D.A., 2021. Are education, exercise and diet interventions a cost-effective treatment to manage hip and knee osteoarthritis? A systematic review. Osteoarthritis Cartilage 29 (4), 456–470.

Messier, S.P., Loeser, R.F., Miller, G.D., Morgan, T.M., Rejeski, W.J., Sevick, M.A., et al., 2004. Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis: the Arthritis, Diet, and Activity Promotion Trial. Arthritis Rheum. 50 (5), 1501–1510.

Mihalko, S.L., Cox, P., Beavers, D.P., Miller, G.D., Nicklas, B.J., Lyles, M., et al., 2019. Effect of intensive diet and exercise on self-efficacy in overweight and obese adults with knee osteoarthritis: the IDEA randomized clinical trial. Transl Behav Med 9 (2), 227–235.
Moseley, A.M., Herbert, R.D., Sherrington, C., Maher, C.G., 2002. Evidence for physiotherapy practice: a survey of the physiotherapy evidence database (PEDro). Aust. J. Physiother. 48 (1), 43–49.
Moss P, Benson HAE, Will R, Wright A. Patients with Knee Osteoarthritis Who Score Highly on the PainDETECT Questionnaire Present with Multimodality Hyperalgesia, Increased Pain, and Impaired Physical Function. (1536-5409 Electronic))..
Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372, n71.
RACGP, 2018. Guideline for the Management of Knee and Hip Osteoarthritis [Available from: https://www.racgp.org.au/clinical-resources/clinical-guidelines/key-racgp-guidelines/view-all-racgp-guidelines/knee-and-hip-osteoarthritis.
Rejeski, W.J., Focht, B.C., Messier, S.P., Morgan, T., Pahor, M., Penninx, B., 2002. Obese, older adults with knee osteoarthritis: weight loss, exercise, and quality of life. Health Psychol. 21 (5), 419–426.
Robson Ek Fau - Hodder RK, Hodder Rk Fau - Kamper SJ, Kamper Sj Fau - O'Brien KM, O'Brien Km Fau - Williams A, Williams A Fau - Lee H, Lee H Fau - Wolfenden L, et al. Effectiveness of Weight-Loss Interventions for Reducing Pain and Disability in People with Common Musculoskeletal Disorders: A Systematic Review with Meta-Analysis. (1938-1344 (Electronic))..
Roddy, E., Zhang, W., Doherty, M., 2005. Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. Ann. Rheum. Dis. 64 (4), 544–548.
Sariyildiz MA, Batmaz I, Bozkurt M, Bez Y, Cetincakmak MG, Yazmalar L, et al. Sleep Quality in Rheumatoid Arthritis: Relationship between the Disease Severity, Depression, Functional Status and the Quality of Life. (1918-3003 (Print))..
Schünemann, H.J., Higgins, J.P., Vist, G.E., Glasziou, P., Akl, E.A., Skoetz, N., et al., 2019. Completing 'Summary of Findings' Tables and Grading the Certainty of the Evidence. Cochrane Handbook for Systematic Reviews of Interventions, pp. 375–402.
Sheehan RB, Herring MP, Campbell MJ. Associations between Motivation and Mental Health in Sport: A Test of the Hierarchical Model of Intrinsic and Extrinsic Motivation. (1664-1078 (Print))..
Smink AJ, van den Ende Ch Fau - Vliet Vlieland TPM, Vliet Vlieland Tp Fau - Swierstra BA, Swierstra Ba Fau - Kortland JH, Kortland Jh Fau - Bijlsma JWJ, Bijlsma Jw Fau - Voorn TB, et al. "Beating osteoARThritis": Development of a Stepped Care Strategy to Optimize Utilization and Timing of Non-surgical Treatment Modalities for Patients with Hip or Knee Osteoarthritis. 1434-9949 (Electronic))..
Stewart KJ. Physical Activity and Aging. 0077-8923 (Print))..
Tanaka, R., Ozawa, J., Kito, N., Moriyama, H., 2013. Efficacy of strengthening or aerobic exercise on pain relief in people with knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. Clin. Rehabil. 27 (12), 1059–1071.
Veenhof, C., Köke, A.J., Dekker, J., Oostendorp, R.A., Bijlsma, J.W., van Tulder, M.W., et al., 2006. Effectiveness of behavioral graded activity in patients with osteoarthritis of the hip and/or knee: a randomized clinical trial. Arthritis Rheum. 55 (6), 925–934.
Vitaloni MA-O, Botto-van Bemden A, Sciortino Contreras RM, Scotton D, Bibas M, Quintero M, et al. Global Management of Patients with Knee Osteoarthritis Begins with Quality of Life Assessment: a Systematic Review. (1471-2474 Electronic))..
Wang, C., Schmid, C.H., Hibberd, P.L., Kalish, R., Roubenoff, R., Rones, R., et al., 2009. Tai Chi is effective in treating knee osteoarthritis: a randomized controlled trial. Arthritis Rheum. 61 (11), 1545–1553.
Wang, C., Schmid, C.H., Iversen, M.D., Harvey, W.F., Fielding, R.A., Driban, J.B., et al., 2016. Comparative effectiveness of tai chi versus physical therapy for knee osteoarthritis: a randomized trial. Ann. Intern. Med. 165 (2), 77–86.
Wang, L., Chen, H., Lu, H., Wang, Y., Liu, C., Dong, X., et al., 2020. The effect of transtheoretical model-lead intervention for knee osteoarthritis in older adults: a cluster randomized trial. Arthritis Res. Ther. 22 (1), 134.
Woolf AD, Pfleger B. Burden of Major Musculoskeletal Conditions. (0042-9686 (Print)..
Ye, J., Cai, S., Zhong, W., Cai, S., Zheng, Q., 2014. Effects of tai chi for patients with knee osteoarthritis: a systematic review. J. Phys. Ther. Sci. 26 (7), 1133–1137.