Osteoarthritis and Cartilage 27 (2019) 378–391

Osteoarthritis and Cartilage

Review

Osteoarthritis year in review 2018: rehabilitation and outcomes

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ARTICLE INFO

Article history:
Received 14 August 2018
Accepted 29 November 2018

Keywords:
Rehabilitation
Exercise
Patient-reported outcomes

SUMMARY

Objective: Conduct a systematic review of systematic reviews and randomised controlled trials (RCTs) from the past year evaluating rehabilitation for people with osteoarthritis, and provide narrative synthesis of findings focused on core recommended treatments for osteoarthritis (exercise, education, biomechanical interventions, weight loss).

Design: A comprehensive search strategy was used to search PubMed, EMBASE and Cochrane databases (16th May 2017 to 22nd March 2018). Search terms included 'osteoarthritis', 'rehabilitation', 'systematic review', and 'randomised controlled trial'. Inclusion criteria were: (1) RCT, or systematic review of randomised clinical trials (RCTs); (2) human participants with osteoarthritis (any joint); (3) evaluation of rehabilitation intervention; and (4) at least one patient-reported measure. Methodological quality was evaluated using the Assessment of Multiple Systematic Reviews (AMSTAR) tool (systematic reviews) and PEDro rating scale (RCTs). Narrative synthesis mapped findings to core recommendations from existing osteoarthritis clinical guidelines.

Results: From 1994 records, 13 systematic reviews and 36 RCTs were included. 73% of these evaluated knee osteoarthritis (36 studies). The remaining studies evaluated hand osteoarthritis (6 studies), hip, hip/knee and general osteoarthritis (each 2 studies), and neck osteoarthritis (1 study). Exercise was the most common intervention evaluated (31%). Updated recommendations for exercise prescription and preliminary guidance for psychological interventions are provided.

Conclusion: Level 1 and 2 osteoarthritis rehabilitation literature continues to be dominated by knee osteoarthritis studies. Consistent with current clinical guidelines, exercise should be a core treatment for osteoarthritis, but future studies should ensure that exercise programs follow published dose guidelines. There is a clear need for research on rehabilitation for hip, hand, foot/ankle, shoulder and spine osteoarthritis.

Introduction

Osteoarthritis (OA) is a serious disease with a substantial global impact[1]. The prevalence and burden of OA is increasing, placing an unsustainable burden on health resources. It is widely recommended that rehabilitation should be the first line of treatment for people with OA[2,3]. This paper presents an update of the latest evidence for rehabilitation in people with OA.

The aim of this systematic review was to synthesise new findings from the past year from systematic reviews and randomised clinical trials (RCTs) that evaluated rehabilitation for people with OA. Consistent with the 2017 year in review[4], we have defined rehabilitation as any non-pharmacological, non-surgical intervention aimed at improving symptoms, function and/or quality of life in people with OA. This includes, but is not limited to, exercise, education, manual therapy, acupuncture, bracing and taping, orthoses, balneotherapies, electrotherapies, and other complementary therapies.

Methods

This systematic review was conducted and reported in consultation with the PRISMA Statement[5]. To facilitate consistency, we replicated the methodology used by Schiphof *et al.*[4] for the 2017 year in review. A systematic search was performed of three

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https://doi.org/10.1016/j.joca.2018.11.010
1063-4584/

databases (MEDLINE, EMBASE, Cochrane Database) on March 22nd 2018, by a single reviewer (HFH). The search strategy for each database is presented in Supplementary file 1, and included search terms such as 'osteoarthritis', 'randomised controlled trial' and 'systematic review'. To avoid overlap with the previous year in review, papers were considered for inclusion if they were published on or after May 16th 2017, or were published in 2017 and not included in Schiphof *et al.*[4]. Papers were included if they: (1) were a RCT, or a systematic review (RCTs or randomised cross-over studies); (2) evaluated human participants with a clinical or radiological diagnosis of OA in any joint; (3) evaluated any non-pharmacological, non-surgical intervention; and (4) evaluated outcome using at least one patient-reported outcome measure (e.g., pain, function, quality of life). We excluded systematic reviews that included non-RCTs, studies that used another study design or were not full-text versions (e.g., quasi-randomised trial, cohort study, immediate effects study, protocol paper, abstract, conference proceedings), studies that evaluated rehabilitation in conjunction with or following a pharmacological or surgical intervention (e.g., total joint replacement), and articles that were published in a language other than English.

Each title and abstract identified by the search strategy was screened for eligibility independently by two reviewers (HFH, KAGM). The third reviewer mediated consensus discussions to address any discrepancies (NJC). Full-text versions were then assessed for eligibility against selection criteria by one reviewer (NJC), with consensus on inclusion reached by all reviewers (NJC, HFH, KAGM).

Methodological quality of included studies was rated by two reviewers (NJC, KAGM). Systematic reviews were evaluated using the Assessment of Multiple Systematic Reviews (AMSTAR) tool[6], while RCTs were evaluated using the PEDro scale. Where available, we used verified PEDro scores published on the PEDro database. For the remaining PEDro scores and the AMSTAR ratings, consensus was reached by discussion, with a third reviewer (HFH) available to resolve discrepancies as required. Studies were considered to be high quality if the AMSTAR or PEDro score was $\geq$7, moderate quality if 4–6, and low quality if $\leq$3[7].

Data for each included paper were extracted and entered in tables by one reviewer (NJC), and checked by a second reviewer (KAGM), to provide a comprehensive overview of all literature. Extracted outcome data were limited to patient-reported outcome measures (PROMs). PROMs reflect the patient's perspective of their condition, which we consider to be the most important outcome of rehabilitation. For systematic reviews that pooled data from two or more studies, we extracted pooled standardised mean differences (SMD) or mean differences (MD). SMDs were interpreted as small effects if $\geq$0.2, moderate if $\geq$0.5, and large if $\geq$0.8[8].

We used narrative synthesis to present findings of included studies, split by affected joint. To facilitate progression of knowledge in this area, and build on outcomes of the preceding year in review by Schiphof and colleagues[4], we elected to map new study findings to existing clinical guidelines. For all joints, we referred to the National Institute for Health and Care Excellence (NICE) guideline for OA care and management (2014)[2]. For knee OA, we also consulted the OARSI guideline for non-surgical management of knee OA (2014)[9], American College of Rheumatology (ACR) recommendations for OA of the hand, hip and knee (2012)[10], European League Against Rheumatism (EULAR) recommendations for hip and knee OA (2013)[11], and the Ottawa Panel guideline for therapeutic exercise in knee OA (2017)[12–14]. For hip OA, we used the OARSI recommendations for hip and knee OA (2008)[3], EULAR recommendations for hip and knee OA[11], ACR recommendations for OA of the hand, hip and knee[10], and the Ottawa Panel guideline for therapeutic exercise in hip OA (2016)[15]. For hand OA, we used the ACR recommendations for OA of the hand, hip and knee[10], and the Ottawa Panel guideline for therapeutic exercise in hand OA (2018)[16]. Table I presents a summary of recommendations from these clinical guidelines. We chose to focus narrative synthesis and discussion on interventions considered to be the core management strategies for all people with OA – exercise, education, self-management, weight loss, and biomechanical interventions (e.g., footwear) – rather than interventions recommended as adjuncts (e.g., bracing, manual therapy, electrotherapy)[2]. We also included discussion on new or emerging treatments for OA, such as psychological interventions. In discussing findings of systematic reviews, we limited this to meta-analyses, given that single study outcomes were likely to have been captured in previous year in review papers.

Results

The search strategy yielded 1994 articles after removal of duplicates (Fig. 1). Of these, 112 full-text versions were screened for eligibility, with 13 systematic reviews and 36 RCTs included. Table II provides a summary of the types of interventions evaluated by the included studies, split by joint evaluated. Of the 13 systematic reviews included, seven evaluated knee OA[17–23], 3 hand OA[24–26], 2 any joint[27,28], and 1 hip OA[29]. Of the 36 included RCTs, 29 evaluated knee OA[30–58], 3 hand OA[59–61], 2 hip or knee OA[62,63], 1 hip OA[64] and 1 neck OA[65]. The search strategy did not identify any systematic reviews or RCTs that evaluated OA of the foot or ankle, shoulder or lower back.

Tables III and IV present a summary of findings for all included systematic reviews and RCTs, respectively, as well as total AMSTAR or PEDro scores. Individual item scores for quality ratings for included systematic reviews (AMSTAR) and RCTs (PEDro) are presented in Supplementary Files 2 and 3, respectively. Overall, systematic reviews were primarily of moderate quality (8/13, 62%), while RCTs were predominantly rated as moderate quality (20/36, 56%). The remainder of the results provides a narrative synthesis of papers that evaluated core OA treatments, and new and emerging treatments.

Rehabilitation for OA

NICE guidelines recommend education, advice, information access, exercise and weight loss (where appropriate) as core treatments for all people with OA[2].

Our search strategy identified one high quality systematic review that evaluated the effects of psychological interventions on pain, function and psychological health in people with OA in any joint[28]. They included 12 RCTs (n = 1307), which compared psychological interventions (e.g., cognitive behavioural therapy, coping skills training, hypnosis/relaxation) to control or placebo. Immediately following intervention, there were small to moderate effects favouring psychological intervention for outcomes of pain (SMD 0.28, 95% CI 0.08 to 0.48) and self-efficacy (SMD 0.58, 95% CI 0.4 to 0.75), while significant effects on fatigue were of trivial magnitude (SMD 0.18, 95% CI 0.01 to 0.34). Although small significant effects were also identified for self-efficacy at 6 months (SMD 0.35, 95% CI 0.1 to 0.6) and 12 months (SMD 0.36, 95% CI 0.1 to 0.63), outcomes on other PROMs were not significant at follow-up conducted after treatment had ceased (three to 18 months). Although effect sizes increased over time on measures of self-reported function (post-intervention, SMD 0.05, 95% CI -0.11 to 0.20; 6 months, SMD 0.14, 95% CI -0.08 to 0.37; 12 months, SMD 0.24, 95% CI -0.02 to 0.5), these did not reach statistical significance. On the basis that effects largely do not persist beyond the intervention period, psychological

Table I
Summary of rehabilitation recommendations from current clinical guidelines

Guideline	Joint	Recommended core treatments	Recommended adjunct treatments (as indicated)	Uncertain or not recommended
NICE[2]	All	Education, advice, information access; strengthening exercise, aerobic fitness training; weight loss (if overweight/obese)	Supports & braces; footwear & insoles; assistive devices; manual therapy; TENS; heat/cold	
OARSI[9]	Knee	Exercise (land, aquatic); self-management and education; strength training; weight management, biomechanical interventions	Balneotherapy; walking stick	Uncertain: acupuncture; TENS; ultrasound Not recommended: neuromuscular electrical stimulation
ACR[10]	Knee	Aerobic, aquatic and/or resistance exercise; weight loss (if overweight)	Conditional recommendations: medial wedge insoles (if valgus knee OA); subtalar strapped lateral insoles (if varus knee OA); medially directed patellar taping; manual therapy; walking aids; thermal agents; tai chi; self-management programs; psychosocial interventions	Balance exercises (alone or with strengthening exercises); laterally wedged insoles; manual therapy alone; knee braces; laterally directed patellar taping
Ottawa Panel[12–14]	Knee	Mind-body exercise: Hatha yoga, Tai Chi Qigong, sun style Tai Chi. Strengthening exercise: in isolation and combined with other types of exercise (e.g., coordination, balance, functional). Aerobic exercise: in isolation and combined with strengthening exercise.		
EULAR[11]	Hip/knee	Core elements: education, pacing of activity, exercise, weight loss (if overweight or obese), mechanical factors (e.g., footwear), walking aids and assistive technology. Biopsychosocial approach; individualised treatment; vocational rehabilitation.		
OARSI[3]	Hip	Information access and education; exercise (aerobic, strengthening, range of motion); weight loss (if overweight); footwear advice	Walking aids; shoe insoles; thermal modalities; TENS; acupuncture	
ACR[10]	Hip	Aerobic, aquatic and/or resistance exercise; weight loss (if overweight)	Conditional recommendations: self-management programs; manual therapy (with supervised exercise); psychosocial interventions; thermal agents; walking aids	Balance exercises (alone or with strengthening exercises); manual therapy alone; tai chi
Ottawa Panel[15]	Hip	Land-based therapeutic exercise (especially strengthening)		
ACR[10]	Hand		Conditional recommendations: instruction in joint protection techniques, assistive devices, thermal modalities, splint (trapeziometacarpal OA)	
Ottawa Panel[16]	Hand	Therapeutic exercise (no specific type; with or without other interventions)		

NICE, National Institute for Health and Care Excellence; OARSI, Osteoarthritis Research Society International; ACR, American College of Rheumatology; EULAR, European League Against Rheumatism; TENS, transcutaneous electrical nerve stimulation; OA, osteoarthritis.
Pharmacological and surgical recommendations have been omitted.

interventions for OA can only be recommended as a short-term adjunct to core treatments.

Evidence update for rehabilitation of OA

Psychological interventions may be recommended as adjuncts to core treatments to improve pain and self-efficacy in the short-term in people with OA, with the understanding that effects may not persist after treatment cessation.

Rehabilitation for knee OA

Specific recommendations for core treatments for knee OA are exercise (resistance, aerobic, aquatic, mind-body), education, self-management, biomechanical interventions, and weight loss[9,10,12–14].

A high-quality RCT compared 1-year effectiveness of 8 weeks of neuromuscular exercise (NEMEX) and analgesic use (PHARMA), in 93 people with early knee OA[42]. This study is the long-term follow-up of a RCT included in the 2017 year in review[4,66]. No significant between-group differences were observed in pain, function, or knee- or health-related quality of life. Significantly greater improvements were observed in the NEMEX group on the symptoms subscale of the Knee injury and Osteoarthritis Outcome Score (KOOS) (MD -7.6, 95% CI -12.7 to −2.6). Although the mean between-group difference was not considered to be clinically meaningful, the authors reported that 47% of the NEMEX group had a clinically relevant improvement in KOOS-symptoms at 12 months (>10 points), compared to 28% of the PHARMA group (number needed to treat 5.3, *P* 0.065). This suggests that NEMEX may be more effective for longer-term management of swelling, stiffness and mechanical symptoms, as measured by the KOOS symptoms subscale. However, it's important to note that adherence during the 8-week intervention was 49% in the NEMEX group, and 7% in the

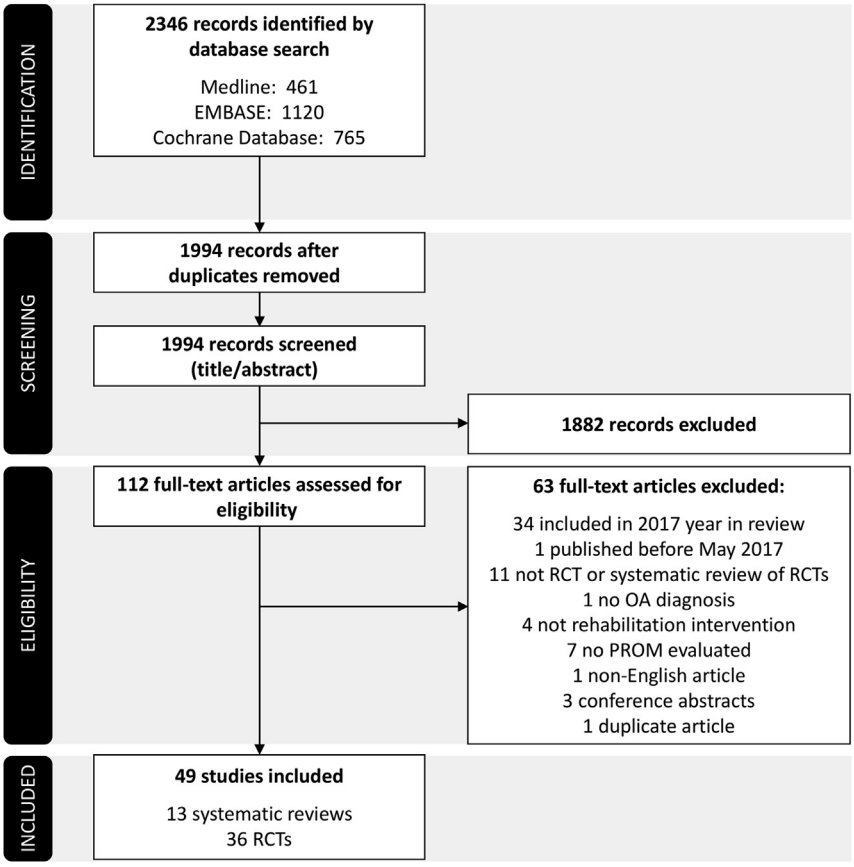

Fig. 1. Flow chart of included papers.

PHARMA group, limiting conclusions made at 8 weeks and 12 months. Findings of this study highlight the importance of adherence strategies for knee OA therapeutic exercise programs, as well as strategies to encourage maintenance of exercise after program completion.

We identified two RCTs that evaluated telephone-based interventions for people with knee OA. O'Brien *et al.*[54] conducted a high-quality RCT evaluating a telephone-based weight loss support program for adults with knee OA. They randomised 120 people to either: (1) an existing non-disease specific weight management and healthy lifestyle service, where participants received up to 10 individually tailored coaching calls over 6 months; or (2) usual care (remain on waitlist for orthopaedic consult). Although the intervention group reported significantly greater health-related quality of life (SF-36 mental component scores) than the control group at 6 months (MD -5.7, 95% CI -9.9 to −1.5), there were no significant differences on other measures of pain, stiffness, function, global change, or pain attitudes and beliefs. Further, self-reported weight loss did not differ between groups at 6 months. Considering associated costs, it is difficult to recommend this intervention for people

Table II
Types of rehabilitation evaluated in included systematic reviews and randomised controlled trials (RCTs)

	Knee	Hand	Hip	Hip/knee	Any joint	Neck
Systematic reviews:						
Exercise		1[26]	1[29]			
Psychological interventions					1[28]	
Combined interventions	2[17,18]	2[24,25]				
Taping, bracing and orthoses	1[21]					
Manual therapy	2[20,23]				1[27]	
Electrophysical agents	2[19,22]					
RCTs:						
Exercise	11[32,36,38,41–43,49–51,56,58]	1[61]	1[64]			
Psychological interventions	2[39,40]			1[62]		
Telerehabilitation, telephone coaching	2[34,54]					
Combined interventions	2[46,52]					
Taping, bracing and orthoses	3[33,55,57]	2[59,60]				
Manual therapy	3[45,47,53]					1[65]
Acupuncture	1[44]					
Electrophysical agents	5[30,31,35,37,48]					
Balneotherapy				1[63]		
TOTAL:	**36**	**6**	**2**	**2**	**2**	**1**

Table III
Characteristics of 13 included systematic reviews

First author	Joint	Aim	PROMs	Summary of findings from meta-analysis*	AMSTAR rating
Exercise:					
Moseng[29]	Hip	Compare land-based, supervised exercise programs with high compliance vs low or uncertain compliance with ACMS recommendations on pain and physical function	Pain (WOMAC pain, NRS, VAS, HOOS pain, IRGL pain); physical function (WOMAC function, HOOS ADL, SF-36 physical function, IRGL mobility, GARS)	Pain: significant effect favouring high compliance exercises over control (SMD 0.42); no effect for uncertain compliance exercises (SMD -0.04) Function: significant effect favouring high compliance exercises over control (SMD 0.41); non-significant effect for uncertain compliance exercises (SMD 0.23)	8
Magni[26]	Hand	Establish whether resistance training increases grip strength, decreases joint pain and improves hand function	Joint pain (AUSCAN pain, NRS/Likert); hand function (AUSCAN function, FIHOA)	Joint pain: significant effect favouring resistance training (SMD 0.23) Hand function: no significant effect (SMD 0.1)	6
Psychological interventions:					
Zhang[28]	Any	Determine the effects of psychological interventions on physiological and psychological health in OA	Pain (VAS, WOMAC, AIMS, AIMS2, GCPS); function (WOMAC, AIMS, AIMS2); psychological disability (AIMS, AIMS2); self-efficacy (ASES); coping strategies (CSQ); anxiety (SAS, BAI, HAMA, PASS); depression (SDS, GDS, BDI, HAMD); quality of life (SF-36); fatigue (FFS, BFI); sleep (WASO)	Pain: significant effect favouring psychological intervention over control immediately post-intervention (SMD 0.28); no difference 3–18 months (SMD 0.13–0.57). Function: no significant effect post-intervention (SMD 0.05), 6 months (0.14) or 12 months (SMD 0.24). Psychological outcomes: significant effect favouring psychological intervention over control for self-efficacy post-intervention (SMD 0.58), 6 months (SMD 0.35) and 12 months (SMD 0.36). Significant effect favouring psychological intervention over control for fatigue (SMD 0.18) and pain coping (MD 1.64 [scale not reported] & 22.2 [scale not reported]) immediately post-intervention. No significant effects post-intervention for anxiety (SMD 0.2) or depression (SMD 0.42). No significant effects for psychological disability post-intervention (SMD 0.27), 6 months (SMD 0.1) or 12 months (SMD 0.15).	7
Combined interventions:					
Alrushud[17]	Knee	Evaluate the effectiveness of combined physical activity and dietary restriction interventions on musculoskeletal function of overweight and obese older adults with knee OA	Pain (WOMAC pain); function (WOMAC function); quality of life (unspecified measure of health-related quality of life)	MD/SMD not calculated; no conclusions made regarding pain, function and quality of life outcomes	8
Briani[18]	Knee	Examine the effect of treatment strategies on quality of life or psychosocial factors	QoL (AQol, SF-36, PQoL, KOOS-QoL, WHOQoL-Bref, QLS); self-efficacy (ASES); coping strategies (CSQ); helplessness (AHI); depression (PHQ-9); psychological distress (K-10); self-management (CSM scale)	Health-related QoL: significant effect favouring exercise over control (SMD 0.7). No difference between physical activity with self-management booklet, and self-management booklet alone (SMD 0). Self-management programs (meetings) are not different to control (self-management booklet or no treatment) (SMD 0.07). Knee-related QoL: significant effect favouring exercise over control (SMD 0.43). Only single studies identified for other constructs.	6
Ahern[24]	Hand	Evaluate the effectiveness of multimodal and unimodal physical therapies for base of thumb OA	Pain (VAS); function (DASH, AUSCAN)	Pain: significant effect favouring multimodal therapy over placebo (MD 2.9 [0–10]) and unimodal over control (MD 3.1 [0–10]). Function: significant effect favouring unimodal over control (MD 6.8 [0–100]).	4
Lue[25]	Hand	Evaluate pharmacological and non-pharmacological therapies in hand OA (update)	Pain (VAS, AUSCAN); function (AUSCAN, Dreiser Functional Index, DASH, FIHOA); global assessment; health-related QoL (HAQ-DI, SF-36); OARSI Omeract responder criteria	Meta-analyses not performed; only provided outcomes for single studies (no data).	4
Taping, bracing and orthoses:					
Ouyang[21]	Knee	(i) Determine whether therapeutic taping is superior to control taping for pain, knee health, function, muscle strength and quality of life; (ii) perform subgroup analyses for non-elastic and elastic taping	Pain (VAS, WOMAC pain, KOOS); general knee health (Lysholm Knee Score, WOMAC, Lequesne Index); quality of life (SF-36, Nottingham Health Profile)	Pain: significant effect favouring taping over control (SMD 1.14); significant effect favouring Leukotape over control (SMD 0.89); no effect for Kinesiotape over control (MD 12.1 [0–100]). General knee health: no effect of taping over control (SMD 0.13).Quality of life: no effect of taping over control (SMD -0.03).	6

Manual therapy:					
Li[20]	Knee	Update and critically evaluate the evidence from RCTs testing the efficacy and safety of cupping therapy for knee OA	Pain (VAS, WOMAC); stiffness (WOMAC); function (WOMAC function); pain/function (Lequesne Index); clinical efficacy measurement (GPCRND-response rate)	Pain: conflicting findings for addition of dry cupping therapy to Western medicine compared to Western medicine alone; significant effects for WOMAC pain (MD 1.01 [0−20]) but not pain VAS (MD 0.32 [0−10]). Stiffness: significant effect favouring dry cupping therapy with Western medicine compared to Western medicine alone (MD 0.81 [0−8]). Function: significant effect favouring dry cupping therapy with Western medicine compared to Western medicine alone (MD 5.53 [0−68]). Pain/function: significant effect favouring cupping therapy with Western medicine compared to Western medicine alone (MD 2.74 [0−24]). Clinical efficacy measurement: significant effect favouring wet cupping therapy with Western medicine compared to Western medicine alone (MD 1.06 [scale not reported]).	8
Xu[23]	Knee	Critically evaluate the effectiveness and adverse events of manual therapy for knee OA	Pain (WOMAC); stiffness (WOMAC); function (WOMAC)	Pain: significant effect favouring manual therapy over control (SMD 0.61). Stiffness: significant effect favouring manual therapy over control (SMD 0.58). Function: significant effect favouring manual therapy over control (SMD 0.49).	6
Nelson[27]	Any[†]	Critically appraise and synthesise the current evidence regarding the effects of massage therapy as a stand-alone treatment on pain and functional outcomes in people with OA or RA	Pain (pain VAS, WOMAC); stiffness (WOMAC); function (WOMAC)	Meta-analyses not performed; only provided outcomes for single studies (no data).	4
Electrophysical agents:					
Chen[19]	Knee	Critically evaluate the efficacy and safety of electroacupuncture in the management of knee OA	Pain (VAS, WOMAC); function (WOMAC, Lysholm Knee Score)	Pain: significant effect favouring electroacupuncture over other treatment (SMD 1.11). Function: significant effect favouring electroacupuncture over other treatment (WOMAC MD 9.81 [0−68]) and pharmacological treatment (Lysholm MD 5.08 [100-0])	3
Rayegani[22]	Knee	Determine the safety and efficacy or low-level laser therapy for knee OA	Pain (VAS, WOMAC); stiffness (WOMAC); function (WOMAC)	Pain (VAS): significant effect favouring low-level laser therapy over placebo at 1 month (SMD 0.45−0.56) and 2 months (SMD 0.95); no difference ≥3 months (SMD -0.07 −0.42) Pain (WOMAC): no difference between low-level laser therapy and placebo at 1, 2 or ≥3 months (SMD -0.08−0.49) Stiffness: significant effect favouring low-level laser therapy over placebo at 1 month (SMD 0.3); no difference ≥2 months (SMD -0.09−0.27) Function: significant effect favouring low-level laser therapy over placebo at 1 month (SMD 0.47); no difference ≥2 months (SMD 0.1−0.61)	4

ACSM, American College of Sports Medicine; ADL, activities of daily living; AHI, Arthritis Helplessness Index; AIMS, Arthritis Impact Measurement Scales; AQoL, Assessment of Quality of Life; ASES, Arthritis Self-efficacy Scale; AUSCAN, Australian Canadian Osteoarthritis Hand Index; BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; BFI, Brief Fatigue Inventory; CSM, Cognitive Symptom Management; CSQ, Coping Strategies Questionnaire; DASH, Disabilities of the Arm, Shoulder and Hand; FIHOA, Functional Index for Hand OsteoArthritis; FFS: Flinders Fatigue Scale; GARS, Groningen Activity Restriction Scale; GCPS, Graded Chronic Pain Scale; GDS, Geriatric Depression Scale; GPCRND, Guiding Principles of Clinical Research on New Drugs; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; HAQ-DI, Health Assessment Questionnaire Disability Index; HOOS, Hip disability and Osteoarthritis Outcome Score; IRGL, Impact of Rheumatic diseases on General health and Lifestyle; K-10,Kessler-10; KOOS, Knee injury and Osteoarthritis Outcome Score; MD, mean difference; NRS, numerical rating scale; OA, osteoarthritis; OARSI, Osteoarthritis Research Society International; PASS, Pain Anxiety Symptoms Scale; PHQ-9, Patient Health Questionnaire-9; PQoL, Perceived Quality of Life; PROM, patient reported outcome measure; QLS, Quality of Life Scale; QoL, quality of life; RA, rheumatoid arthritis; RCT, randomised controlled trial; SAS, Self-Rating Anxiety Scale; SDS, Self-rating Depression Scale; SF-36, Medical Outcomes Short-Form Health Survey; SMD, standardised mean difference; WASO, Wake After Sleep Onset; VAS, visual analogue scale; WHOQoL-Bref, World Health Organisation Quality of Life, abbreviated version; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

[*] Pooled data from two or more studies. Positive value for SMD/MD favours intervention; negative value favours comparator. Values in square brackets [] represent possible score range (first number is best health state).

[†] also included participants with rheumatoid arthritis (RA); only data relevant to OA is presented.

Table IV
Characteristics of 36 included RCTs

First author	Joint	Sample size	Intervention length	Intervention	Control	PROMs	Summary of findings	PEDro rating†
Exercise:								
Apparao[32]	Knee	104	8w	A. Stabilisation exercises (isometric, multiple angle isometric, co-contraction, active resisted, neuromuscular, proprioception, stretching)	B. Conventional exercises (strengthening, stretching)	Pain (KOOS, VAS) Symptoms (KOOS) Function (KOOS) KR-QoL (KOOS)	No difference A > B A > B A > B	5†
Braghin[36]	Knee	42	8w	A. Exercises	B. No treatment	Pain (WOMAC) Stiffness (WOMAC) Function (WOMAC)	NR NR NR	7†
Dias[38]	Knee	73	6w	A. Hydrotherapy + education	B. Education	Pain (WOMAC) Function (WOMAC)	A > B A > B	7†
Gomiero[41]	Knee	64	16w	A. Sensory-motor training (agility, coordination, balance)	B. Resistance training	Pain (VAS) Function (WOMAC) HR-QoL (SF-36)	A > B No difference A > B (MH); B > A (RP, RE, VT)	7†
Holsgaard-Larsen[42]	Knee	93	8w	A. Neuromuscular exercises	B. Analgesics and NSAIDs	Pain (KOOS) Symptoms (KOOS) Function (KOOS) KR-QoL (KOOS) HR-QoL (EQ-5D)	No difference A > B, 12m No difference No difference No difference	7†
Huang[43]	Knee	250	NR	A. Isometric quadriceps exercises	B. Local physiotherapy (not defined) + NSAIDs	Pain (VAS) Function (WOMAC)	A > B, 3m A > B, 3m	4†
Loew[49]	Knee	69	6m	A. Supervised community-based walking program	B. Unsupervised walking program	Pain (WOMAC) Stiffness (WOMAC) Function (WOMAC) HR-QoL (EQ-5D)	No difference A > B* No difference A > B*	6†
Lu[50]	Knee	46	24w	A. Tai Ji Quan	B. Education	HR-QoL (SF-36) Sleep quality (PSQI)	A > B (PCS) A > B	7†
Marconcin[51]	Knee	80	12w	A. Exercise + self-management	B. Education	Pain (KOOS) Symptoms (KOOS) Function (KOOS) KR- QoL (KOOS) HR-QoL (EQ-5D) Self-management (CSM, CWP)	No difference No difference No difference No difference No difference A > B (CWP)	6†
Taglietti[56]	Knee	60	8w	A. Aquatic exercise	B. Education	Pain (VAS, WOMAC) Function (WOMAC) HR-QoL (SF-36) Depression (YGDS)	A > B (WOMAC), 8w A > B, 8w & 12w No difference No difference	7†
Zhu[58]	Knee	46	24w	A. Tai Ji Quan	B. Education	Pain (WOMAC) Stiffness (WOMAC) Function (WOMAC)	A > B A > B A > B	6
Bieler[64]	Hip	152	4m	A. Nordic walking (supervised) B. Lower limb strength training (supervised)	C. Home exercise (strengthening, stretching)	Pain (WOMAC) Stiffness (WOMAC) Function (WOMAC) Global assessment Self-efficacy (stairs, ASES) HR-QoL (SF-36)	A > C, 4m B > A/C, 2m No difference A/B > C, 2m A > C, 4m & 12m (stairs); B > C, 4m (stairs); A > B, 12m (ASES) A > C, 2m, 4m & 12m (RP, VT, MH); A > C, 4m (BP); A > C 2m & 4m (RE); A > B, 2m, 4m & 12m (MH); B > C, 2m (RE, MH); B > C, 4m & 12m (RP); B > C, 2m & 4m (BP, VT)	6†
Perez-Marmol[61]	Hand	45	8w	A. Fine motor skills rehabilitation + conventional OT (exercise, orthotic devices)	B. Conventional OT	Function (DASH, Barthel Index, Lawton & Brody Scale) Self-efficacy (GSES)	No difference No difference	6†
Psychological interventions:								
Focht[39]	Knee	80	9m	A. Group-mediated cognitive behavioural physical activity intervention	B. Traditional exercise therapy	Function (satisfaction) Self-efficacy (SRSE, MRSE)	A > B, 3m & 12m A > B (SRSE), 3m & 12m	6†
Gilbert[40]	Knee	155	2y	A. Motivational interviewing (nurse/OT) + brief physician counselling	B. Brief physician counselling	Pain (VAS, WOMAC) Stiffness (WOMAC)	No difference No difference	7†

Table IV (*continued*)

First author	Joint	Sample size	Intervention length	Intervention	Control	PROMs	Summary of findings	PEDro rating†
						Function (WOMAC)	A > B, 2y	
						HR-QoL (SF-36)	No difference	
Clarke[62]	Hip/knee	31	6w	A. Group acceptance commitment therapy	B. Usual care	Pain (NRS, ICOAP)	A > B (ICOAP constant Rasch) 2m & 4m; NRS, 4m	5†
						General health (GHQ-12)	No difference	
						Pain-related fear (PASS-20)	A > B, 2m & 4m	
						Pain acceptance (CPAQ)	A > B, 2m	
Telerehabilitation, telephone coaching:								
Azma[34]	Knee	76	6w	A. Telerehabilitation (telephone) + exercise	B. Office-based physiotherapy (heat, TENS, ultrasound) + exercise	Pain (VAS, KOOS)	No difference	4
						Symptoms (KOOS)	No difference	
						Function (KOOS, WOMAC)	No difference	
						KR-QoL (KOOS)	No difference	
O'Brien[54]	Knee	120	6m	A. Telephone-based weight management and healthy lifestyle service	B. Usual care (orthopaedic wait list)	Pain (NRS, WOMAC)	No difference	7†
						Stiffness (WOMAC)	No difference	
						Function (WOMAC)	No difference	
						Global change (GPE)	No difference	
						HR-QoL (SF-12)	A > B (MCS), 26w	
						Pain attitudes, beliefs (SOPA)	No difference	
						Depression, anxiety (DASS-21)	No difference	
						Fear avoidance beliefs (FABQ)	B > A, 26w	
						Sleep quality (PSQI)	No difference	
Combined interventions:								
Kessler[46]	Knee	151	12w	A. Multi-modal Ayurvedic treatment	B. Multimodal conventional care	Pain (NRS, WOMAC, PDI, SES)	A > B, 12w	7
						Stiffness (WOMAC)	A > B, 12w	
						Function (WOMAC)	A > B, 12w	
						HR-QoL (SF-36)	A > B (PCS), 12w	
						Mood states (POMS)	No difference	
Mat[52]	Knee	41	6m	A. Individualised multifactorial program (exercise, falls education, home hazards, cardiovascular, visual, medication review)	B. General health advice + conventional treatment	Pain (KOOS)	No difference	5†
						Symptoms (KOOS)	No difference	
						Function (KOOS)	No difference	
						KR-QoL (KOOS)	No difference	
Taping, bracing and orthoses:								
Aydogdu[33]	Knee	54	3w	A. Kinesiotape + conventional treatment (exercise, heat, ultrasound, TENS)	B. Conventional treatment	Pain (VAS, KOOS)	No difference	6†
						Symptoms (KOOS)	No difference	
						Function (KOOS)	No difference	
						KR-QoL (KOOS)	No difference	
Rahlf[55]	Knee	141	3d	A. Kinesiotape	B. Sham tape C. No treatment	Pain (WOMAC)	A > C	7
						Stiffness (WOMAC)	A > B, A > C	
						Function (WOMAC)	A > B, A > C	
Taheri[57]	Knee	36	6w	A. Tape (3w) + exercise + NSAIDs	B. Exercise + NSAIDs	Pain (VAS)	A > B, 3w & 6w	6†
Amaral[59]	Hand	39	30d	A. Assistive devices	B. Guideline leaflet	Pain (VAS)	No difference	6†
						Function (COPM, SACRAH)	A > B (COPM), 30d	
						QoL (WHOQOL-BREF)	No difference	
Arazpour[60]	Thumb (CMCJ)	25	4w	A. Thumb splint	B. No treatment	Pain (VAS)	A > B	5
						Function (MHQ)	No difference	
Manual therapy:								
Kaya Mutlu[45]	Knee	72	4w	A. Mobilisation with movement + exercise B. Passive joint mobilisation + exercise	C. Electrotherapy + exercise	Pain (VAS, WOMAC)	A/B > C (VAS), 12m	7†
							No difference	
						Stiffness (WOMAC)	A/B > C, 12m	
						Function (WOMAC)		
Li[47]	Knee	150	8w	A. Verum acupressure	B. Sham acupressure	Pain (NRS, WOMAC)	A > C, 8w; B > C (WOMAC), 8w	8
					C. Usual care	Function (WOMAC)	A > C, 8w; B > C, 8w	
Nasiri[53]	Knee	90	3w	A. Aromatherapy massage (lavender)	B. Placebo massage (almond oil) C. No treatment	Function (WOMAC)	A > C, 3w & 4w	6

(*continued on next page*)

Table IV (*continued*)

First author	Joint	Sample size	Intervention length	Intervention	Control	PROMs	Summary of findings	PEDro rating†
Maicki[65]	Neck	80	2w	A. Proprioceptive neuromuscular facilitation (PNF) + laser & TENS	B. Manual therapy + laser & TENS	Pain (SF-MPQ) Function (FRI)	A > B, 2w & 3m A > B, 2w & 3m	6†
Acupuncture:								
Huang[44]	Knee	95	4w	A. Modified green dragon swaying its tail needling manipulation	B. Common acupuncture manipulation	Pain (SF-MPQ, VAS, PPI) Pain/function (Lequesne)	A > B, 4w No difference	5
Electrophysical agents:								
Ahn[30]	Knee	40	5d	A. tDCS	B. Sham tDCS	Pain (NRS, WOMAC, SF-MPQ) Stiffness (WOMAC) Function (WOMAC)	A > B (NRS), 1w, 2w, 3w No difference No difference	8
Alfredo[31]	Knee	40	11w	A. Low level laser therapy + exercise	B. Placebo low level laser therapy + exercise	Pain (VAS, WOMAC) Stiffness (WOMAC) Function (WOMAC) Pain/function (Lequesne)	No difference No difference No difference No difference	6†
Boonhong[35]	Knee	61	2w	A. Ultrasound + TENS	B. Phonophoresis (piroxicam) + sham TENS	Pain (VAS, WOMAC)	No difference	9
Chang[37]	Knee	30	8w	A. Active tDCS + exercise	B. Sham tDCS + exercise	Pain (VAS, WOMAC) Function (WOMAC)	No difference No difference	8
Lizis[48]	Knee	40	5w	A. ESWT	B. Kinesiotherapy (exercise)	Pain (WOMAC) Stiffness (WOMAC) Function (WOMAC)	A > B, 5w A > B, 5w A > B, 5w	8†
Balneotherapy:								
Hanzel[63]	Hip/knee	50	3w	A. Mineral water balneotherapy	B. Tap water balneotherapy	Pain (VAS, WOMAC) Stiffness (WOMAC) Function (WOMAC) HR-QoL (SF-36)	No between-group comparisons presented	4

ASES, Arthritis Self-efficacy Scale; CMCJ, carpometacarpal joint; COPM, Canadian Occupational Performance Measure; CPAQ, Chronic Pain Acceptance Questionnaire; CSM, Cognitive Symptom Management; CWP, communication with physician scale; DASH, Disabilities of the Arm, Shoulder and Hand; DASS-21, Depression Anxiety Stress Scale-21; EQ-5D, EuroQol-5D; EWST, extracorporeal shockwave therapy; FABQ, Fear Avoidance Beliefs Questionnaire; FRI, Functional Rating Index; GHQ-12, General Health Questionnaire-12; GPE, Global Perceived Effect; GSES, General Self-Efficacy Scale; ICOAP, Intermittent and Constant Osteoarthritis Pain Scale; KOOS, Knee injury and Osteoarthritis Outcome Score; Lequesne, Lequesne Index; MHQ, Michigan Hand Questionnaire; MRSE, Mobility-Related Self-Efficacy; NR, not reported; NRS, numerical rating scale; NSAIDs, non-steroidal anti-inflammatory drugs; OT, Occupational Therapy/Therapist; PASS-20, Pain Anxiety Symptoms Scale-20; PDI, Pain Disability Index; POMS, Profile of Mood States; PPI, Present Pain Intensity; PSQI, Pittsburgh Sleep Quality Index; SACRAH, Score for the Assessment and Quantification of Chronic Rheumatoid Affections of the Hand; SES, Pain Experience Scale; SF-12, 12-item Short-Form Health Survey; SF-36, Medical Outcomes Short-Form Health Survey (subscales: PF, physical function; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role emotional; MH, mental health; PCS, physical component score; MCS, mental component score); SF-MPQ, Short-Form McGill Pain Questionnaire; SOPA, Survey of Pain Attitudes; SRSE, Self-Regulatory Self-Efficacy; tDCS, transcranial direct current stimulation; TENS, transcutaneous electrical nerve stimulation; VAS, visual analogue scale; WHOQoL, World Health Organisation Quality of Life; WHOQoL-Bref, World Health Organisation Quality of Life, abbreviated version; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; YGDS, Yesavage Geriatric Depression Scale.

* If received & adherent with preferred treatment.

† confirmed scores taken from PEDro website.

with knee OA. It is plausible that a weight loss support program targeted for knee OA may achieve more optimal outcomes in this population. A moderate quality RCT compared the efficacy of telerehabilitation with office-based physical therapy in 76 adults with knee OA[34]. Both groups received instruction in a home exercise program at an initial visit, which they were asked to complete 3 times a week for 6 weeks. The telerehabilitation group then received weekly telephone calls from a medical doctor to monitor exercise progression. The office-based group attended physical therapy 3 times a week for 6 weeks, where they received transcutaneous electrical nerve stimulation (TENS), ultrasound and heat pack treatment. There were no significant between-group differences for any measures of pain, symptoms, function and knee-related quality of life ($P < 0.05$). Because the study was not designed as a non-superiority trial, and sample size calculations were not provided, we are unable to make recommendations to support either intervention.

Two RCTs evaluated psychological interventions in people with knee OA. Focht *et al.*'s[39] moderate quality RCT compared a group-mediated cognitive behavioural (GMCB) physical activity intervention with traditional group-based exercise therapy ($n = 80$). Both groups received 36 contact hours and the same exercise program, which consisted of 30–40 min of walking, and 20 min of lower body strengthening. While the traditional exercise group underwent 3 sessions per week for 3 months, the GMCB intervention had a different structure (sessions spaced over 9 months), sequence and goals, aimed at using group dynamics as an agent of behavioural change. Compared to the traditional exercise group, the GMCB group reported significantly greater satisfaction with function ($P < 0.01$; effect size: 3 months 0.63, 12 months 0.95) and self-regulatory self-efficacy ($P < 0.02$; effect size 3 months 0.31, 12 months 0.58). This suggests that GMCB intervention may be a useful adjunct to currently recommended physical activity and exercise programs. Gilbert *et al.*[40] conducted a high-quality RCT, evaluating the effects of motivational interviewing intervention. All participants received a brief counselling session on physical activity with a physician, while the intervention group also received a minimum of five sessions of motivational interviewing conducted

by a nurse or occupational therapist. 155 adults with knee OA were included, as well as 185 adults with rheumatoid arthritis (RA), with results for each pathology presented separately. Although the intervention group reported significantly greater function when averaged over the 2-year study period (Western Ontario and McMaster Osteoarthritis Index [WOMAC], MD 2.2, 95% CI 0.01 to 4.41), there were no significant between-group differences in pain, stiffness, or health-related quality of life. Taken together with findings that objective measures of physical activity were also not different between groups at 2 years, motivational interviewing cannot be recommended as a standalone intervention for knee OA at this time.

One moderate quality systematic review evaluated the effects of various interventions on psychological outcomes in people with knee OA[18]. 23 RCTs were included, with a total of 3668 participants. Meta-analyses found small to moderate effects favouring exercise over control for knee-related quality of life (SMD 0.43, 95% CI 0.1 to 0.75) and health-related quality of life (SMD 0.7, 95% 0.2 to 1.2). Pooled data for health-related quality of life found no difference between self-management meetings, self-management booklets and control; and no significant effects when physical activity was added to a self-management booklet (compared to booklet alone) ($P > 0.05$).

Evidence update for rehabilitation of knee OA

Exercise remains a core recommendation for knee OA, and may have beneficial effects on knee-related and health-related outcomes. Consider using GMCB approach to exercise and physical activity to enhance satisfaction with function and self-efficacy.

Rehabilitation for hip OA

Specific recommendations for core treatments for hip OA are exercise (resistance, aerobic, aquatic, range of motion), education, mechanical interventions (e.g., footwear advice), and weight loss[3,10,11,15].

A high quality systematic review investigated the importance of dose for land-based exercise for hip OA[29]. Exercise programs from 12 RCTs (total $n = 1202$) were classified as having high compliance to the American College of Sports Medicine's (ACSM) recommendations for cardiorespiratory, resistance and flexibility exercise[67], or uncertain compliance to ACSM recommendations. All 12 RCTs included resistance training in their exercise programs, nine also included flexibility exercises, and two incorporated cardiorespiratory exercise. Findings from meta-analyses demonstrate small effects favouring high compliance exercise programs over control for outcomes of pain (SMD 0.42, 95% CI 0.26 to 0.58) and function (SMD 0.41, 95% CI 0.24 to 0.58). However, there were no significant effects for exercise programs with uncertain compliance (pain: SMD -0.04, 95% CI -0.31 to 024; function: SMD 0.23, 95% CI -0.06 to 0.52). This suggests that exercise programs for hip OA should comply with ACSM dose recommendations to improve pain and function outcomes.

Beiler *et al.*[64] conducted a moderate quality RCT that compared three exercise interventions for people with hip OA ($n = 152$): (1) supervised Nordic walking; (2) supervised strength training; and (3) unsupervised home-based exercise. They reported superior outcomes for the Nordic walking group compared to the home-based exercise group on measures of pain (4 months), global assessment (2 months), stairs self-efficacy (4 months, MD 11.6, 95% CI 1.3 to 22; 12 months, MD 14.2, 95% CI 2.3 to 25.9), and health-related quality of life (2–12 months) (Table IV). Strength training resulted in significantly greater outcomes for self-efficacy than home-based exercise (4 months, MD 10.6, 95% CI 1.6 to 19.7). Between-group comparisons for supervised Nordic walking and strength training favoured Nordic walking for self-efficacy at 12 months (Arthritis Self-Efficacy Scale; pain subscale MD 11.1, 95% CI 0.1 to 22.2; functional subscale MD 7.6, 95% CI 0.7 to 14.4) and the mental health subscale of the SF-36 at 2, 4 and 12 months ($P < 0.05$). Strength training resulted in significantly greater improvements in WOMAC stiffness at 2 months ($P < 0.05$). Findings of this study suggest that supervised exercise is superior to unsupervised home-based exercise for hip OA, with the authors concluding that Nordic walking may be preferable to strength training due to greater effects on self-efficacy and mental health.

Evidence update for rehabilitation of hip OA

Exercise remains a recommended core intervention for hip OA. New evidence suggests that exercise dose should comply with ACSM guidelines. Nordic walking may be recommended as an additional form of exercise effective for people with hip OA.

Rehabilitation for hand OA

Therapeutic exercise is recommended as a core intervention for hand OA[16].

Magni *et al.*[26] performed a moderate quality systematic review and meta-analysis of resistance training for hand OA, which included five studies (total $n = 350$). Pooled data showed small effects favouring resistance training over control (no treatment, sham cream, usual care, limited advice) (SMD 0.23, 95% CI 0.04 to 0.42), but no effects for function (SMD 0.1, 95% CI -0.13 to 0.33). The authors reported that the majority of exercise programs did not meet dose recommendations for muscle strengthening, such as intensity, frequency and progression criteria. Given the low quality of the included RCTs, small clinically unimportant improvements in pain, and lack of compliance with strengthening dose recommendation, the authors concluded that further studies of resistance training programs for hand OA are required.

A moderate quality RCT evaluated the effectiveness of a fine motor skills rehabilitation program 45 adults with hand OA[61]. The fine motor skills intervention consisted of standardised and structured activity, where participants made tissue paper balls and stuck them onto a picture template. The difficulty of the task was increased over time (e.g., number and size of balls), to progress from more gross hand function to fine pinch movements. The intervention group also received conventional occupational therapy consisting of hand and upper limb exercises and orthotic devices, as did the control group. There were no significant between-group differences for patient-reported function (Disabilities of the Arm, Shoulder and Hand [DASH], MD 9.5, 95% CI -5.6 to 24.7; Barthel Index, MD -0.7, 95% CI -7.9 to 6.5; Lawton and Brody Scale, MD 0.8, 95% −0.2 to 1.7) or self-efficacy (MD 5.3, 95% −9.7 to 20.4). On this basis, it is difficult to recommend incorporation of fine motor skills training into conventional occupational therapy programs. However, the authors did report significantly greater improvements in manual dexterity and finger range of motion in the fine motor skills group. Further studies are required, including investigation of whether the 8-week intervention was not sufficiently long to see transfer of physical improvements into patient-reported outcomes.

Evidence update for rehabilitation of hand OA

Although exercise remains a core recommended intervention for hand OA, new studies do not provide updated guidelines regarding types of exercise that may be effective for people with hand OA.

Discussion

The 2018 year in review identified 13 systematic reviews and 36 RCTs evaluating rehabilitation strategies for OA. This represents

fewer papers than the 2017 year in review, which yielded 20 systematic reviews and 61 RCTs using the same search strategy[4]). Consistent with 2017 findings[4], the overwhelming majority of included papers (73%) evaluated rehabilitation of knee OA. We included only six papers on hand OA, 2 on hip OA, 2 on hip/knee OA, 2 on general OA, and 1 on neck OA. Notable is the absence of studies published on other joints, such as the foot and ankle, shoulder, and lower back. We reiterate recommendations from the 2017 year in review, regarding the clear need for studies evaluating OA rehabilitation strategies for joints other than the knee. Furthermore, echoing findings from 2017, exercise was the most common type of rehabilitation evaluated (15 papers, 31%), followed by manual therapy (7 papers, 14%) and electrophysical agents (7 papers, 14%). Considering that exercise is a recommended core treatment for OA in all clinical guidelines referred to in this review[2,3,9–16], it is important that further studies are conducted to improve outcomes of exercise. We identified one RCT that evaluated a weight loss intervention[54], whose findings do not support telephone delivery of weight loss strategies. Our search strategy did not identify any systematic reviews or RCTs that investigated other recommended core treatments such as education, self-management, or biomechanical interventions (e.g., footwear).

Based on findings from the 2018 year in review, we provided evidence-based updates for rehabilitation of OA. For OA in any joint, psychological interventions may be useful adjuncts to core treatments for short-term effects on pain and self-efficacy. For knee, hip and hand OA, exercise remains a core recommendation. Group-mediated cognitive behavioural approaches to exercise and physical activity may enhance satisfaction with function and self-efficacy in people with knee OA. For hip OA, exercise dose should comply with ACSM guidelines, while Nordic walking may be recommended as an additional form of exercise. Taken together, these findings suggest that further studies should explore alternative or complementary methods of exercise delivery, such as Nordic walking and group- and psychological-based exercise, which may optimise adherence and long-term effects.

A consistent theme from included studies is the importance of prescribing exercise programs that follow recommended dose parameters for cardiovascular, strength and flexibility exercise, such as the ACSM guidelines[67]. Findings from systematic reviews that we identified suggest that exercise programs that do not comply with such guidelines may not be effective for OA of the hip or hand. It is plausible that small to moderate effect sizes observed in RCTs of exercise for knee and hip OA may be due to insufficient dose[68,69]. A recent systematic review by Minshull *et al.*[70] evaluated 34 RCTs on exercise programs for knee OA, with respect to application and reporting of resistance training principles[71]. The authors found that resistance training principles were inconsistently applied and inadequately reported across all studies, decreasing confidence that non-significant findings are due to a lack of efficacy (rather than limitations with exercise prescription and participant adherence). There is a clear need for future RCTs of exercise for OA to ensure appropriate exercise doses are prescribed and performed, to facilitate maximal outcomes. Minshull *et al.*[70] provided recommendations for future resistance training studies in knee OA: (1) define exercise goals (e.g., strength, power, endurance); (2) ensure that the exercise program reflects these goals; (3) clearly report exercise prescription and rationale (allowing replication); and (4) collect and report adherence data for individual participants. Our findings suggest that these principles should be applied to RCTs evaluating exercise for OA in any joint.

An interesting finding was the number of studies evaluating psychological interventions for OA, and/or evaluating psychological outcomes of rehabilitation strategies. We identified one systematic review of psychological interventions for OA in any joint, as well as three RCTs that investigated a group-mediated cognitive behavioural physical activity intervention, motivational interviewing, and group acceptance commitment therapy. This builds on studies identified in the 2017 year in review, which evaluated effects of internet cognitive behaviour therapy for depression[72], behavioural interventions[73], as well as pain coping skills training in combination with therapeutic exercise[74,75]. Our findings suggest that psychological interventions may be useful adjuncts to core treatments for knee OA, such as exercise, until long-term efficacy can be established. Notably, the consistent publication of studies investigating psychological interventions for OA highlights a shift towards a biopsychosocial approach to OA management. This is supported by a systematic review identified by our search, which evaluated the effects of OA interventions on psychological outcomes. Interestingly, more than half of RCTs included in this review used a patient-reported measure of quality of life or psychological health. This highlights a more holistic evaluation of the individual with OA, rather than focusing on pain and physical symptoms and function, which should be considered in the design of future RCTs.

While we chose to focus the narrative review on recommended core treatments for OA, our review also identified a number of systematic reviews and RCTs that evaluated combined interventions and adjunct treatments. Combined or multimodal treatment programs reflect clinical management of OA, and are recommended for other musculoskeletal pain conditions (e.g., patellofemoral pain)[7]. We consider that combined intervention programs should include exercise as a key component. The systematic review of Ahern *et al.*[24] included five RCTs, two of which evaluated a multimodal program including therapeutic exercise. Pooled outcomes support the use of a multimodal intervention that includes therapeutic exercise for base of thumb OA[24]. The RCT of Kessler *et al.*[46] found that a 12-week multimodal Ayurvedic treatment resulted in greater improvements in pain, stiffness, function and health-related quality of life, compared to multimodal conventional care, in people with knee OA. However, the Ayurvedic program contained minimal exercise, only advice regarding knee-specific yoga poses. Thus, while evidence supports combined interventions for thumb OA, we are unable to make specific recommendations regarding combined interventions for knee OA, or for other affected joints. With respect to adjunct interventions, we found evidence to support the use of tape for knee OA[21,55,57], assistive devices for hand OA[59], thumb splints for thumb OA[60], manual therapy for knee OA[23,45,47,53] and neck OA[65], acupuncture for knee OA[44], and electrophysical agents for knee OA[19,22,48] (Tables III and IV), while conflicting evidence was found for transcranial direct current stimulation (tDCS)[30,37] (Table IV). Taken together with established clinical guidelines, our findings reinforce that these interventions should be adjuncts to accompany core recommended interventions for OA, rather than be used as standalone or key treatments[2,3,9–16].

Conclusion

The literature on rehabilitation for OA continues to be dominated by level 1 and 2 studies on knee OA. Consistent with current clinical guidelines, exercise should be a core treatment for OA, with new evidence informing updates to exercise recommendations. Further studies seeking to evaluate exercise for OA should prioritise exercise programs that comply with published dose guidelines. Importantly, RCTs are required to increase the evidence base for managing OA in other joints, such as the hip, hand, foot, ankle,

shoulder and spine, as well as emerging treatments such as psychological interventions.

Contributions

NJC, HFH and KAGM contributed to the conception, study design, and acquisition of articles. HFH performed the database searches. NJC, HFH and KAGM determined article eligibility. NJC and KAGM performed quality ratings, data extraction, and data interpretation. NJC drafted the manuscript. HFH and KAGM critically reviewed the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

All authors declare no conflicts of interest.

Acknowledgements

NJC is supported by an Arthritis Queensland Fellowship (2018). The authors wish to thank Professor Kay Crossley for her comments on the final manuscript.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.joca.2018.11.010.

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