2018 EULAR recommendations for physical activity in people with inflammatory arthritis and osteoarthritis

Anne-Kathrin Rausch Osthoff,[1,2] Karin Niedermann,[1] Jürgen Braun,[3,4] Jo Adams,[5] Nina Brodin,[6,7] Hanne Dagfinrud,[8] Tuncay Duruoz,[9] Bente Appel Esbensen,[10,11] Klaus-Peter Günther,[12] Emailie Hurkmans,[13] Carsten Bogh Juhl,[14,15] Norelee Kennedy,[16] Uta Kiltz,[3,4] Keegan Knittle,[17] Michael Nurmohamed,[18] Sandra Pais,[19] Guy Severijns,[20] Thijs Willem Swinnen,[21,22] Irene A Pitsillidou,[23] Louise Warburton,[24] Zhivko Yankov,[25] Theodora P M Vliet Vlieland[2]

Handling editor Josef S Smolen

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/annrheumdis-2018-213585).

For numbered affiliations see end of article.

Correspondence to
Professor Karin Niedermann, School of Health Professions, Institute of Physiotherapy, Zurich University of Applied Sciences, Winterthur, Switzerland;
karin.niedermann@zhaw.ch

A-KRO and KN contributed equally.

Received 14 April 2018
Revised 5 June 2018
Accepted 16 June 2018
Published Online First 11 July 2018

ABSTRACT

Regular physical activity (PA) is increasingly promoted for people with rheumatic and musculoskeletal diseases as well as the general population. We evaluated if the public health recommendations for PA are applicable for people with inflammatory arthritis (iA; Rheumatoid Arthritis and Spondyloarthritis) and osteoarthritis (hip/knee OA) in order to develop evidence-based recommendations for advice and guidance on PA in clinical practice. The EULAR standardised operating procedures for the development of recommendations were followed. A task force (TF) (including rheumatologists, other medical specialists and physicians, health professionals, patient-representatives, methodologists) from 16 countries met twice. In the first TF meeting, 13 research questions to support a systematic literature review (SLR) were identified and defined. In the second meeting, the SLR evidence was presented and discussed before the recommendations, research agenda and education agenda were formulated. The TF developed and agreed on four overarching principles and 10 recommendations for PA in people with iA and OA. The mean level of agreement between the TF members ranged between 9.8 and 8.8. Given the evidence for its effectiveness, feasibility and safety, PA is advocated as integral part of standard care throughout the course of these diseases. Finally, the TF agreed on related research and education agendas. Evidence and expert opinion inform these recommendations to provide guidance in the development, conduct and evaluation of PA-interventions and promotion in people with iA and OA. It is advised that these recommendations should be implemented considering individual needs and national health systems.

Check for updates

© Author(s) (or their employer(s)) 2018. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Rausch Osthoff A-K, Niedermann K, Braun J, *et al*. *Ann Rheum Dis* 2018;**77**:1251–1260.

INTRODUCTION

Physical activity (PA) is defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure above resting (basal) levels. PA broadly encompasses exercise, sports and physical activities done as part of daily living, occupation, leisure and active transportation'.[1 2] Exercise is a subcategory of PA 'that is planned, structured and repetitive and [that] has, as a final or intermediate objective, the improvement or maintenance of one or more dimensions of physical fitness'.[1 2] PA-interventions can be provided or performed individually or in groups, supervised or non-supervised, in acute or chronic health states, but should always include behavioural change techniques (BCT) to promote long-term adherence.[3 4]

To promote the health benefits of PA in the general population, the WHO[5] and American College of Sports Medicine (ACSM)[2] have provided internationally accepted recommendations for PA (table 1). In this manuscript, the term PA always includes both physical activity and exercise according to the definitions above.

Inflammatory arthritis (iA, in this manuscript encompassing rheumatoid arthritis (RA) and spondyloarthritis (SpA)) and osteoarthritis (OA) (in this manuscript encompassing hip/knee OA (HOA/KOA)) are major causes of pain and disability worldwide.[6] There is strong evidence for the benefits of PA on improvements on disease activity,[7] activities and participation; however, people with rheumatic and musculoskeletal diseases (RMDs) are in general less active compared with healthy controls.[8–10] Possible underlying reasons could be that healthcare providers (HCP, including rheumatology health professionals (eg, physiotherapist (PT), occupational therapist (OT), nurse, podiatrist, psychologist), physical education professions and medical doctors (rheumatologists and other specialists)) and people with iA and OA may be reluctant towards engaging in PA, fearing flare-up or joint damage by exercising.[11] Furthermore, current clinical management recommendations such as the European League Against Rheumatism (EULAR) recommendations on the management of RA,[12] SpA[13] or HOA/KOA[14] and the ACSM guidelines for exercise testing and prescription[15] recommend exercise and/or PA, but none of these is specific regarding the required type and dosage. Therefore, it is not clear how these recommendations should be used in routine clinical care. In particular, the evidence on the effectiveness and safety of exercise and PA to a level that meets public health (PH) recommendations has not yet been clearly examined and defined in people with RMDs. A EULAR task force (TF) was therefore set up (1) to evaluate if the PH recommendations for PA are applicable for people with iA and OA; (2) to

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

Table 1 Public Health recommendations for PA

The ACSM-AHA primary physical activity recommendations*	
► All healthy adults aged 18–65 years should participate in moderate intensity aerobic PA for a minimum of 30 min on 5 days/week or vigorous intensity aerobic activity for a minimum of 20 min on 3 days/week.	
► Combinations of moderate and vigorous intensity exercise can be performed to meet this recommendation.	
► Moderate intensity aerobic activity can be accumulated to total the 30 min minimum by performing bouts each lasting ≥10 min.	
► Every adult should perform activities that maintain or increase muscular strength and endurance for a minimum of 2 days/week.	
► Because of the dose-response relationship between PA and health, individuals who wish further improve their fitness, reduce their risk of chronic diseases and disabilities and/or prevent unhealthy weight gain my benefit by exceeding the minimum recommended amounts of PA.	
Cardiorespiratory ('aerobic') exercise†	
Frequency	≥5 days/week of moderate exercise or ≥3 days/week of vigorous exercise or a combination of moderate and vigorous exercise on ≥3–5 days/week is recommended.
Intensity	Moderate and/or vigorous intensity is recommended for most adults. Light to moderate intensity exercise may be beneficial in deconditioned persons.
Time	30–60 min/day (150 min/week) of purposeful moderate exercise or 20–60 min/day (75 min/week) of vigorous exercise or a combination of moderate and vigorous exercise per day is recommended for most adults. ≥20 min/day (150 min/week) of exercise can be beneficial, especially in previously sedentary persons.
Type	Regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature is recommended.
Volume	A target volume of ≥500–1000 MET min/week is recommended. Increasing pedometer step counts by ≥2000 steps per day to reach a daily step count ≥7000 steps per day is beneficial. Exercising below these volumes may still be beneficial for persons unable or unwilling to reach this amount of exercise.
Pattern	Exercise may be performed in one (continuous) session per day or in multiple sessions of ≥10 min to accumulate the desired duration and volume of exercise per day. Exercise bouts of ≥10 min may yield favourable adaptations in very deconditioned individuals. Interval training can be effective in adults.
Progression	A gradual progression of exercise volume by adjusting exercise duration, frequency and/or intensity is reasonable until the desired exercise goal (maintenance) is attained. This approach may enhance adherence and reduce risks of musculoskeletal injury and adverse CHD events.
Resistance exercise†	
Frequency	Each major muscle group should be trained on 2–3 days/week
Intensity	60%–70% of the 1RM (moderate to hard intensity) for novice to intermediate exercisers to improve strength.
	≥80% of the 1RM (hard to very hard intensity) for experienced strength trainers to improve strength.
	40%–50% of the 1RM (very light to light intensity) for older persons beginning exercise to improve strength.
	40%–50% of the 1RM (very light to light intensity) may be beneficial for improving strength in sedentary persons beginning a resistance training programme.
	≤50% of the 1RM (light to moderate intensity) to improve muscular endurance.
	20%–50% of the 1RM in older adults to improve power.
Time	No specific duration of training has been identified for effectiveness.
Type	Resistance exercises involving each major muscle group are recommended. A variety of exercise equipment and/or body weight can be used to perform these exercises.
Repetitions	8–12 repetitions are recommended to improve strength and power in most adults. 10–15 repetitions are effective in improving strength in middle-aged and older persons starting exercise 15–20 repetitions are recommended to improve muscular endurance.
Sets	Two to four sets are the recommended for most adults to improve strength and power. A single set of resistance exercise can be effective especially among older and novice exercisers. ≤2 sets are effective in improving muscular endurance.
Pattern	Rest intervals of 2–3 min between each set of repetitions are effective.
	A rest of ≥48 hours between sessions for any single muscle group is recommended.
Progression	A gradual progression of greater resistance and/or more repetitions per set and/or increasing frequency is recommended.
Flexibility exercise†	
Frequency	≥2–3 day/week is effective in improving joint range of motion, with the greatest gains occurring with daily exercise.
Intensity	Stretch to the point of feeling tightness or slight discomfort.
Time	Holding a static stretch for 10–30 s is recommended for most adults. In older persons, holding a stretch for 30–60 s may confer greater benefit. For PNF stretching, a 3–6 s contraction at 20%–75% maximum voluntary contraction followed by a 10–30 s assisted stretch is desirable.
Type	A series of flexibility exercises for each of the major muscle–tendon units is recommended. Static flexibility (active or passive), dynamic flexibility, ballistic flexibility and PNF are each effective.
Volume	A reasonable target is to perform 60 s of total stretching time for each flexibility exercise.
Pattern	Repetition of each flexibility exercise two to four times is recommended. Flexibility exercise is most effective when the muscle is warmed through light to moderate aerobic activity or passively through external methods such as moist heat packs or hot baths.
Progression	Methods for optimal progression are unknown.
Neuromotor exercise training†	
Frequency	≥2–3 days/week is recommended.
Intensity	An effective intensity of neuromotor exercise has not been determined.
Time	≥20–30 min/day may be needed.
Type	Exercises involving motor skills (eg, balance, agility, coordination and gait), proprioceptive exercise training and multifaceted activities (eg, tai ji and yoga) are recommended for older persons to improve and maintain physical function and reduce falls in those at risk for falling. The effectiveness of neuromuscular exercise training in younger and middle-aged persons has not been established, but there is probable benefit.
Volume	The optimal volume (eg, number of repetitions, intensity) is not known.

Continued

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

Table 1 Continued

The ACSM-AHA primary physical activity recommendations*	
Pattern	The optimal pattern of performing neuromotor exercise is not known.
Progression	Methods for optimal progression are not known.

*ACSM, American College of Sports Medicine; AHA, American Heart Association; extracted from the ACSM Guidelines for Exercising Testing and Prescription, chapter 1, p. 4.[15]
†Extracted from ACSM position stand,[2] table 2, p. 1336.
1 RM, one-repetition maximum; CHD, coronary heart disease; MET, metabolic equivalent of task; PA, physical activity; PNF, proprioceptive neuromuscular facilitation.

develop evidence-based recommendations on PA-promotion and -delivery in the management of people with iA and OA and (3) formulate an educational and research agenda.

These EULAR recommendations for PA in people with iA and OA are for HCPs, patient organisations and policy makers.

METHODS

The EULAR standardised operating procedures for the development of recommendations were followed.[16] The AGREE II-instrument[17] was used to structure this manuscript.

The multidisciplinary TF consisted of a selection of 22 European PA-experts (six medical doctors, including three rheumatologists, one of them specialised in cardiovascular diseases, one GP), one orthopaedic surgeon; nine PTs, a psychologist, an OT, a nurse and a human movement scientist) and three patient representatives. A steering group managed the process (convenor KN, methodologist TVV, expert JB, fellow AR).

During the first TF meeting, definitions of exercise and PA were clarified and the TF agreed to follow the ACSM position stand.[2] The TF agreed that RA and SpA as predominant iA conditions, and HOA/KOA as most relevant for PA recommendations would represent the field of iA and OA, respectively. Clinically relevant questions on the provision of advice and guidance regarding exercise and PA, from which 13 research questions were defined by consensus to guide the subsequent detailed systematic literature review (SLR) (online supplementary table S1).

Two SLRs were performed by AR with the support of two librarians and under the supervision of the convenor and methodologists. The questions were written according to the Population, Intervention, Comparison, Outcome (PICO) format,[18] resulting in two PICOs: (1) on effectiveness, safety and feasibility of PA and (2) on facilitators and barriers towards PA (online-supplementary table S2). For the first PICO, the fellow searched for key meta-analyses (MAs) or systematic reviews (SRs) including randomised controlled trials (RCTs) that investigated the effectiveness of PA-interventions in adults with RA/SpA/HOA/KOA. The SLR was performed in PubMed/Medline, Cochrane Library, Embase, Web of Science, Emcare and PsycInfo, using both MeSH terms and freetext, covering the time frame until 4/2017. For the second PICO, a SLR, covering the time frame until 7/2017, was performed in PubMed/Medline and Cochrane Library including qualitative studies if they described facilitators and barriers regarding PA (including exercise) in people with RA/SpA/HOA/KOA. Experts in the field of RA (EH), SpA (HD), OA (CJ) and behaviour change (KK), respectively, checked if all relevant titles and abstracts were included.

Based on the PICOs, the same author (AR) screened the titles and abstracts according to inclusion and exclusion criteria. Potentially relevant articles were identified and full text versions evaluated. Studies including adults (>18 years) with RA/SpA/HOA/KOA that included PA interventions that met the PH recommendations according to the ACSM principles[2] regarding frequency, intensity and duration for effective interventions were eligible for inclusion. All data extractions were checked by experts from the TF.

Studies measuring the effectiveness of PA-interventions were meta-analysed. These results and detailed descriptions of the methods are reported elsewhere.[19] Studies were used for answering more than one research question if appropriate. For clinical studies evaluating the effectiveness of PA, the Cochrane Risk of Bias Assessment Tool was used to assess selection bias, performance bias, detection bias, attrition bias and reporting bias[20] by two independent assessors (AR, CH). An additional person (KN) helped to resolve any differences in rating between the assessors. The research evidence was categorised according to the Oxford levels of evidence.[21]

During the second TF meeting, the results from the SLR were presented, and the experts developed 'overarching principles' (background statements to preface recommendations) and drafted 10 recommendations through an iterative process of discussion and consensus. After the meeting, the recommendations were collated and sent to the TF members by email, to rate the level of agreement (LoA) independently and anonymously on a 0–10 point scale (0=totally disagree, 10=totally agree). Mean LoA >8 would be considered a 'high' LoA. Furthermore, the TF formulated a research agenda and education agenda based on identified gaps in the evidence.

RESULTS

The search yielded 3471 references, 96 of which were included in the SLR: Four MA/SR[7 22–24] and 66 RCTs[25–93] investigated the effects of exercise interventions, 11 RCTs[94–106] investigated the effects of a PA-promotion-intervention, 11 qualitative studies and literature reviews[3 11 107–115] described barriers and facilitators regarding PA (figure 1A,B). The included RCTs were published between 1985 and 2017. Most information is from studies with low (48%) or unclear (39%) risk of bias (online-supplementary figure S1).

The TF agreed on four overarching principles and 10 recommendations for PA in people with RA/SpA/HOA/KOA based on SLR and expert opinion. High loA was achieved for 9 out of 10 recommendations and 2 recommendations were graded as strength level A. Table 2 summarises the overarching principles and recommendations with their associated level of evidence, strength of recommendation and LoA.

Recommendation 1: PA as integral part of standard care

Given the evidence for effectiveness, feasibility and safety, the PH recommendations for PA are applicable, and thus, PA should be an integral part of standard care for people with RA/SpA/HOA/KOA. PA according to PH recommendations[2] is effective on PA level, physical fitness as well as disease-specific and general outcomes in people with RA/SpA/HOA/KOA (category 1 evidence[16]). Our MA including 16 RCTs[26 35 36 42 43 50 54 56 57 61 70] showed that cardiovascular exercises have a moderate beneficial effect on cardiovascular fitness

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

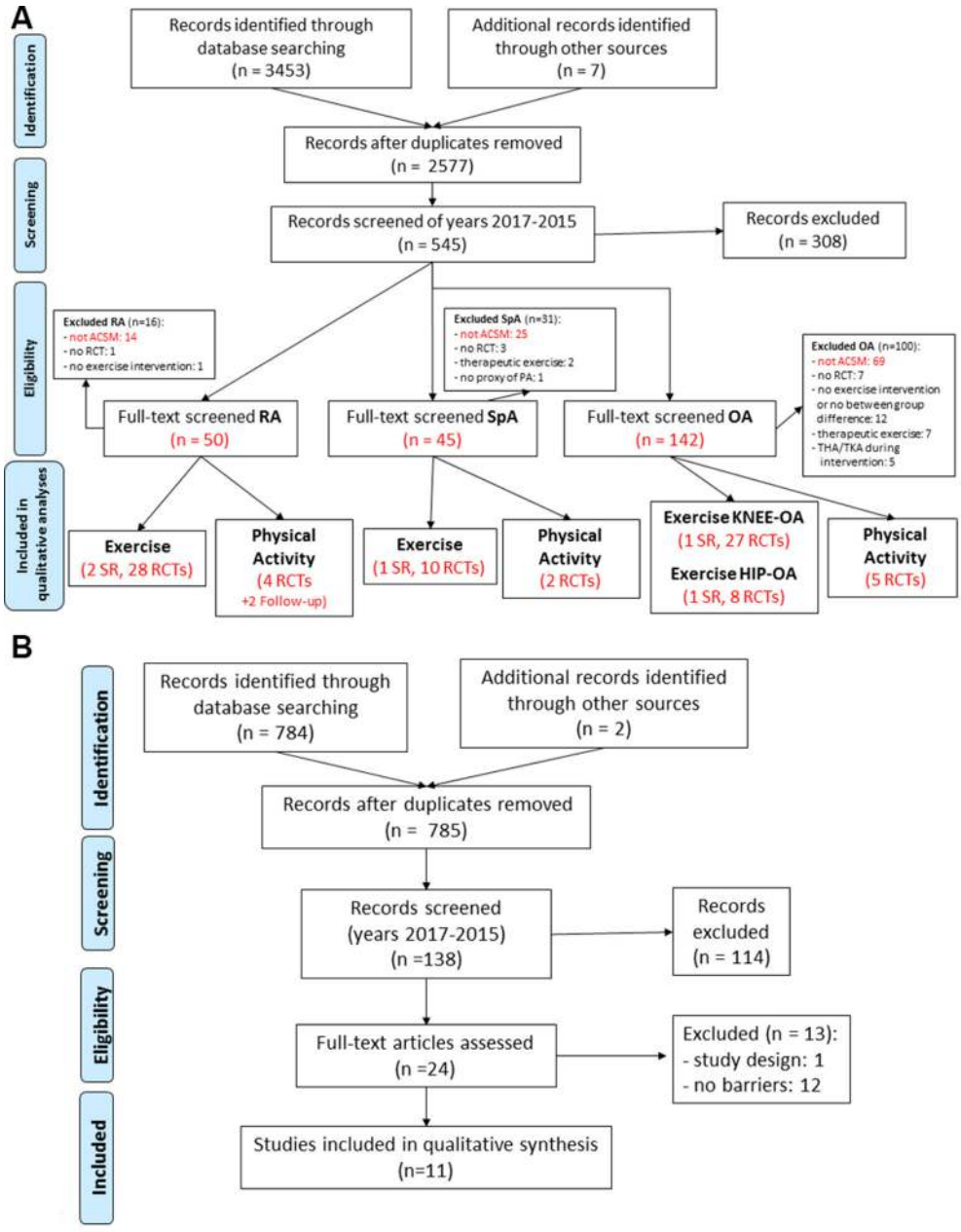

Figure 1 Flowcharts of the literature search related to PICO_1 (A) and PICO_ 2 (B). ACSM, American College of Sports Medicine; OA, osteoarthritis; PA, physical activity; PICO, Population, Intervention, Comparison, Outcome; RA, rheumatoid arthritis; RCT, randomised controlled trial; SpA, spondyloarthritis; SR, systematic review.

(evaluated in VO2 max) in all three conditions. Our MA including 25 RCTs[25 28 31 34 38 39 44 47 49–51 59 62–66 72 75–78 81–83 85 86 88 90 91] showed that muscle strength exercises have a moderate beneficial effect for muscle strength in people with RA and HOA/KOA. Our MA including seven RCTs[52 55 58 78 88 90 116] showed that combined exercises (aerobic or strength exercises plus flexibility exercises) had no effect on flexibility in people with SpA or HOA/KOA. However, exercise conditions, assessments and outcome measures varied greatly. There is no study comparing the effect of flexibility exercises alone versus no exercises. In one RCT,[48] the effect of a neuromotor-exercise programme on neuromotor performance was investigated in people with RA showing a positive effect. Eleven RCTs described the promotion of daily PA. Our MA including six RCTs[95 98 101 102 104 117] applying BCTs for the counselling intervention showed a small beneficial effect.

Feasibility of interventions can be captured by adherence to the intervention or the study protocol.[118] Adherence to interventions (number of sessions attended/total number of sessions) has been reported in 26 RCTs (35%) and the mean adherence was 69% in people with SpA, 71% in people with RA and 79% in people with HOA/KOA. However, the (self-) reported adherence to intervention might be overestimated due to recall bias or social desirability. In 68 RCTs (94%), protocol violations were reported, with approximately 10% of these being disease-related or intervention-related.

PH recommendations for PA can be considered safe. No detrimental effects were reported, rather beneficial effects on disease activity and symptoms in iA.[7] Forty-four per cent of all included RCTs reported on adverse events (AE), of those 62% described no AE and 38% describe minor AE such as transitional exercise related joint or muscle pain.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

Table 2 Recommendations for PA and exercise in people with inflammatory arthritis and OA

Overarching principles

1. PA is part of a general concept to optimise health related quality of life.
2. PA has health benefits for people with RA/SpA/HOA/KOA.
3. General PA recommendations, including the four domains (cardiorespiratory fitness, muscle strength, flexibility and neuromotor performance) are applicable (feasible and safe) to people with RA/OA/SpA.
4. The planning of PA requires a shared decision between healthcare providers and people with RA/SpA/HOA/KOA, which takes people's preferences, capabilities and resources into account.

Recommendations	Category of evidence	Strength of recommendation	Level of Agreement mean (SD) Median (Range)
1. Promoting PA consistent with general PA recommendations should be an integral part of standard care throughout the course of disease in people with RA/SpA/HOA/KOA.	1B	A	9.81 (0.39) 10 (9–10)
2. All healthcare providers involved in the management of people with RA/SpA/HOA/KOA should take responsibility for promoting PA and should cooperate, including making necessary referrals, to ensure that people with RA/SpA/HOA/KOA receive appropriate PA-interventions.	4	D	9.14 (0.98) 9 (7–10)
3. PA interventions should be delivered by healthcare providers competent in their delivery to people with RA/SpA/HOA/KOA.	4	D	8.86 (1.48) 10 (5–10)
4. Healthcare providers should evaluate the type, intensity, frequency and duration of the people's actual PA by means of standardised methods to identify which of the four domains of general PA recommendations can be targeted for improvement.	3	C	9.05 (1.04) 9 (6–10)
5. General and disease-specific contraindications for PA should be identified and taken into account in the promotion of PA.	4	D	9.10 (1.41) 10 (5–10)
6. PA interventions should have clear personalised aims, which should be evaluated over time, preferably by use of a combination of subjective and objective measures (including self-monitoring when appropriate).	4	D	9.05 (1.25) 9 (5–10)
7. General and disease-specific barriers and facilitators related to performing PA, including knowledge, social support, symptom control and self-regulation should be identified and addressed.	3	C	9.19 (1.13) 10 (6–10)
8. Where individual adaptations to general PA recommendations are needed, these should be based on a comprehensive assessment of physical, social and psychological factors including fatigue, pain, depression and disease activity.	4	D	9.24 (0.86) 9 (7–10)
9. Healthcare providers should plan and deliver PA interventions that include the behavioural change techniques self-monitoring, goal setting, action planning, feedback and problem solving.	1A	A	9.48 (0.79) 10 (7–10)
10. Healthcare providers should consider different modes of delivery of PA (eg, supervised/not-supervised, individual/group, face-to-face/online, booster strategies) in line with people's preferences.	4	D	9.00 (1.30) 9 (5–10)

HOA, hip osteoarthritis; KOA, knee osteoarthritis; OA, osteoarthritis; PA, physical activity; RA, rheumatoid arthritis; SpA, spondyloarthritis.

Recommendation 2: Responsibility for PA promotion

All HCPs should have a responsibility for PA promotion and collaborative working that facilitate a close cooperation between different professions to support appropriate disease management. This statement was based on the finding that 66% of the included studies reported the profession of the HCP providing the intervention, of which 75% were PTs.[25 31 36 40 44 45 48 50 53 55 58 61 64–66 70 73–79 81 84 87 88 91 94 96 101–105 119 120] However, the functions and responsibilities of HCPs vary across Europe.[121 122] Therefore, the TF agreed that PA advice should be provided by all HCPs.

Recommendation 3: Delivery of PA

The delivery of interventions should be performed by HCPs competent in the field of PA principles and rheumatic conditions. The reporting of training on PA guidelines was rare. One study[59] described a '4 hours education session on cardiovascular training', others described the instructing person as 'trained'[25 50 69 70 84 88 123] or 'experienced'.[31 49 76 77 88] Some studies with focus on the promotion of daily PA described training sessions on behaviour change skills like Motivational Interviewing.[94 96 104]

Recommendation 4: Evaluation of PA

The PA level (active or non-active) and the exercise domains (cardiorespiratory, muscle strength, flexibility and neuromotor) should be routinely assessed. Of 11 trials investigating the effect of PA promotion interventions, three RCTs[94 96 105] described baseline screening to distinguish between active and non-active persons before starting the tailored PA-intervention. Specific tools are needed to assess each domain.[15,p. 68]

Recommendation 5: General and disease-specific contraindications

Tools for specific contraindications (CIs) were found;[15 94 124] however, available general or national guidelines defining absolute or relative CIs should be followed as a priority.

Recommendation 6: Personalised aims and evaluation

The PA-interventions should be based on individual aims, which should be regularly evaluated. This can be done by PA assessments and any other assessments related to the individual aims. As PA assessments, performance–based tests, patient-reported outcome measures (eg, SQUASH,[104] PASE[94]) and self-monitoring

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

tools (eg, wearables such as Fitbit,[100] pedometer[99] or accelerometer[101]) were identified. However, we did not evaluate the validity and reliability of the assessments applied.

Recommendation 7: General and disease-specific barriers and facilitators

General and disease-specific barriers (that are not CI per se) and facilitators should be addressed as described in 11 studies.[11 107–115 125] Disease-specific barriers included lack of knowledge about the disease, lack of knowledge about safe exercising (both in people with iA/OA and HCPs) and symptoms like pain, fatigue, stiffness, reduced mobility, fear of flare-ups or causing damage. Disease-specific facilitators included positive impact of exercise in symptoms or disease control, information about disease and correct exercising, the use medication for pain prior to exercising, using self-regulation techniques, supportive, but not controlling encouragement from HCPs and a supportive social background.

Recommendation 8: Individual adaptations to PA following individualised assessment

Adaptations to PA should be made on a comprehensive individual assessment. However, no evidence on the necessity of general adaptations in people with RA/SpA/HOA/KOA was found. In some RA studies the '24 hour-rule' was applied, that is, the exercise intensity was reduced when the increased pain persisted for more than 24 hours.[23 40 50] ACSM provides adaptations to exercise testing in people with arthritis (eg, no high-intensity testing if acute inflammation) and training such as exercising when pain is typically least severe or to train carefully in order to reduce risk of associated injuries, although no clear evidence that high-impact activities cannot be engaged during active inflammation.[15, pp. 298–301] Individual disease-related barriers (eg, symptoms) may determine these adaptations.

Recommendation 9: Behaviour change techniques

BCTs should be an integral component of PA-interventions. Several behaviour change theories were used in PA promotion interventions in the field of RA and HOA/KOA,[4 126] but the reporting was poor. Future research based on theories in design, evaluation and interpretation of findings is needed.

A meta-analysis of six RCTs[94 95 98 101 102 104] investigating the effects of a PA promotion intervention according to general PA recommendations[2] and based on counselling interventions that apply BCTs showed a small beneficial effect on PA level.[19] Counselling interventions show a small beneficial effect if BCTs are applied.[19]

Recommendation 10: Modes of delivery

HCPs should consider the whole range of modes to deliver interventions. No evidence on the superiority of specific delivery modes was found. The delivery modes of PA-interventions vary considerably and are mostly described as 'land-based and/or water-based' and 'supervised and individualised', the latter usually applied to group settings. As booster strategies phone calls,[36 96 98 105] devices (eg, pedometer,[98 99] wearable[100 101]), home visits,[63 70] log book,[36 51 76 98] web-based instructions,[127] written material,[51 54 103] visual instructions (eg, video[103]) were reported.

Research and education agendas

Based on the gaps identified in the literature, the TF discussed and proposed a research agenda (box 1) with the prioritised research topics and an education agenda (box 2) with topics for education and training in PA promotion for HCPs. Evidence on impact of (reducing) sedentary behaviour emerged as an important future research topic.

Box 1 Research agenda for physical activity (PA) in people with inflammatory arthritis and osteoarthritis

1. To evaluate the long-term effectiveness of PA at different intensities and types and monitoring of adverse events (AE).
2. To evaluate links between PA behaviour and disease-specific outcomes.
3. To evaluate the long-term effectiveness of sedentary behaviour reduction, including the monitoring of AE.
4. To evaluate links between sedentary behaviour and disease-specific outcomes.
5. To identify which PA-intervention strategies work best to increase PA level and adherence in various subgroups.
6. To identify markers of response and non-response to PA treatment.
7. To identify disease-specific contraindications on different exercise domains (cardiovascular, strength, flexibility, neuromotor).
8. To further develop and evaluate strategies to reduce and monitor a change in sedentary behaviour.
9. To develop PA-interventions targeting all exercise dimensions simultaneously with special focus on feasibility.
10. To evaluate and recommend valid PA assessments feasible for the use in clinical practice.
11. To study how to facilitate PA behaviour change immediately from screening onwards and how to address facilitators and barriers.
12. To identify facilitators and barriers of healthcare providers towards applying the PA recommendations.
13. To perform long-term effectiveness trials on combined interventions including other health behaviours.

DISCUSSION

The TF agreed on 4 overarching principles and 10 recommendations for PA in people with RA/SpA/HOA/KOA, which integrated the perspectives of the TF members from different professional, cultural and personal backgrounds. This led to a broad consensus on the principles and recommendations within the group and ought to foster its feasibility and practicability in the diverging health systems across Europe.

Box 2 Education agenda for physical activity (PA) in people with inflammatory arthritis and osteoarthritis

1. Increase knowledge about PA among health professionals (HPs), physicians and people with inflammatory arthritis and osteoarthritis.
2. Increase HPs' and physicians' skills in communicating the role of PA in managing general health and disease-specific issues.
3. Include knowledge and skills on PA promotion in all HPs' and physicians' undergraduate training curricula.
4. Develop a EULAR training module on PA for HPs and rheumatologists.
5. Propose a session on PA at every EULAR congress.
6. Develop education materials for people with inflammatory arthritis and osteoarthritis.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

The LoA on the recommendations among the TF members was very high. The only exception was about the competency of HCP, which may be due to country specific differences in the availability of HCP competent in PA promotion.

Although the PH recommendations for PA are well established, the feasibility and applicability of these for people with iA and OA has not been assessed so far. Accordingly, the development of the recommendations was needed. Expectedly, they emphasise the importance of PA and will guide future PA-interventions in people with chronic rheumatic conditions.

PA promotion is a behavioural intervention and therefore BCT are central components in PA-interventions. Identifying effective and cost-effective BCT within PA promotion intervention in people with chronic conditions is currently a hot topic in research and for example a research priority of the National Institute for Health and Care Excellence, UK.[128]

We decided a priori to include only studies fulfilling the PH recommendations for PA according to ACSM principles.[2] This was a far-reaching decision, which allowed drawing stronger conclusions on the effectiveness and especially the safety of correctly dosed PA-interventions. We followed a pragmatic search strategy with the plan to answer all RQs related to PICO 1 with findings of available SR/MA. However, there were no SR/MA on all exercise dimensions and all conditions available; this led to extracting single RCTs from high-quality SR/MA. This, however, excluded high-quality reviews (eg, Cochrane reviews) and RCTs that did not fulfil the ACSM principles and affected the potential to report 1A evidence according to Oxford levels of evidence.[21] Furthermore, only one reviewer screened the abstracts and decided on unclear abstracts together with a second reviewer, which is not fully in line with standard procedures of a SLR.[129] However, we applied a double-check by experts to ensure that no relevant studies were missed.

A major problem for data extraction and interpretation was that the reporting of interventions in most studies was incomplete. Manuscripts that applied TIDieR[130] (Template for Intervention Description and Replication) guidelines reported more precisely the PA-interventions and substantially improved the objective evaluation of the PA-interventions.

For the research questions related to the effectiveness and safety of PA-interventions and BCT, the PICO scheme was applied, resulting in 1A level of evidence. All other research questions we had to answer in a descriptive way limiting the level of evidence to 3 to 4. However, this limitation is due to the nature of the research questions. Nevertheless, the qualitative studies may provide valuable insight into important PA-related fields, such as assessments, barriers and facilitators, PA promotion strategies.

The recommendations focused on the conditions RA/SpA/HOA/KOA, the most prevalent RMD conditions to increase the generalisability and applicability of the recommendations. However, large heterogeneity between these conditions may limit the precision of the recommendations. Therefore, additional disease-specific recommendations are desirable. In addition, not all subconditions were considered and represented (eg, juvenile arthritis).

The research agenda highlights several areas where scientific evidence is lacking. It is a clear ambition to implement these recommendations into daily clinical routine. Due to the different health systems across Europe, development and evaluation of target group and culture-specific implementation strategies are needed and should involve all stakeholders.

Author affiliations
[1]School of Health Professions, Institute of Physiotherapy, Zurich University of Applied Sciences, Winterthur, Switzerland
[2]Department of Orthopaedics, Rehabilitation and Physical Therapy, Leiden University Medical Center, Leiden, Netherlands
[3]Rheumazentrum Ruhrgebiet, Herne, Germany
[4]Ruhr University, Bochum, Germany
[5]Faculty of Health Sciences and Arthritis Research UK Centre of Excellence for Sport, Exercise and Osteoarthritis, University of Southampton, Southampton, UK
[6]Department of Orthopaedics, Danderyd University Hospital Corp., Stockholm, Sweden
[7]Department of Neurobiology, Care Sciences and Society, Division of Physiotherapy, Karolinska Institutet, Huddinge, Sweden
[8]National Advisory Unit on Rehabilitation in Rheumatology, Diakonhjemmet Hospital, Oslo, Norway
[9]PMR Department, Rheumatology Division, Marmara University, School of Medicine, Istanbul, Turkey
[10]Copenhagen Center for Arthritis Research, Center for Rheumatology and Spine Diseases, Centre for Head and Orthopaedics, Rigshospitalet., Glostrup, Denmark
[11]Department of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark
[12]University Center of Orthopaedics and Traumatology, University Medicine at Technische Universität Dresden, Dresden, Germany
[13]Department Social Affaire and Health, ECORYS Nederland BV, Rotterdam, Netherlands
[14]Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark
[15]Departmentof Occupational and Physical Therapy, University of Copenhagen, Herlev and Gentofte Hospital, Copenhagen, Denmark
[16]School of Allied Health, Faculty of Education and Health Sciences and Health Research Institute, University of Limerick, Limerick, Ireland
[17]Department of Social Psychology, Faculty of Social Sciences, University of Helsinki, Helsinki, Finland
[18]Department of Rheumatology, Amsterdam Rheumatology and immunology Center, VU University Medical Center, Amsterdam, The Netherlands
[19]Centre for Biomedical Research, University of Algarve, Faro, Portugal
[20]EULAR PARE Patient Research Partner, ReumaNet, Leuven, Belgium
[21]Department of Development and Regeneration, Skeletal Biology and Engineering Research Center, KU Leuven, Leuven, Belgium
[22]Division of Rheumatology, University Hospitals Leuven, Leuven, Belgium
[23]EULAR Patient Research Partner, Cyprus League Against Rheumatism, Nicosia, Cyprus
[24]Primary Health Care Sciences, Keele University, Keele, UK
[25]PRP (Patient Research Partner EULAR), Bulgarian Ankylosing Spondylitis Patient Society, Sofia, Bulgaria and ASIF (Ankylosing Spondylitis International Federation), London, UK

Acknowledgements We thank the librarians Mrs José Plevier and Mr Jan W Schoones, Walaeus Library, Leiden University Medical Center, the Netherlands, for supporting our literature search, and Christian Horvath, Zurich University of Applied Sciences, Switzerland, MSc student for his help in the Cochrane risk of bias assessment.

Contributors AR and KN contributed equally. AR was the research fellow for the project, undertaking the SLR. The fellow was supervised by the steering group consisting of KN (convenor), TPMVV (methodologist), JB (expert). KN and TPMVV supervised the process of the SLR. KN organised and chaired the TF meetings. AR and KN drafted the manuscript with advice from TPMVV and JB. All authors have contributed to the recommendations by participating in the TF meetings; during discussion and agreement on the recommendations; revising and approving the manuscript for publication.

Funding The TF would like to thank EULAR for financial support of this work.

Competing interests None declared.

Patient consent Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep* 1985;100:126–31.
2 Garber CE, Blissmer B, Deschenes MR, *et al*. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and science in sports and exercise* 2011;43:1334–59.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

3 Larkin L, Gallagher S, Cramp F, *et al*. Behaviour change interventions to promote physical activity in rheumatoid arthritis: a systematic review. *Rheumatol Int* 2015;35:1631–40.
4 Keogh A, Tully MA, Matthews J, *et al*. A review of behaviour change theories and techniques used in group based self-management programmes for chronic low back pain and arthritis. *Man Ther* 2015;20:727–35.
5 Organization WH. Global recommendations on physical activity for health. Geneve: Organization WH, 2010.
6 Al Maini M, Adelowo F, Al Saleh J, *et al*. The global challenges and opportunities in the practice of rheumatology: white paper by the World Forum on Rheumatic and Musculoskeletal Diseases. *Clin Rheumatol* 2015;34:819–29.
7 Sveaas SH, Smedslund G, Hagen KB, *et al*. Effect of cardiorespiratory and strength exercises on disease activity in patients with inflammatory rheumatic diseases: a systematic review and meta-analysis. *Br J Sports Med* 2017;51:1065–72.
8 Hernández-Hernández V, Ferraz-Amaro I, Díaz-González F. Influence of disease activity on the physical activity of rheumatoid arthritis patients. *Rheumatology* 2014;53:722–31.
9 Swinnen TW, Scheers T, Lefevre J, *et al*. Physical activity assessment in patients with axial spondyloarthritis compared to healthy controls: a technology-based approach. *PLoS One* 2014;9:e85309.
10 de Groot IB, Bussmann JB, Stam HJ, *et al*. Actual everyday physical activity in patients with end-stage hip or knee osteoarthritis compared with healthy controls. *Osteoarthritis Cartilage* 2008;16:436–42.
11 Iversen MD, Scanlon L, Frits M, *et al*. Perceptions of physical activity engagement among adults with rheumatoid arthritis and rheumatologists. *Int J Clin Rheumtol* 2015;10:67–77.
12 Agca R, Heslinga SC, Rollefstad S, *et al*. EULAR recommendations for cardiovascular disease risk management in patients with rheumatoid arthritis and other forms of inflammatory joint disorders: 2015/2016 update. *Ann Rheum Dis* 2017;76:17–28.
13 van der Heijde D, Ramiro S, Landewé R, *et al*. 2016 update of the ASAS-EULAR management recommendations for axial spondyloarthritis. *Ann Rheum Dis* 2017;76:978–91.
14 Fernandes L, Hagen KB, Bijlsma JW, *et al*. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Ann Rheum Dis* 2013;72:1125–35.
15 American College of Sports M. *Guidelines for exercise testing and prescription*, 2017.
16 van der Heijde D, Aletaha D, Carmona L, *et al*. 2014 Update of the EULAR standardised operating procedures for EULAR-endorsed recommendations. *Ann Rheum Dis* 2015;74:8–13.
17 Brouwers MC, Kho ME, Browman GP, *et al*. AGREE II: advancing guideline development, reporting and evaluation in health care. *Can Med Assoc J* 2010;182:E839–E842.
18 Health P. *PICO Framework Secondary PICO Framework*. 2017.
19 Rausch Osthoff AK, Juhl C, Knittle K, *et al*. *Effects of exercise and physical activity promotion: meta-analysis informing the 2018 EULAR recommendations for physical activity in people with rheumatoid arthritis spondyloarthritis and hip/knee osteoarthritis. under revision, RMD open*, 2018.
20 Higgins J, Green S. *Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0*, 2011.
21 Group OLoEW. The Oxford Levels of Evidence 2. *Oxford Centre for Evidence-Based Medicine* 2011.
22 Bartholdy C, Juhl C, Christensen R, *et al*. The role of muscle strengthening in exercise therapy for knee osteoarthritis: A systematic review and meta-regression analysis of randomized trials. *Semin Arthritis Rheum* 2017;47:9–21.
23 Swärdh E, Brodin N. Effects of aerobic and muscle strengthening exercise in adults with rheumatoid arthritis: a narrative review summarising a chapter in *Physical activity in the prevention and treatment of disease* (FYSS 2016). *Br J Sports Med* 2016;50:362–7.
24 Moseng T, Dagfinrud H, Smedslund G, *et al*. The importance of dose in land-based supervised exercise for people with hip osteoarthritis. A systematic review and meta-analysis. *Osteoarthritis Cartilage* 2017;25:1563–76.
25 Baillet A, Payraud E, Niderprim VA, *et al*. A dynamic exercise programme to improve patients' disability in rheumatoid arthritis: a prospective randomized controlled trial. *Rheumatology* 2009;48:410–5.
26 Baslund B, Lyngberg K, Andersen V, *et al*. Effect of 8 wk of bicycle training on the immune system of patients with rheumatoid arthritis. *J Appl Physiol* 1993;75:1691–5.
27 de Jong Z, Munneke M, Zwinderman AH, *et al*. Is a long-term high-intensity exercise program effective and safe in patients with rheumatoid arthritis? Results of a randomized controlled trial. *Arthritis Rheum* 2003;48:2415–24.
28 de Jong Z, Munneke M, Kroon HM, *et al*. Long-term follow-up of a high-intensity exercise program in patients with rheumatoid arthritis. *Clin Rheumatol* 2009;28:663–71.
29 Durcan L, Wilson F, Cunnane G. The effect of exercise on sleep and fatigue in rheumatoid arthritis: A randomised controlled study. *Irish Journal of Medical Science* 2014;1:S110–S11.
30 Flint-Wagner HG, Lisse J, Lohman TG, *et al*. Assessment of a sixteen-week training program on strength, pain, and function in rheumatoid arthritis patients. *J Clin Rheumatol* 2009;15:165–71.
31 Häkkinen A. Effectiveness and safety of strength training in rheumatoid arthritis. *Curr Opin Rheumatol* 2004;16:132–7.
32 Häkkinen A, Häkkinen K, Hannonen P. Effects of strength training on neuromuscular function and disease activity in patients with recent-onset inflammatory arthritis. *Scand J Rheumatol* 1994;23:237–42.
33 Häkkinen A, Sokka T, Kotaniemi A, *et al*. A randomized two-year study of the effects of dynamic strength training on muscle strength, disease activity, functional capacity, and bone mineral density in early rheumatoid arthritis. *Arthritis Rheum* 2001;44:515–22.
34 Hansen TM, Hansen G, Langgaard AM, *et al*. Longterm physical training in rheumatoid arthritis. A randomized trial with different training programs and blinded observers. *Scand J Rheumatol* 1993;22:107–12.
35 Harkcom TM, Lampman RM, Banwell BF, *et al*. Therapeutic value of graded aerobic exercise training in rheumatoid arthritis. *Arthritis Rheum* 1985;28:32–9.
36 Hsieh LF, Chen SC, Chuang CC, *et al*. Supervised aerobic exercise is more effective than home aerobic exercise in female chinese patients with rheumatoid arthritis. *J Rehabil Med* 2009;41:332–7 http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/945/CN-00687945/frame.html.
37 Janse van Rensburg DC, Ker JA, Grant CC, *et al*. Effect of exercise on cardiac autonomic function in females with rheumatoid arthritis. *Clin Rheumatol* 2012;31:1155–62.
38 Komatireddy GR, Leitch RW, Cella K, *et al*. Efficacy of low load resistive muscle training in patients with rheumatoid arthritis functional class II and III. *The Journal of rheumatology* 1997;24:1531–9.
39 Lemmey AB, Marcora SM, Chester K, *et al*. Effects of high-intensity resistance training in patients with rheumatoid arthritis: a randomized controlled trial. *Arthritis Rheum* 2009;61:1726–34.
40 Lyngberg KK, Harreby M, Bentzen H, *et al*. Elderly rheumatoid arthritis patients on steroid treatment tolerate physical training without an increase in disease activity. *Arch Phys Med Rehabil* 1994;75:1189–95.
41 Melikoglu MA, Karatay S, Senel K, *et al*. Association between dynamic exercise therapy and IGF-1 and IGFBP-3 concentrations in the patients with rheumatoid arthritis. *Rheumatol Int* 2006;26:309–13.
42 Minor MA, Hewett JE, Webel RR, *et al*. Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis. *Arthritis Rheum* 1989;32:1396–405.
43 Neuberger GB, Aaronson LS, Gajewski B, *et al*. Predictors of exercise and effects of exercise on symptoms, function, aerobic fitness, and disease outcomes of rheumatoid arthritis. *Arthritis Rheum* 2007;57:943–52.
44 Sanford Smith S, MaxcKay-Lyons M, Nunes-Clement S. Therapeutic benefits of aquaerobics for individuals with rheumatoid arthritis. *Physiotherapy Canada* 1998;50:40–6.
45 Seneca T, Hauge EM, Maribo T. Comparable effect of partly supervised and self-administered exercise programme in early rheumatoid arthritis-a randomised, controlled trial. *Danish medical journal* 2015;62:A5127.
46 Shapoorabadi YJ, Vahdatpour B, Salesi M, *et al*. Effects of aerobic exercise on hematologic indices of women with rheumatoid arthritis: A randomized clinical trial. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences* 2016;21:9.
47 Siqueira US, Orsini Valente LG, de Mello MT, *et al*. Effectiveness of Aquatic Exercises in Women With Rheumatoid Arthritis: A Randomized, Controlled, 16-Week Intervention-The HydRA Trial. *American journal of physical medicine & rehabilitation* 2017;96:167–75.
48 da Silva KN, Teixeira LE, Imoto AM, *et al*. Effectiveness of sensorimotor training in patients with rheumatoid arthritis: a randomized controlled trial. *Rheumatol Int* 2013;33:2269–75.
49 Strasser B, Leeb G, Strehblow C, *et al*. The effects of strength and endurance training in patients with rheumatoid arthritis. *Clin Rheumatol* 2011;30:623–32.
50 van den Ende CH, Hazes JM, le Cessie S, *et al*. Comparison of high and low intensity training in well controlled rheumatoid arthritis. Results of a randomised clinical trial. *Ann Rheum Dis* 1996;55:798–805.
51 Westby MD, Wade JP, Rangno KK, *et al*. A randomized controlled trial to evaluate the effectiveness of an exercise program in women with rheumatoid arthritis taking low dose prednisone. *The Journal of rheumatology* 2000;27:1674–80.
52 Altan L, Korkmaz N, Dizdar M, *et al*. Effect of Pilates training on people with ankylosing spondylitis. *Rheumatol Int* 2012;32:2093–9.
53 Fang H, Cai W, Pan Y, *et al*. Six-month home-based exercise and supervised training in patients with ankylosing spondylitis. *International Journal of Clinical and Experimental Medicine* 2016;9:6635–41.
54 Hsieh LF, Chuang CC, Tseng CS, *et al*. Combined home exercise is more effective than range-of-motion home exercise in patients with ankylosing spondylitis: a randomized controlled trial. *Biomed Res Int* 2014;2014:1–9.
55 Ince G, Sarpel T, Durgun B, *et al*. Effects of a multimodal exercise program for people with ankylosing spondylitis. *Physical Therapy* 2006;86:924–35.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

56 Jennings F, Oliveira HA, de Souza MC, *et al*. Effects of Aerobic Training in Patients with Ankylosing Spondylitis. *J Rheumatol* 2015;42:2347–53.
57 Karapolat H, Eyigor S, Zoghi M, *et al*. Are swimming or aerobic exercise better than conventional exercise in ankylosing spondylitis patients? A randomized controlled study. *European journal of physical and rehabilitation medicine* 2009;45:449–57.
58 Kjeken I, Bø I, Rønningen A, *et al*. A three-week multidisciplinary in-patient rehabilitation programme had positive long-term effects in patients with ankylosing spondylitis: randomized controlled trial. *J Rehabil Med* 2013;45:260–7.
59 Niedermann K, Sidelnikov E, Muggli C, *et al*. Effect of cardiovascular training on fitness and perceived disease activity in people with ankylosing spondylitis. *Arthritis Care Res* 2013;65:1844–52.
60 Roşu MO, Ţopa I, Chirieac R, *et al*. Effects of Pilates, McKenzie and Heckscher training on disease activity, spinal motility and pulmonary function in patients with ankylosing spondylitis: a randomized controlled trial. *Rheumatol Int* 2014;34:367–72.
61 Sveaas SH, Berg IJ, Provan SA, *et al*. Efficacy of high intensity exercise on disease activity and cardiovascular risk in active axial spondyloarthritis: a randomized controlled pilot study. *PLoS One* 2014;9:e108688.
62 Anwer S, Alghadir A. Effect of isometric quadriceps exercise on muscle strength, pain, and function in patients with knee osteoarthritis: a randomized controlled study. *J Phys Ther Sci* 2014;26:745–8.
63 Baker KR, Nelson ME, Felson DT, *et al*. The efficacy of home based progressive strength training in older adults with knee osteoarthritis: A randomized controlled trial. *Journal of Rheumatology* 2001;28:1655–65.
64 Bennell KL, Egerton T, Pua YH, *et al*. Efficacy of a multimodal physiotherapy treatment program for hip osteoarthritis: a randomised placebo-controlled trial protocol. *BMC Musculoskelet Disord* 2010;11:238.
65 Börjesson M, Robertson E, Weidenhielm L, *et al*. Physiotherapy in knee osteoarthrosis: effect on pain and walking. *Physiother Res Int* 1996;1:89–97.
66 Bruce-Brand RA, Walls RJ, Ong JC, *et al*. Effects of home-based resistance training and neuromuscular electrical stimulation in knee osteoarthritis: a randomized controlled trial. *BMC Musculoskelet Disord* 2012;13:118.
67 Cheung C, Wyman JF, Bronas U, *et al*. Managing knee osteoarthritis with yoga or aerobic/strengthening exercise programs in older adults: a pilot randomized controlled trial. *Rheumatol Int* 2017;37:389–98.
68 Cheung C, Wyman JF, Resnick B, *et al*. Yoga for managing knee osteoarthritis in older women: a pilot randomized controlled trial. *BMC Complement Altern Med* 2014;14:160.
69 da Silva FS, de Melo FE, do Amaral MM, *et al*. Efficacy of simple integrated group rehabilitation program for patients with knee osteoarthritis: Single-blind randomized controlled trial. *J Rehabil Res Dev* 2015;52:309–22.
70 Ettinger WH, Burns R, Messier SP, *et al*. A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis. The Fitness Arthritis and Seniors Trial (FAST). *JAMA* 1997;277:25–31.
71 Fernandes L, Storheim K, Sandvik L, *et al*. Efficacy of patient education and supervised exercise vs patient education alone in patients with hip osteoarthritis: a single blind randomized clinical trial. *Osteoarthritis Cartilage* 2010;18:1237–43.
72 Foroughi N, Smith RM, Lange AK, *et al*. Lower limb muscle strengthening does not change frontal plane moments in women with knee osteoarthritis: A randomized controlled trial. *Clin Biomech* 2011;26:167–74.
73 Fransen M, Nairn L, Winstanley J, *et al*. Physical activity for osteoarthritis management: a randomized controlled clinical trial evaluating hydrotherapy or Tai Chi classes. *Arthritis Rheum* 2007;57:407–14.
74 Henriksen M, Klokker L, Graven-Nielsen T, *et al*. Association of exercise therapy and reduction of pain sensitivity in patients with knee osteoarthritis: a randomized controlled trial. *Arthritis Care Res* 2014;66:1836–43.
75 Hermann A, Holsgaard-Larsen A, Zerahn B, *et al*. Preoperative progressive explosive-type resistance training is feasible and effective in patients with hip osteoarthritis scheduled for total hip arthroplasty–a randomized controlled trial. *Osteoarthritis Cartilage* 2016;24:91–8.
76 Jan MH, Lin JJ, Liau JJ, *et al*. Investigation of clinical effects of high- and low-resistance training for patients with knee osteoarthritis: a randomized controlled trial. *Phys Ther* 2008;88:427–36.
77 Jorge RT, Souza MC, Chiari A, *et al*. Progressive resistance exercise in women with osteoarthritis of the knee: a randomized controlled trial. *Clin Rehabil* 2015;29:234–43.
78 Juhakoski R, Tenhonen S, Malmivaara A, *et al*. A pragmatic randomized controlled study of the effectiveness and cost consequences of exercise therapy in hip osteoarthritis. *Clin Rehabil* 2011;25:370–83.
79 Kim H, Suzuki T, Saito K, *et al*. Effectiveness of exercise with or without thermal therapy for community-dwelling elderly Japanese women with non-specific knee pain: a randomized controlled trial. *Arch Gerontol Geriatr* 2013;57:352–9.
80 Lee HJ, Park HJ, Chae Y, *et al*. Tai Chi Qigong for the quality of life of patients with knee osteoarthritis: a pilot, randomized, waiting list controlled trial. *Clin Rehabil* 2009;23:504–11.
81 Lim JY, Tchai E, Jang SN. Effectiveness of aquatic exercise for obese patients with knee osteoarthritis: a randomized controlled trial. *Pm R* 2010;2:723–31.
82 Lin DH, Lin CH, Lin YF, *et al*. Efficacy of 2 non-weight-bearing interventions, proprioception training versus strength training, for patients with knee osteoarthritis: a randomized clinical trial. *J Orthop Sports Phys Ther* 2009;39:450–7.
83 Mikesky AE, Mazzuca SA, Brandt KD, *et al*. Effects of strength training on the incidence and progression of knee osteoarthritis. *Arthritis Rheum* 2006;55:690–9.
84 Røgind H, Bibow-Nielsen B, Jensen B, *et al*. The effects of a physical training program on patients with osteoarthritis of the knees. *Arch Phys Med Rehabil* 1998;79:1421–7.
85 Salli A, Sahin N, Baskent A, *et al*. The effect of two exercise programs on various functional outcome measures in patients with osteoarthritis of the knee: A randomized controlled clinical trial. *Isokinetics and Exercise Science* 2010;18:201–9.
86 Sayers SP, Gibson K, Cook CR. Effect of high-speed power training on muscle performance, function, and pain in older adults with knee osteoarthritis: a pilot investigation. *Arthritis Care Res* 2012;64:46–53.
87 Steinhilber B, Haupt G, Miller R, *et al*. Exercise therapy in patients with hip osteoarthritis: Effect on hip muscle strength and safety aspects of exercise-results of a randomized controlled trial. *Mod Rheumatol* 2017;27:493–502.
88 Svege I, Fernandes L, Nordsletten L, *et al*. Long-Term Effect of Exercise Therapy and Patient Education on Impairments and Activity Limitations in People With Hip Osteoarthritis: Secondary Outcome Analysis of a Randomized Clinical Trial. *Phys Ther* 2016;96:818–27.
89 Tsai PF, Chang JY, Beck C, *et al*. A pilot cluster-randomized trial of a 20-week Tai Chi program in elders with cognitive impairment and osteoarthritic knee: effects on pain and other health outcomes. *J Pain Symptom Manage* 2013;45:660–9.
90 Wang TJ, Belza B, Elaine Thompson F, *et al*. Effects of aquatic exercise on flexibility, strength and aerobic fitness in adults with osteoarthritis of the hip or knee. *J Adv Nurs* 2007;57:141–52.
91 Weng MC, Lee CL, Chen CH, *et al*. Effects of different stretching techniques on the outcomes of isokinetic exercise in patients with knee osteoarthritis. *Kaohsiung J Med Sci* 2009;25:306–15.
92 Munneke M, de Jong Z, Zwinderman AH, *et al*. Effect of a high-intensity weight-bearing exercise program on radiologic damage progression of the large joints in subgroups of patients with rheumatoid arthritis. *Arthritis Rheum* 2005;53:410–7.
93 Jan MH, Lin CH, Lin YF, *et al*. Effects of weight-bearing versus nonweight-bearing exercise on function, walking speed, and position sense in participants with knee osteoarthritis: a randomized controlled trial. *Arch Phys Med Rehabil* 2009;90:897–904.
94 Bennell KL, Campbell PK, Egerton T, *et al*. Telephone Coaching to Enhance a Home-Based Physical Activity Program for Knee Osteoarthritis: A Randomized Clinical Trial. *Arthritis Care Res* 2017;69:84–94.
95 Bieler T, Siersma V, Magnusson SP, *et al*. OP0006-HPR Even in The Long Run Nordic Walking Is Superior To Strength Training and Home Based Exercise for Improving Physical Function in Older People with Hip Osteoarthritis - An RCT. *Ann Rheum Dis* 2016;75:55.1–55.
96 Brodin N, Eurenius E, Jensen I, *et al*. Coaching patients with early rheumatoid arthritis to healthy physical activity: a multicenter, randomized, controlled study. *Arthritis Rheum* 2008;59:325–31 http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/538/CN-00630538/frame.html.
97 Sjöquist ES, Brodin N, Lampa J, *et al*. Physical activity coaching of patients with rheumatoid arthritis in everyday practice: a long-term follow-up. *Musculoskeletal Care* 2011;9:75–85 http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/704/CN-00799704/frame.html.
98 Brosseau L, Wells GA, Kenny GP, *et al*. The implementation of a community-based aerobic walking program for mild to moderate knee osteoarthritis: a knowledge translation randomized controlled trial: part II: clinical outcomes. *BMC Public Health* 2012;12:1073.
99 Hiyama Y, Yamada M, Kitagawa A, *et al*. A four-week walking exercise programme in patients with knee osteoarthritis improves the ability of dual-task performance: a randomized controlled trial. *Clin Rehabil* 2012;26:403–12.
100 Katz P, Margaretten M, Gregorich S, *et al*. Physical Activity to Reduce Fatigue in Rheumatoid Arthritis: A Randomized Controlled Trial. *Arthritis Care Res* 2018;70:1–10.
101 Lc L, Sayre EC, Xie H, *et al*. A Community-Based Physical Activity Counselling Program for People With Knee Osteoarthritis: Feasibility and Preliminary Efficacy of the Track-OA Study. *JMIR Mhealth Uhealth* 2017;5:e86.
102 O'Dwyer T, Monaghan A, Moran J, *et al*. Behaviour change intervention increases physical activity, spinal mobility and quality of life in adults with ankylosing spondylitis: a randomised trial. *J Physiother* 2017;63:30–9.
103 Rodriguez-Lozano C, Juanola X, Cruz-Martinez J, *et al*. Outcome of an education and home-based exercise programme for patients with ankylosing spondylitis: a nationwide randomized study. *Clinical and experimental rheumatology* 2013;31:739–48.
104 Knittle K, De Gucht V, Hurkmans E, *et al*. Targeting motivation and self-regulation to increase physical activity among patients with rheumatoid arthritis: a randomised controlled trial. *Clin Rheumatol* 2015;34:231–8.
105 van den Berg MH, Ronday HK, Peeters AJ, *et al*. Engagement and satisfaction with an Internet-based physical activity intervention in patients with rheumatoid arthritis. *Rheumatology* 2007;46:545–52.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.

106 Hurkmans E, van der Giesen FJ, Vliet Vlieland TP, *et al*. Dynamic exercise programs (aerobic capacity and/or muscle strength training) in patients with rheumatoid arthritis. *Cochrane Database Syst Rev* 2009;4:Cd006853.
107 Veldhuijzen van Zanten JJ, Rouse PC, Hale ED, *et al*. Perceived Barriers, Facilitators and Benefits for Regular Physical Activity and Exercise in Patients with Rheumatoid Arthritis: A Review of the Literature. *Sports Med* 2015;45:1401–12.
108 Baxter S, Smith C, Treharne G, *et al*. What are the perceived barriers, facilitators and attitudes to exercise for women with rheumatoid arthritis? A qualitative study. *Disabil Rehabil* 2015;38:773–80.
109 Halls S, Law RJ, Jones JG, *et al*. Health Professionals' Perceptions of the Effects of Exercise on Joint Health in Rheumatoid Arthritis Patients. *Musculoskeletal Care* 2017;15:196–209.
110 Larkin L, Kennedy N, Fraser A, *et al*. 'It might hurt, but still it's good': People with rheumatoid arthritis beliefs and expectations about physical activity interventions. *J Health Psychol* 2017;22.
111 O'Dwyer T, McGowan E, O'Shea F, *et al*. Physical Activity and Exercise: Perspectives of Adults With Ankylosing Spondylitis. *J Phys Act Health* 2016;13:504–13.
112 Dobson F, Bennell KL, French SD, *et al*. Barriers and Facilitators to Exercise Participation in People with Hip and/or Knee Osteoarthritis: Synthesis of the Literature Using Behavior Change Theory. *Am J Phys Med Rehabil* 2016;95:372–89.
113 Carmona-Terés V, Moix-Queraltó J, Pujol-Ribera E, *et al*. Understanding knee osteoarthritis from the patients' perspective: a qualitative study. *BMC Musculoskelet Disord* 2017;18:225.
114 Petursdottir U, Arnadottir SA, Halldorsdottir S. Facilitators and barriers to exercising among people with osteoarthritis: a phenomenological study. *Phys Ther* 2010;90:1014–25.
115 Loeppenthin K, Esbensen B, Ostergaard M, *et al*. Physical activity maintenance in patients with rheumatoid arthritis: a qualitative study. *Clin Rehabil* 2014;28:289–99.
116 FANG F-fu, Han G, Zhou F, *et al*. Physical therapy in grassroot military medical units of PLA: current situation. *Academic Journal of Second Military Medical University* 2015;36:65–8.
117 Nicolson PJA, Hinman RS, French SD, *et al*. Improving Adherence to Exercise: Do People With Knee Osteoarthritis and Physical Therapists Agree on the Behavioral Approaches Likely to Succeed? *Arthritis Care Res* 2018;70:388–97.
118 Keogh JWL, Grigg J, Vertullo CJ, *et al*. High-Intensity Interval Training Cycling Feasible and Safe for Patients With Knee Osteoarthritis?: Study Protocol for a Randomized Pilot Study. *Orthopaedic Journal of Sports Medicine* 2017;5.
119 Karapolat H, Akkoc Y, Sari I, *et al*. Comparison of group-based exercise versus home-based exercise in patients with ankylosing spondylitis: effects on Bath Ankylosing Spondylitis Indices, quality of life and depression. *Clin Rheumatol* 2008;27:695–700.
120 Bieler T, Magnusson SP, Kjaer M, *et al*. SAT0451 Supervised Strength Training, NORDIC Walking or Unsupervised Home Based Exercise in Older People with Hip Osteoarthritis? A Randomized Trial. *Ann Rheum Dis* 2014;73:757.1–757.
121 van Eijk-Hustings Y, van Tubergen A, Boström C, *et al*. EULAR recommendations for the role of the nurse in the management of chronic inflammatory arthritis: Table 1. *Ann Rheum Dis* 2012;71:13–19.
122 Stamm T, Hill J. Extended roles of non-physician health professionals and innovative models of care within Europe: results from a web-based survey. *Musculoskeletal Care* 2011;9:93–101.
123 Bennell KL, Hunt MA, Wrigley TV, *et al*. Hip strengthening reduces symptoms but not knee load in people with medial knee osteoarthritis and varus malalignment: a randomised controlled trial. *Osteoarthritis Cartilage* 2010;18:621–8.
124 Riebe D, Franklin BA, Thompson PD, *et al*. Updating ACSM's Recommendations for Exercise Preparticipation Health Screening. *Medicine & Science in Sports & Exercise* 2015;47:2473–9.
125 Larkin L, Kennedy N, Gallagher S. Promoting physical activity in rheumatoid arthritis: a narrative review of behaviour change theories. *Disabil Rehabil* 2015;37:2359–66.
126 Demmelmaier I, Iversen MD. How Are Behavioral Theories Used in Interventions to Promote Physical Activity in Rheumatoid Arthritis? A Systematic Review. *Arthritis Care Res* 2018;70:185–96.
127 Hurkmans EJ, van den Berg MH, Ronday KH, *et al*. Maintenance of physical activity after Internet-based physical activity interventions in patients with rheumatoid arthritis. *Rheumatology* 2010;49:167–72.
128 NICE. Behaviour change: individual approaches. *Secondary Behaviour change: individual approaches*, 2014.
129 Higgins JP, Green S. Cochrane Handbook for systematic reviews of interventions. *Secondary* 2011.
130 Hoffmann TC, Glasziou PP, Boutron I, *et al*. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014;348:g1687.

Ann Rheum Dis: first published as 10.1136/annrheumdis-2018-213585 on 11 July 2018. Downloaded from http://ard.bmj.com/ on 17 September 2018 by guest. Protected by copyright.