EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis

Linda Fernandes,[1] Kåre B Hagen,[1] Johannes W J Bijlsma,[2] Oyvor Andreassen,[3] Pia Christensen,[4,5] Philip G Conaghan,[6] Michael Doherty,[7] Rinie Geenen,[8] Alison Hammond,[9] Ingvild Kjeken,[1] L Stefan Lohmander,[10,11,12] Hans Lund,[11] Christian D Mallen,[13] Tiziana Nava,[14] Susan Oliver,[15] Karel Pavelka,[16] Irene Pitsillidou,[17] José Antonio da Silva,[18] Jenny de la Torre,[19] Gustavo Zanoli,[20] Theodora P M Vliet Vlieland[21]

▶ Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/annrheumdis-2012-202745).

For numbered affiliations see end of article.

Correspondence to
Dr Linda Fernandes, National Resource Center for Rehabilitation in Rheumatology, Diakonhjemmet Hospital, Postboks 23, Vinderen, Oslo 0319, Norway; linda.fernandes1@gmail.com

Accepted 24 March 2013
Published Online First 17 April 2013

ABSTRACT

The objective was to develop evidence -based recommendations and a research and educational agenda for the non-pharmacological management of hip and knee osteoarthritis (OA). The multidisciplinary task force comprised 21 experts: nurses, occupational therapists, physiotherapists, rheumatologists, orthopaedic surgeons, general practitioner, psychologist, dietician, clinical epidemiologist and patient representatives. After a preliminary literature review, a first task force meeting and five Delphi rounds, provisional recommendations were formulated in order to perform a systematic review. A literature search of Medline and eight other databases was performed up to February 2012. Evidence was graded in categories I–IV and agreement with the recommendations was determined through scores from 0 (total disagreement) to 10 (total agreement). Eleven evidence-based recommendations for the non-pharmacological core management of hip and knee OA were developed, concerning the following nine topics: assessment, general approach, patient information and education, lifestyle changes, exercise, weight loss, assistive technology and adaptations, footwear and work. The average level of agreement ranged between 8.0 and 9.1. The proposed research agenda included an overall need for more research into non-pharmacological interventions for hip OA, moderators to optimise individualised treatment, healthy lifestyle with economic evaluation and long-term follow-up, and the prevention and reduction of work disability. Proposed educational activities included the required skills to teach, initiate and establish lifestyle changes. The 11 recommendations provide guidance on the delivery of non-pharmacological interventions to people with hip or knee OA. More research and educational activities are needed, particularly in the area of lifestyle changes.

INTRODUCTION

Osteoarthritis (OA) is one of the most common chronic diseases, with an estimated overall prevalence in the general adult population of 11% and 24% for hip and knee OA, respectively.[1] OA is age related, with manifestations often not occurring until middle age. In elderly people, OA is the most common cause of disability, including pain and limitations of activities and participation.[2–4] As life expectancy is increasing the number of people living for prolonged periods with severe OA is expected to grow.

The need for high-quality care for a condition with major personal and societal impact is generally recognised and several guidelines for such care are available.[5–9] International recommendations for management of OA are often divided into three main categories: non-pharmacological, pharmacological and surgical.[6] During the past decade, much emphasis has been put on non-pharmacological management. However, recommendations are not sufficiently specific about the content, timing, intensity, frequency, duration and mode of delivery of each non-pharmacological option. This lack of detailed guidance may be one of the reasons why the quality of care for people with hip or knee OA is found to be suboptimal in several studies.[10 11]

In order to deal with this problem, the European League Against Rheumatism (EULAR) convened a group of experts to produce evidence-based recommendations for the non-pharmacological management of people with hip or knee OA, in accordance with the EULAR standard operating procedures,[12] and to develop a research and educational agenda for future activities. These recommendations would provide more detail and would therefore be an addition to existing management guidelines and would be easier to implement. The target groups for these recommendations are all healthcare providers involved in the delivery of non-pharmacological interventions, researchers in the field of OA, officials in healthcare governance, reimbursement agencies and policy makers. In addition, people with hip or knee OA can use the recommendations for information on non-pharmacological management strategies.

METHODS

The task force aimed to aggregate available information on non-pharmacological management of hip and knee OA into practical recommendations, using EULAR standardised operational procedures.[12] These involved the assembly of an expert committee to develop consensus, based both on research evidence provided by a systematic literature review and expert opinion.

The task force comprised 21 people with particular knowledge of OA from 10 European

countries, specifically: two nurses (SO, JdlT); one psychologist (RG); one dietician (PC); two occupational therapists (AH, IK); three physiotherapists (KBH, HL, TN); five rheumatologists (JWJB, PGC, MD, KP, JAdS); two orthopaedic surgeons (LSL, GZ); one general practitioner (CDM); two persons representing people with hip and/or knee OA (OA, IP); a clinical epidemiologist (TPMVV); and a research fellow (LF).

The process was based on both research evidence and consensus (see online supplementary appendix tables S1–S2 and figures S1–S12), and included, between June 2011 and May 2012, two task force meetings, systematic literature reviews (SLR) and extensive discussions. If a recommendation was shown to be inaccurate, based on data from the SLR, it could be rejected. Research evidence was graded in categories I–IV (table 1).[12] During the second task force meeting, votes for level of agreement (LOA) were cast anonymously, by giving a score on a numeric rating scale from 0 (total disagreement) to 10 (total agreement) for each recommendation; mean and 95% CI of scores were calculated. Topics for the research and educational agenda were formulated based on discussions of the lack of evidence to substantiate the recommendations and weaknesses in current healthcare delivery.

RESULTS

Development of the recommendations

After the first meeting, a total of 168 propositions were suggested by the experts. Propositions that were identical were merged and propositions containing one word only were excluded. The second Delphi round comprised 140 propositions, with topics being very broad and including far more non-pharmacological interventions than currently included in these recommendations. After five Delphi rounds, consensus on 11 recommendations was achieved, which are presented with complete formulation in table 2 with the accompanying level of evidence (LOE) and LOA. The 11 recommendations are ordered in a logical sequence or procedural and chronological hierarchy rather than by any considered importance.

The terms 'non-pharmacological' and 'non-surgical' management were discussed by the expert group. The terms were considered to be negative owing to their prefix 'non' and were therefore not considered optimal; finding a new terminology was included in the research agenda (table 3). In addition, research evidence specifically for hip OA was sparse and, in general, recommendations for the management of people with hip OA were derived largely from trials including people with both hip and knee OA or with knee OA only.

Initial assessment

Research data on how a comprehensive assessment of people with hip or knee OA should best be carried out are scarce. Since initial assessment will always be a part of the management in any person with hip or knee OA, controlled trials evaluating assessment will have difficulties in selecting the most appropriate comparator. One randomised, controlled trial (RCT) comparing a comprehensive assessment and management approach with usual care showed no difference in pain or physical function.[13] However, in that study, both approaches included initial assessments, but with different content and were executed by different professionals.[13]

The group considered a comprehensive initial assessment to be a prerequisite for the individualised management strategy described in recommendation 2. The recommendation on the initial assessment included the following elements: the person's physical status, activities of daily living, participation, mood and health education needs, health beliefs and motivation to self-manage. In the absence of evidence from studies on the effectiveness of various forms of assessment, the group based the recommended content of the initial assessment on the main areas of disease consequences, including potentially interacting personal and environmental factors described in the literature.[14–22] Evaluation of cardiovascular disease, people's expectations and self-efficacy were also discussed as important aspects in a biopsychosocial approach.[14 17] Moreover, the group found that a comprehensive assessment, which is applicable to the initial consultation, should also be repeated during regular follow-up of the person.

Table 1 Categories of levels of evidence

Category	Level of evidence
Ia	Meta-analysis of randomised controlled trials
Ib	At least one randomised controlled trial
IIa	At least one controlled trial without randomisation
IIb	At least one type of quasi-experimental study
III	Descriptive studies, such as comparative studies, correlation studies or case–control studies
IV	Expert committee reports or opinions and/or clinical experience of respected authorities

Individualised treatment

The task force agreed unanimously that the overarching principle for treatment of a person with hip or knee OA should be individualised, which is in line with previous guidelines.[7–9 23] Individualised treatment does not imply that every treatment should be individually provided, it means rather that treatment is personalised, or tailored. RCTs on individualised non-pharmacological management are scant. The available studies showed reduced pain (mean difference, 95% CI (0–20 point scale): −1.19, −2.1 to −0.3 and −1.10, −1.84 to −0.19; and (0–100 scale): −17.0, −23.6 to −10.4) and improved physical function (mean difference, 95% CI (0–68 point scale): 3.65, 1.0 to 6.3 and 3.33, 0.78 to 5.88) compared with usual care,[24–26] but not compared with group-based rehabilitation[25 27 28] or information on healthy lifestyle.[29 30] Follow-ups at 9, 18 or 30 months showed no effect on pain.[31 32]

As the data underpinning this recommendation are limited the factors to be considered for the tailoring of management were mainly based on prognostic factors shown in the literature. An important and modifiable risk factor for knee OA is weight,[20 33 34] implying individualised targeting at weight reduction in people who are overweight or obese.

Moreover, individualised treatment being the standard of care in OA and chronic disease in general[7 35 36] was considered to imply informed, shared decision-making, taking into account the person's wishes and preferences. The group noted that with the conduct of an RCT to study the impact of individualisation, the patient's view cannot be wholly taken into account and that some element of individualisation will always be incorporated in any treatment. To better understand individualised treatment, the group found that future research should focus on factors that affect outcome—that is, moderators, not individualisation as such.

Comprehensive package of care

This recommendation deals with the provision of an integrated package of care rather than single treatments alone or in succession. The group recommended five core interventions to be

Table 2 EULAR recommendations for the non-pharmacological core management of hip and knee OA, with levels of evidence (LOE) and level of agreement (LOA). The propositions are ordered by topic

No.	Recommendation	LOE I–IV	LOA (95% CI)
1	In people with hip or knee OA, initial assessments should use a biopsychosocial approach including: a physical status (including pain; fatigue; sleep quality; lower limb joint status (foot, knee, hip); mobility; strength; joint alignment; proprioception and posture; comorbidities; weight) b activities of daily living c participation (work/education, leisure, social roles) d mood e health education needs, health beliefs and motivation to self-manage	Ib, mixed	8.6 (7.9 to 9.2)
2	Treatment of hip and/or knee OA should be individualised according to the wishes and expectations of the individual, localisation of OA, risk factors (such as age, sex, comorbidity, obesity and adverse mechanical factors), presence of inflammation, severity of structural change, level of pain and restriction of daily activities, societal participation and quality of life	Ib, mixed Ib, knee	8.7 (8.2 to 9.2)
3	All people with knee/hip OA should receive an individualised management plan (a package of care) that includes the core non-pharmacological approaches, specifically: a information and education regarding OA b addressing maintenance and pacing of activity c addressing a regular individualised exercise regimen d addressing weight loss if overweight or obese e* reduction of adverse mechanical factors (eg, appropriate footwear) f* consideration of walking aids and assistive technology	Ib, hip Ib, knee	8.7 (8.2 to 9.3)
4	When lifestyle changes are recommended, people with hip or knee OA should receive an individually tailored programme, including long-term and short-term goals, intervention or action plans, and regular evaluation and follow-up with possibilities for adjustment of the programme	Ib, mixed Ib, knee	8.0 (7.1 to 9.0)
5	To be effective, information and education for the person with hip or knee OA should: a* be individualised according to the person's illness perceptions and educational capability b* be included in every aspect of management c† specifically address the nature of OA (a repair process triggered by a range of insults), its causes (especially those pertaining to the individual), its consequences and prognosis d† be reinforced and developed at subsequent clinical encounters; e† be supported by written and/or other types of information (eg, DVD, website, group meeting) selected by the individual f† include partners or carers of the individual, if appropriate	Ia, mixed	8.4 (7.7 to 9.1)
6	The mode of delivery of exercise education (eg, individual 1 : 1 sessions, group classes, etc) and use of pools or other facilities should be selected according both to the preference of the person with hip or knee OA and local availability. Important principles of all exercise include: a† 'small amounts often' (pacing, as with other activities) b† linking exercise regimens to other daily activities (eg, just before morning shower or meals) so they become part of lifestyle rather than additional events c* starting with levels of exercise that are within the individual's capability, but building up the 'dose' sensibly over several months	Ia, knee, delivery mode Ia, mixed, water-based exercise	8.9 (8.5 to 9.3)
7	People with hip and/or knee OA should be taught a regular individualised (daily) exercise regimen that includes: a strengthening (sustained isometric) exercise for both legs, including the quadriceps and proximal hip girdle muscles (irrespective of site or number of large joints affected) b aerobic activity and exercise c adjunctive range of movement/stretching exercises * Although initial instruction is required, the aim is for people with hip or knee OA to learn to undertake these regularly on their own in their own environment	Ia, hip, overall exercise Ia, knee, overall exercise Ia, knee, strength Ia, knee, aerobic Ia, mixed, mixed programmes	8.5 (7.7 to 9.3)
8	Education on weight loss should incorporate individualised strategies that are recognised to effect successful weight loss and maintenance*—for example: a† regular self-monitoring, recording monthly weight b† regular support meetings to review/discuss progress c† increase physical activity d† follow a structured meal plan that starts with breakfast e† reduce fat (especially saturated) intake; reduce sugar; limit salt; increase intake of fruit and vegetables (at least '5 portions' a day) f† limit portion size; g† addressing eating behaviours and triggers to eating (eg, stress) h† nutrition education i† relapse prediction and management (eg, with alternative coping strategies)	III, hip Ia, knee	9.1 (8.6 to 9.5)
9	a‡ The use of appropriate and comfortable shoes is recommended. b Recommendation rejected: a lateral-wedged insole could reduce symptoms in medial knee pain.	Ib, knee. Ib, knee	8.7 (8.2 to 9.2) 8.0 (7.0 to 9.1)
10	Walking aids, assistive technology and adaptations at home and/or at work should be considered, to reduce pain and increase participation—for example: a† a walking stick used on the contralateral side, walking frames and wheeled 'walkers' b* increasing the height of chairs, beds and toilet seats c* hand-rails for stairs d* replacement of a bath with a walk-in shower e* change to car with high seat level, easy access and automatic gear change	III, hip III, knee	8.9 (8.5 to 9.3)

Continued

Table 2 Continued

No.	Recommendation	LOE I–IV	LOA (95% CI)
11	People with hip or knee OA at risk of work disability or who want to start/return to work should have rapid access to vocational rehabilitation, including counselling about modifiable work-related factors such as altering work behaviour, changing work tasks or altering work hours, use of assistive technology, workplace modification, commuting to/from work and support from management, colleagues and family towards employment	III, hip III, knee Ib, mixed, sick leave	8.9 (8.3 to 9.5)

Recommendations with different LOE within the recommendation are listed below. In the absence of grading of evidence for hip OA populations, the LOE equals IV. LOA was computed as a 0–10 scale, based on 17 votes of agreement with the recommendation.
*The specific element was not included in composite interventions and LOE for the inclusion of this specific element could not be graded.
†The specific element was included in composite interventions and LOE for the inclusion of this specific element was graded as Ib (ie, no. 5c–f, mixed populations; no. 6a and b, mixed or knee populations; no. 8, knee populations; no. 10a, knee populations).
‡Comparisons between different pairs of comfortable shoes.
LOA, level of agreement; LOE, level of evidence; OA, osteoarthritis.
Mixed, the evidence is extracted from studies including a mixed population—that is, people with hip and/or knee OA.

considered comprehensively in every patient with hip or knee OA. The recommendation specifically implies that a person with hip or knee OA should receive education about her/his condition (3a), and be managed accordingly (3b–e).

With the exception of walking aids and assistive technology and dealing with adverse mechanical factors, the literature supports the delivery of combined interventions including information and education, exercise and/or weight reduction.

In people with hip and/or knee OA the combination of patient education or self-management intervention plus exercise was found to have a significant effect on pain, but a less marked effect on function.[26 31 37–40] In people with hip OA the effect of such combinations was mainly seen on function (0–100 point scale) at 3 and 6 months after intervention (mean difference, 95% CI −7.5, −13.9 to −1.0; and −8.4, −15.1 to −1.7).[41 42] In people with knee OA effects on pain and/or function were seen in eight studies,[24 25 43–48] whereas no effect was seen in four studies.[32 49–51] The addition of advice from a dietician for overweight or obese patients to the combination of patient education or self-management intervention plus exercise was found to improve both pain and function in patients with hip or knee OA.[52–55]

Principles of lifestyle changes

Recommendation 4 deals with key elements of the delivery of interventions aimed to initiate and maintain lifestyle changes. It is known that behavioural changes are difficult to achieve and maintain, and the effect of advice and counselling by healthcare providers is disappointing.[56] The literature search for this recommendation was limited to lifestyle changes considered most relevant for hip and knee OA—that is, exercise and weight loss.

The common feature in the trials supporting this recommendation was to teach and encourage behavioural change strategies through goal setting of physical activity and weight changes, action plans to maintain changes and regular follow-up over at least 1 year to re-evaluate and discuss goals and action plans.[28 39 40 53 57–62]

Reports examining the effectiveness of specific elements to be included in interventions aiming to change behaviour are scarce. The literature suggests that the following factors improve adherence to exercise or physical activity: individual exercise, graded activity, individualisation according to the person's exercise goals, feedback on progress made towards the goals, iterative problem solving with emphasis on skills that will improve adherence, reinforcements of maintaining exercise such as additional motivational programmes, exercise plans and log books, written information and audiotape or videotape, and booster sessions.[28 39 40 61–63] In addition, some studies found an effect on pain[39 40] or function[59] from lifestyle interventions that integrate such elements. A systematic review including a mixed population of people with OA and/or rheumatoid

Table 3 Research and educational agenda for non-pharmacological management of hip and knee OA

Research theme	Research questions
Terminology	Defining non-pharmacological management Finding an appropriate terminology for non-pharmacological management
General	Evaluating effectiveness and safety of non-pharmacological management strategies, specifically in hip OA
Individualised treatment	Assessing moderators of the outcome of hip and knee OA to optimise individualised treatment
Delivery of care	Defining to whom, and at what stage, the package of care needs to be delivered Assessing by which professionals the package of care can best be delivered
Lifestyle changes	Assessing the long-term outcomes (≥ 2 years) of exercise, physical activity and weight reduction with outcomes including adherence and cardiovascular morbidity
Footwear	Assessing the effectiveness and costs of various forms of footwear
Assistive technology	Assessing the use of, and satisfaction with, assistive technology
Work ability	Assessing the effectiveness and costs of interventions aiming to prevent or reduce work disability and/or increase return, or entering, the workforce
Research methodology	Developing and including measures of societal participation Developing and including measures of adherence Including economic analyses in studies on non-pharmacological management Conducting studies with appropriate sample sizes
Education	**Research questions**
	Need for training courses on the required skills to initiate and establish lifestyle changes; this education should be aimed at professionals, people with arthritis and the public

arthritis found effect sizes of 0.21 (95% CI 0.08 to 0.34) for pain and 0.69 (95% CI 0.49 to 0.88) for increased physical activity from lifestyle interventions aiming at increasing physical activity.[64] Over 40% of the included lifestyle interventions prompted problem solving, self-monitoring, goal setting and regular feedback.[64]

For people with knee OA or knee pain, improvements were seen in pain, function and weight loss from diet interventions that included individual weight-loss goals, problem solving on how to reach these goals and follow-up visits to re-evaluate and discuss goals in combination with exercise.[53 60] In obese patients, weight-loss programmes with explicit weight-loss goals showed a higher mean change in weight than programmes without explicit goals.[65] This indicates that the elements in recommendation 4 are important for the change and long-term maintenance of behaviour. The group discussed the importance of regular follow-up that includes feedback on the progress towards explicit goals and extends over a long time to achieve long-term effects of a healthy lifestyle.

Principles of information and education

Recommendation 5 is concerned with the content and method of delivery of various forms of educational programmes to best benefit the person with hip or knee OA. It is grounded in the general recognition that appropriate information and education are indispensable in prompting adequate self-management in chronic diseases. The recommendation is underpinned by the majority of studies on education interventions provided to patients with hip and/or knee OA. In general, small, but statistically significant effect sizes on pain (0.06, 95% CI 0.02 to 0.10) and physical function (0.06, 95% CI 0.02 to 0.10) have been reported from attending education or self-management programmes.[6 66] Lower costs of community-based care and medication up to 12 months has been achieved from attending a combined self-management and exercise programme, and a reduced number of medical consultations from attending self-management programmes in patients with hip and/or knee OA have been reported.[32 67 68]

The literature review included trials that compared education or self-management programmes with usual care, attention controls or no intervention. These trials described one or several elements from 5c to f (table 2) in their interventions.[69–85] The literature did not support the additional value of spouse-assisted coping skills training,[79] and no trials were found for individualisation according to illness perception and educational capability, or for inclusion of education in every aspect of management. The group, however, considered the inclusion of spouses in the intervention to be a question of individualisation and appropriate in some cases. One systematic review found that, in people with OA, effective self-management interventions followed a protocol, included elements of cognitive behavioural theory or social cognitive theory and were led by trained health professionals.[86] These elements are not specifically dealt with in the recommendation, yet they were supported by the group.

Principles of exercise education

Recommendation 6 deals with the principles of the delivery of education about exercise and physical activity. There is convincing evidence for the overall effectiveness of exercise on pain (ES, 95% CI: 0.40, 0.30 to 0.50) and function (ES, 95% CI: 0.37, 0.25 to 0.49) in people with knee OA,[87] and to a lesser extent in people with hip OA (ES, 95% CI, pain 0.38, 0.08 to 0.68).[88]

Few studies have directly compared different exercise 'dosage' (frequency, intensity and duration) and progression approaches in people with OA.[87 89 90] One RCT reported reduced pain from attending a progressive functional strengthening programme compared with a non-progressive programme in people with knee OA,[90] but two trials could not show any differences from attending various intensity levels of aerobic or resistance-exercise programmes.[89 91] Hence, the optimal exercise 'dosage' and rate of progression remain uncertain.

In patients with knee OA different delivery modes (individual, group-based or home programmes) have all been shown to effectively reduce pain (individual, ES, 95% CI 0.55, 0.29 to 0.81; group-based, ES, 95% CI 0.37, 0.24 to 0.51; and, home, ES, 95% CI 0.28, 0.16 to 0.39) and improve function (individual, ES, 95% CI 0.52, 0.19 to 0.86; group-based, ES, 95% CI 0.35, 0.19 to 0.50; and, home, ES, 95% CI 0.28, 0.17 to 0.38) compared with education, telephone calls, waiting list, relaxation, ultrasound, hot-packs or no treatment.[87] In patients with hip and/or knee OA, water-based exercise was found to significantly reduce pain (ES, 95% CI 0.19, 0.04 to 0.35) and improve function (ES, 95% CI 0.26, 0.11 to 0.42) compared with education, telephone calls or no intervention.[92] Home-based exercise was found to be as effective as water-based exercise in one small RCT in people with hip OA.[93] Water-based exercise can include swimming and/or different types of exercise programmes. Since the different modes of delivery are equally effective, the person's preference, findings of the initial assessment and local availability should determine the choice of mode of delivery in clinical practice.

The literature suggests that pacing of activity and/or integrating physical activity into daily living as part of a comprehensive exercise regimen is more effective in people with hip or knee OA or with knee pain than usual care or written information, but not compared with standardised exercise or a pharmacy review.[24–26 29 31 38 46 57 58 77–79 94]

This recommendation suggests the need for an increase in the intensity and/or duration of exercise over time. This is based on the literature, where most strength training exercise programmes evaluated in people with knee OA included dynamic exercises with progression over time.[95] Moreover, in one study comparing progressive and non-progressive approaches in people with knee OA, the former was found to reduce pain more effectively.[90] General recommendations for dosage and progression of exercise in older people and people with chronic disease are aerobic moderate-intensity training for at least 30 min/day or up to 60 min for greater benefit, and progressive strength training involving the major muscle groups at least 2 days/week at a level of moderate to vigorous intensity (60–80% of one repetition maximum) for 8–12 repetitions.[96 97] These recommendations emphasise that in people with chronic disease who do not reach the recommended level, they should be as physically active as their abilities and condition allow.[97]

Exercise regimen

Before considering the evidence for specific exercises in hip and knee OA, it should be noted that although exercise has been shown to reduce pain in patients with hip OA,[88] overall there is a lack of information to support treatment effects of exercise in hip OA.[8 88 98–103] The LOE for the recommendation of different types of exercise in people with hip OA therefore could not be graded. For knee OA, however, high-quality research evidence has reported that exercise reduces pain and improves

physical function.[6 87 104] Results for the effect of exercise on quality of life are inconsistent.[90 92 95 99 102 104 105]

Research about strengthening exercises in knee OA shows that both specific quadriceps strengthening exercises or strength training for the lower limb reduce pain effectively (ES, 95% CI 0.29, 0.06 to 0.51 and 0.53, 0.27 to 0.79, respectively) and improve physical function (ES, 95% CI 0.24, 0.06 to 0.42 and 0.58, 0.27 to 0.88, respectively).[87] The literature on strength training in people with knee OA in most cases describes dynamic exercises, whereas research on isometric exercises is sparse.[95] Hip strengthening exercises have been poorly evaluated in people with hip OA.[103] However, in people with medial tibiofemoral knee OA, hip strengthening exercises reduced knee pain and improved physical function.[106]

Aerobic training (walking) is effective in reducing pain (ES, 95% CI 0.48, 0.13 to 0.43) and improving physical function (ES, 95% CI 0.35, 0.11 to 0.58) in patients with knee OA.[87]

The evidence for mixed exercise programmes, including strengthening, aerobic and flexibility components, in patients with knee OA is conflicting.[107 108] One type of exercise has not been shown to be better than another (strength, aerobic or mixed exercises).[87 107 108]

The group reached consensus that mixed programmes should be recommended. However, it was noted that with mixed programmes the minimal requirements to improve or maintain muscle strength, aerobic capacity and/or joint range of motion need to be met,[97] as some reports suggest that mixed programmes may be less effective than focused programmes.[108]

This recommendation states that initial instruction is required, but that in the longer term the person should integrate exercise into daily life. This part of the recommendation is substantiated by studies showing that the number of supervised sessions influences outcome in people with knee OA.[87] Twelve or more directly supervised sessions have been shown to be more effective than a smaller number on pain (ES 0.46, 95% CI 0.32 to 0.60 vs ES 0.28, 95% CI 0.16 to 0.40, p=0.03) and physical function (ES 0.45, 95% CI 0.29 to 0.62 vs ES 0.23, 95% CI 0.09 to 0.37, p=0.02).[87]

In addition, it was noted that research evidence is growing for tai chi and yoga. Though not included in the literature review, tai chi has been found to be effective for the reduction of pain in patients with hip or knee OA, with ES ranging from 0.28 to 1.67.[108]

Education on weight loss

In recommendation 8, the principles of education about weight management are included. The recommendation is mainly supported by the literature in knee OA, as no evidence to support the effect of weight loss in patients with hip OA is available. However, being overweight or obese has been shown to be associated with hip OA (OR=1.11, 95% CI 1.07 to 1.16).[33]

In patients with knee OA, the effectiveness of weight-loss programmes on body weight, pain and/or physical function was demonstrated in programmes delivered as weekly supervised sessions for a range of 8 weeks to 2 years.[54 60 109–113] The effects on pain, function and weight loss from attending weight-loss programmes were small but significant (ES, 95% CI, pain 0.20, 0.00 to 0.39; physical function 0.23, 0.04 to 0.42; mean weight loss, 95% CI, 6.1 kg, 4.7 to 7.6).[109] The interventions included strategies on how to reduce calorie intake by meal plans, reduce fat and sugar, reduce portion size, meal replacements, and comprised behavioural modifications, self-monitoring, weight-loss goals and maintaining body weight in participants who had reached their goals and/or exercises for some of them.[54 60 109–112] Overall, the evidence from RCTs for the maintenance of achieved weight loss after the interventions have ended is absent in people with hip and knee OA.

In general, in overweight or obese populations, healthy eating, limiting fat and salt intake, eating at least five portions of fruit and vegetables a day, being physically active for at least 30 min/day and elements such as self-monitoring, explicit weight-loss goals, and motivational interviewing have all been suggested to promote weight loss and that regular follow-up over 4 years helps in maintenance of the weight loss.[65 114–118] Weight-loss programmes in older obese people that included explicit weight-loss goals showed mean changes in weight of −4.0 kg (95% CI −7.3 to −0.7), which was significantly more than programmes without explicit weight-loss goals (mean change, 95% CI, −1.3 kg, −2.9 to 0.3).[65] To achieve a structured meal plan with a balanced combinations of low calorie and sufficient vitamin and mineral intake, meal replacement bars or powders can be an addition to healthy eating.[54 60 109 110] Though not included in the literature review, it has been suggested that bariatric surgery should be part of comprehensive weight management in people with hip or knee OA who are morbidly obese, and could help reduce weight and joint pain.[119 120]

Footwear

Although research evidence is scant, the group was unanimous in its view that the use of appropriate footwear should be recommended in patients with hip or knee OA. Shoes may help through different mechanisms, such as acting as shock absorbers or controlling foot pronation.[121 122] Appropriate shoes implies no raised heel, thick, shock-absorbing soles, support for the arches of the foot and a shoe size big enough to give a comfortable space for the toes.[121–123]

In patients with hip OA there is no evidence to support the effect of specific shoes or insoles on pain or function. In patients with knee OA, the use of shoes with shock-absorbing insoles for 1 month reduced pain and improved physical function in a pre–post test design.[124] No differences in knee pain from the use of specialised shoes (unstable Masai technology shoe or variable-stiffness shoe) compared with conventional athletic shoes have been seen, but reduced pain was seen in both groups over time.[125 126] In addition, decreased knee joint loads were found when specialised mobility shoes were used.[121]

The literature on the effectiveness of the use of lateral wedged insoles in patients with medial knee OA found no significant effect on pain or function.[121 127 128] There is no support for whether one type of insole would be better than another,[129] and adverse effects including foot-sole pain, low-back pain and popliteal pain have been reported.[121 128 129] In light of evidence for no clinical effects of the use of lateral wedged insoles and the report of adverse effects, the group rejected the recommendation (table 2, 9b).

Assistive technology and adaptations at home and/or at work

The frequent use of assistive technology and the high satisfaction rates with its use indicate that walking aids, assistive technology and adaptations are important and useful for people with hip or knee OA.[130–133] There are, however, no clinical trials to substantiate elements in this proposition, except for the use of a cane in patients with knee OA.[134] However, the group was unanimous in its view that in all patients with hip or knee OA walking aids, assistive technology and adaptations at home and/or at work should be considered systematically and recurrently. The group noted that the value of some of these interventions is so obvious and has an immediate effect

in individual cases that further research into the effectiveness of specific devices or adaptations can hardly be expected. Cross-sectional studies show that walking aids, assistive technology and adaptations at home and/or work are important and often used by people with hip or knee OA. Most people with severe hip (63%) or knee pain (90%) reported the use of walking aids.[130 131] In people with arthritis, a mean of 9.9–10.8 devices has been reported to be in use and the satisfaction rate for all categories of device was more than 87%.[132] Moreover, unmet needs for new assistive technology to help perform activities that individuals could not do were identified.[132] Having access to a walking aid or other assistive technologies can be a help and provide security for individuals with constant or fluctuating symptoms. The group found that future observational studies on the use, satisfaction from and suggestions for new technology or improvements of existing technology are needed.

Management of work ability

Recommendation 11 deals with the effectiveness of work-related interventions. The proportion of employed people who have work disability due to OA is substantial. Although there are known occupational risk factors for knee OA and its progression—for example, heavy work, knee squatting or bending, lifting and specific sports,[18] there are no studies to support the effect of vocational rehabilitation on pain, physical function or quality of life specifically in patients with hip or knee OA. One study in patients with peripheral OA found that a specialist-run, protocol-based early intervention significantly reduced the number of days of sick leave compared with standard primary care.[135] The intervention was administered by a rheumatologist and comprised three main elements: education, protocol-based clinical management and administrative duties. The educational part included information about the condition, reassurance that serious disease was not present, self-management, exercises, ergonomic care, booklets, optimal level of physical activity and early return to work. Descriptive studies have found that environmental factors, such as having access to public transport or a car for mobility outside home are facilitators and that the absence of these is associated with limitations to daily activity.[136 137] Some elements in this recommendation may have to be adapted to the country in which they are executed, since availability and accessibility of services in the healthcare and social security system may vary greatly. The group concluded that there is a clear paucity of research evidence for work-related interventions in people with hip and knee OA.

DISCUSSION

Eleven recommendations for the core non-pharmacological management of people with hip and knee OA were developed based on research evidence and expert consensus. While the 11 evidence-based recommendations are not exhaustive and do not include all existing non-pharmacological treatments, they cover the main principles of non-pharmacological management. The selected recommendations support a patient-centred, multidisciplinary approach rather than a discipline-specific approach.

There was a considerable body of evidence underlying the recommendations, with systematic reviews and/or RCTs available for most. It is worth noting, however, that overall the research evidence for hip OA was poorer than for knee OA, limiting conclusions about the effectiveness of non-pharmacological interventions in this patient group. Moreover, most trials found in the literature review used pain or physical function as the primary outcome and surprisingly few included quality-of-life outcome measures. Mental health, physical independence, autonomy and social participation have been reported as important domains by people with OA and older adults.[138 139] Given these observations, the task force recommends that future research should include well-powered studies to evaluate the effect of core non-pharmacological treatments specifically in people with hip OA, moderators of effect and the inclusion of quality-of-life measurements that reflect physical, mental and social health in their evaluation.

Several RCTs found in the systematic literature review compared two non-pharmacological interventions and found no significant differences in pain or physical function between them. This does not mean that the interventions were ineffective, but that neither was better than the other. For example, a well-powered RCT compared a behavioural graded activity intervention with education and exercise following the Dutch physiotherapy guideline for patients with hip and/or knee OA and found no differences between groups.[57] Nevertheless, both groups showed improvements in pain and physical function over time. Moreover, it was found that non-pharmacological interventions often consisted of combinations of different treatments, with the combinations varying largely between studies. This hampered comparisons between studies and also the ability to define the effect of the individual components, so that the underpinning of every specific element in some of the recommendations proved to be difficult. Hence, the aim of developing detailed recommendations could not always be fulfilled. However, compared with previous recommendations[5–9] the current recommendations are more specific. They provide substantiated and more detailed recommendations about content (for patient education, exercise, weight reduction and combined treatment), frequency (at least 12 sessions, activity pacing and follow-ups) and mode of delivery (1 : 1, group-based or home exercise) than previously published recommendations. In addition, principles for optimising long-term adherence and effect are described. The optimal exercise volume ('dose') could not be substantiated. Exercise volume is difficult to investigate as it includes exercises performed at a gym or at the physiotherapy clinic and the total amount of exercise performed in daily life. Exercise volume therefore varies widely between individuals. The matter of timing lacks research evidence and the topic was included in the research agenda. Furthermore, the effect sizes for several non-pharmacological interventions reported in the literature were generally relatively low. It should be noted, however, that the costs of these interventions are generally limited, and the occurrence of adverse effects is low. The results of the LOA in addition to the traditional determination of the LOE are therefore important, as this reflects the experts' interpretation of all the above-mentioned aspects.

Limitations to the methodological quality of the systematic literature review were that only one person (LF) extracted data from the literature. According to the assessment of multiple systematic reviews,[140] at least two independent data extractors are recommended. However, the research fellow (LF) presented and discussed all results with the conveners (JWJB, KBH, TPMVV) and the extracted data were, thereafter, reviewed by experts in the committee. Another limitation was that, owing to limited time and resources, no scoring of the methodological quality of the systematic reviews or individual trials included in the literature review was done. Also, owing to limited resources, some potential healthcare providers playing a role in the management of hip and knee OA, such as the podiatrist or rehabilitation specialist, were not represented in the task force.

To obtain a broad consensus and practical applicability of the recommendations, the task force had an inclusive and multidisciplinary approach. Nine different professional disciplines and people with OA were included in the committee. The task force followed a procedure similar to that used for other management recommendations, such as for the general management of OA, rheumatoid arthritis and ankylosing spondylitis,[8 9 141 142] but is the first with such an inclusive approach. It has been strongly recommended that a minimum of two patient research partners with the relevant disease are included in development of recommendations.[143] The participation of the people with OA in this task force was successful, with their experiential knowledge ensuring that clinical relevance was integrated throughout the process.

Finally, the task force reached consensus on a research and educational agenda, with general topics including the definition and nomenclature for non-pharmacological and non-surgical management and the need for more knowledge on their effectiveness in hip OA. Specific needs for additional research and/or education included the optimisation of tailoring of treatment and the mode of delivery, the long-term effects of lifestyle interventions, vocational rehabilitation and footwear, the measurement of adherence and participation and the conduct of studies with a sufficient sample size. An important subject regarding education pertained to lifestyle interventions, highlighting the need for educational activities not only for healthcare providers, but also for people with OA and the public.

Author affiliations
[1]National Resource Center for Rehabilitation in Rheumatology, Diakonhjemmet Hospital, Oslo, Norway
[2]Department of Rheumatology and Clinical Immunology, University Medical Center Utrecht, Utrecht, The Netherlands
[3]Department of Rheumatology, Patient Panel, Diakonhjemmet Hospital, Oslo, Norway
[4]Department of Rheumatology, The Parker Institute, Copenhagen University Hospital at Fredriksberg, Copenhagen, Denmark
[5]Department of Nutrition, Exercise and Sports, University of Copenhagen, Copenhagen, Denmark
[6]Division of Musculoskeletal Disease, University of Leeds, and NIHR Leeds Musculoskeletal Biomedical Research Unit, Leeds, UK
[7]Academic Rheumatology, University of Nottingham, Nottingham, UK
[8]Department of Clinical and Health Psychology, Utrecht University, Utrecht, The Netherlands
[9]Centre for Health Sciences Research, University of Salford, Salford, UK
[10]Department of Orthopaedics, Clinical Sciences Lund, University of Lund, Lund, Sweden
[11]Research Unit for Musculoskeletal Function and Physiotherapy, Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark
[12]Department of Orthopaedics and Traumatology, University of Southern Denmark, Odense, Denmark
[13]Arthritis Research UK Primary Care Centre, Keele University, Keele, UK
[14]Faculty of Physiotherapy, University of Studies of Milan, Milan, Italy
[15]Nurse Consultant Rheumatology, Minerva Health Centre, Preston, UK
[16]Institute of Rheumatology and Clinic of Rheumatology, First Medical Faculty, Charles University, Prague, Czech Republic
[17]Cyprus League Against Rheumatism, Cyprus, Cyprus
[18]Department of Rheumatology, Centro Hospitalar Universitário de Coimbra, Coimbra, Portugal
[19]Rheumatology Department, Alicante General and University Hospital, Alicante, Spain
[20]Università degli Studi di Ferrara Casa di Cura SM Maddalena, Ferrara, Italy
[21]Department of Orthopaedics, Leiden University Medical Center, Leiden, The Netherlands

Contributors All authors have contributed to the development of the recommendations, commented on the manuscript and approved the submission.

Funding This study was funded by EULAR (2010).

Competing interests LF, KBH, JWJB, OA, PC, PGC, MD, RG, AH, IK, HL, CDM, TN, KP, IP, JAdS, JdlT, TPMVV: none declared. LSL: honoraria for consultancies and educational lectures from Flexion, MerckSerono, NicOx, Pfizer and SanofiAventis. LSL is the editor-in-chief of *Osteoarthritis and Cartilage*. SO: honoraria for speaker fees or educational training from Servier Laboratories and Pfizer in the past year. GZ: Please, see attached document for Dr Zanoli's competing interest.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **Pereira D,** Peleteiro B, Araujo J, *et al*. The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. *Osteoarthritis Cartilage* 2011;**19**:1270–85.
2. **Bijlsma JW,** Berenbaum F, Lafeber FP. Osteoarthritis: an update with relevance for clinical practice. *Lancet* 2011;**377**:2115–26.
3. **Felson DT,** Lawrence RC, Dieppe PA, *et al*. Osteoarthritis: new insights. Part 1: the disease and its risk factors. *Ann intern Med* 2000;**133**:635–46.
4. **Woolf AD,** Pfleger B. Burden of major musculoskeletal conditions. *Bull World Health Organ* 2003;**81**:646–56.
5. **Hochberg MC,** Altman RD, April KT, *et al*. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2012;**64**:455–74.
6. **Zhang W,** Nuki G, Moskowitz RW, *et al*. OARSI recommendations for the management of hip and knee osteoarthritis. Part III: changes in evidence following systematic cumulative update of research published through January 2009. Osteoarthritis Cartilage 2010;**18**:476–99.
7. **National Collaborating Centre for Chronic Conditions.** NICE clinical guideline 59. Osteoarthritis: the care and management of osteoarthritis in adults. *NICE* 2008;**59**:1–22.
8. **Zhang W,** Doherty M, Arden N, *et al*. EULAR evidence based recommendations for the management of hip osteoarthritis: report of a task force of the EULAR Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT). *Ann Rheum Dis* 2005;**64**:669–81.
9. **Jordan KM,** Arden NK, Doherty M, *et al*. EULAR Recommendations 2003: an evidence based approach to the management of knee osteoarthritis: Report of a Task Force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). *Ann Rheum Dis* 2003;**62**:1145–55.
10. **Broadbent J,** Maisey S, Holland R, *et al*. Recorded quality of primary care for osteoarthritis: an obervational study. *Br J Gen Pract* 2008;**58**:839–43.
11. **Snijders GF,** den Broeder AA, van Riel PLCM, *et al*. Evidence-based tailored conservative treatment of knee and hip osteoarthritis: between knowing and doing. *Scand J Rheumatol* 2011;**40**:225–31.
12. **Dougados M,** Betteridge N, Burmester GR, *et al*. EULAR standardised operating procedures for the elaboration, evaluation, dissemination, and implementation of recommendations endorsed by the EULAR standing committees. *Ann Rheum Dis* 2004;**63**:1172–6.
13. **Hill J,** Lewis M, Bird H. Do OA patients gain additional benefit from care from a clinical nurse specialist?–a randomized clinical trial. *Rheumatology* 2009;**48**:658–64.
14. **Benyon K,** Hill S, Zadurian N, *et al*. Coping strategies and self-efficacy as predictors of outcome in osteoarthritis: a systematic review. *Musculoskeletal Care* 2010;**8**:224–36.
15. **Van Dijk GM,** Dekker J, Veenhof C, *et al*. Course of functional status and pain in osteoarthritis of the hip or knee: a systematic review of the literature. *Arthritis Rheum* 2006;**55**:779–85.
16. **Fransen M,** Agaliotis M, Bridgett L, *et al*. Hip and knee pain: role of occupational factors. *Best Pract Res Clin Rheumatol* 2011;**25**:81–101.
17. **Kirkness CS,** Yu J, Asche CV. The effect on comorbidity and pain in patients with osteoarthritis. *J Pain Palliat Care Pharmacother* 2008;**22**:336–48.
18. **McWilliams DF,** Leeb BF, Muthuri SG, *et al*. Occupational risk factors for osteoarthritis of the knee: a meta-analysis. *Osteoarthritis Cartilage* 2011;**19**:829–39.
19. **Muthuri SG,** McWilliams DF, Doherty M, *et al*. History of knee injuries and knee osteoarthritis: a meta-analysis of observational studies. *Osteoarthritis Cartilage* 2011;**19**:1286–93.
20. **Muthuri SG,** Hui M, Doherty M, *et al*. What if we prevent obesity? Risk reduction in knee osteoarthritis estimated through a meta-analysis of observational studies. *Arthritis Care Res* 2011;**63**:982–90.
21. **Tanamas S,** Hanna FS, Cicuttini FM, *et al*. Does knee malalignment increase the risk of development and progression of knee osteoarthritis? A systematic review. *Arthritis Rheum* 2009;**61**:459–67.
22. **Wright AA,** Cook C, Abbott JH. Variables associated with the progression of hip osteoarthritis: a systematic review. *Arthritis Rheum* 2009;**61**:925–36.
23. **Zhang W,** Moskowitz RW, Nuki G, *et al*. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis Cartilage* 2008;**16**:137–62.
24. **Hay EM,** Foster NE, Thomas E, *et al*. Effectiveness of community physiotherapy and enhanced pharmacy review for knee pain in people aged over 55 presenting to primary care: pragmatic randomised trial. *BMJ* 2006;**333**:995–8.

25. **Hurley MV,** Walsh NE, Mitchell HL, *et al*. Clinical effectiveness of a rehabilitation program integrating exercise, self-management, and active coping strategies for chronic knee pain: a cluster randomized trial. *Arthritis Rheum* 2007; **57**:1211–9.
26. **van-Baar ME,** Dekker J, Oostendorp RA, *et al*. The effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a randomized clinical trial. *J Rheumatol* 1998;**25**:2432–9.
27. **Fransen M,** Crosbie J, Edmonds J. Physical therapy is effective for patients with osteoarthritis of the knee: a randomized controlled clinical trial. *J Rheumatol* 2001;**28**:156–64.
28. **Hughes SL,** Seymour RB, Campbell RT, *et al*. Fit and Strong!: bolstering maintenance of physical activity among older adults with lower-extremity osteoarthritis. *Am J Health Behav* 2010;**34**:750–63.
29. **Murphy SL,** Lyden AK, Smith DM, *et al*. Effects of a tailored activity pacing intervention on pain and fatigue for adults with osteoarthritis. *Am J Occup Ther* 2010;**64**:869–76.
30. **Halbert J,** Crotty M, Weller D, *et al*. Primary care-based physical activity programs: effectiveness in sedentary older patients with osteoarthritis symptoms. *Arthritis Rheum* 2001;**45**:228–34.
31. **van-Baar ME,** Dekker J, Oostendorp RA, *et al*. Effectiveness of exercise in patients with osteoarthritis of hip or knee: nine months' follow up. *Ann Rheum Dis* 2001;**60**:1123–30.
32. **Hurley MV,** Walsh NE, Mitchell H, *et al*. Long-term outcomes and costs of an integrated rehabilitation program for chronic knee pain: a pragmatic, cluster randomized, controlled trial. *Arthritis Care Res* 2012;**64**:238–47.
33. **Jiang L,** Rong J, Wang Y, *et al*. The relationship between body mass index and hip osteoarthritis: a systematic review and meta-analysis. *Joint Bone Spine* 2011;**78**:150–5.
34. **Blagojevic M,** Jinks C, Jeffery A, *et al*. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. *Osteoarthritis Cartilage* 2010;**18**:24–33.
35. **Leong AL,** Euller-Ziegler L. Patient advocacy and arthritis: moving forward. *Bull World Health Organ* 2004;**82**:115–20.
36. **National Collaborating Centre for Chronic Conditions.** NICE guideline 138. Patient experience in adult NHS services: improving the experience of care for people using adult NHS services. *NICE* 2012;**138**:1–29.
37. **Walsh NE,** Mitchell HL, Reeves BC, *et al*. Integrated exercise and self-management programmes in osteoarthritis of the hip and knee: a systematic evew of effectiveness. *Phys Ther Rev* 2006;**11**:289–97.
38. **Hopman-Rock M,** Westhoff MH. The effects of a health educational and exercise program for older adults with osteoarthritis for the hip or knee. *J Rheumatol* 2000;**27**:1947–54.
39. **Hughes SL,** Seymour RB, Campbell R, *et al*. Impact of the fit and strong intervention on older adults with osteoarthritis. *Gerontologist* 2004;**44**:217–28.
40. **Hughes SL,** Seymour RB, Campbell RT, *et al*. Long-term impact of Fit and Strong! on older adults with osteoarthritis. *Gerontologist* 2006;**46**:801–14.
41. **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.
42. **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.
43. **Dias RC,** Dias JM, Ramos LR. Impact of an exercise and walking protocol on quality of life for elderly people with OA of the knee. *Physiother Res Int* 2003;**8**:121–30.
44. **Kovar PA,** Allegrante JP, Mackenzie CR, *et al*. Supervised fitness walking in patients with osteoarthritis of the knee: a randomized, controlled trial. *Ann Intern Med* 1992;**116**:529–34.
45. **Peterson MG,** Kovar-Toledano PA, Otis JC, *et al*. Effect of a walking program on gait characteristics in patients with osteoarthritis. *Arthritis Care Res* 1993; **6**:11–6.
46. **Thomas KS,** Muir KR, Doherty M, *et al*. Home based exercise programme for knee pain and knee osteoarthritis: randomised controlled trial. *BMJ* 2002;**325**:752.
47. **Yip YB,** Sit JW, Fung KK, *et al*. Impact of an Arthritis Self-Management Programme with an added exercise component for osteoarthritic knee sufferers on improving pain, functional outcomes, and use of health care services: an experimental study. *Patient Educ Couns* 2007;**65**:113–21.
48. **Yip Y-BS**. A 1-year follow-up of an experimental study of a self-management arthritis programme with an added exercise component of clients with osteoarthritis of the knee. *Psychol Health Med* 2008;**13**:402–14.
49. **Bennell KL,** Hinman RS, Metcalf BR, *et al*. Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial. *Ann Rheum Dis* 2005;**64**:906–12.
50. **Quilty B,** Tucker M, Campbell R, *et al*. Physiotherapy, including quadriceps exercises and patellar taping, for knee osteoarthritis with predominant patello-femoral joint involvement: randomized controlled trial. *J Rheumatol* 2003;**30**:1311–7.
51. **McKnight PE,** Kasle S, Going S, *et al*. A comparison of strength training, self-management, and the combination for early osteoarthritis of the knee. *Arthritis Care Res* 2010;**62**:45–53.
52. **Tak E,** Staats P, Van HA, *et al*. The effects of an exercise program for older adults with osteoarthritis of the hip. *J Rheumatol* 2005;**32**:1106–13.
53. **Messier SP,** Loeser RF, Miller GD, *et al*. Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis: the Arthritis, Diet, and Activity Promotion Trial. *Arthritis Rheum* 2004;**50**:1501–10.
54. **Miller GD,** Nicklas BJ, Davis C, *et al*. Intensive weight loss program improves physical function in older obese adults with knee osteoarthritis. *Obesity* 2006;**14**:1219–30.
55. **Rejeski WJ,** Focht BC, Messier SP, *et al*. Obese, older adults with knee osteoarthritis: Weight loss, exercise, and quality of life. *Health Psychol* 2002;**21**:419–26.
56. **Mazieres B,** Thevenon A, Coudeyre E, *et al*. Adherence to, and results of, physical therapy programs in patients with hip or knee osteoarthritis. Development of French clinical practice guidelines. *Joint, Bone, Spine: Revue du Rhumatisme* 2008;**75**:589–96.
57. **Veenhof C,** Koke AJA, Dekker J, *et al*. Effectiveness of behavioral graded activity in patients with osteoarthritis of the hip and/or knee: A randomized clinical trial. *Arthritis Care Res* 2006;**55**:925–34.
58. **Pisters MF,** Veenhof C, Schellevis FG, *et al*. Long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a randomized controlled trial comparing two different physical therapy interventions. *Osteoarthritis Cartilage* 2010;**18**:1019–26.
59. **Weinberger M,** Tierney WM, Booher P, *et al*. The impact of increased contact on psychosocial outcomes in patients with osteoarthritis: a randomized, controlled trial. *J Rheumatol* 1991;**18**:849–54.
60. **Foy CG,** Lewis CE, Hairston KG, *et al*. Intensive lifestyle intervention improves physical function among obese adults with knee pain: findings from the Look AHEAD trial. *Obesity* 2011;**19**:83–93.
61. **Pisters MF,** Veenhof C, Van Meeteren NLU, *et al*. Long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: A systematic review. *Arthritis Care Res* 2007;**57**:1245–53.
62. **Pisters MF,** Veenhof C, de-Bakker DH, *et al*. Behavioural graded activity results in better exercise adherence and more physical activity than usual care in people with osteoarthritis: a cluster-randomised trial. *J Physiother* 2010;**56**:41–7.
63. **Jordan JL,** Holden MA, Mason EE, *et al*. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Syst Rev* 2010;**1**:CD005956.
64. **Conn VS,** Hafdahl AR, Minor MA, *et al*. Physical activity interventions among adults with arthritis: meta-analysis of outcomes. *Semin Arthritis Rheum* 2008;**37**:307–16.
65. **Witham MD,** Avenell A. Interventions to achieve long-term weight loss in obese older people. A systematic review and meta-analysis. *Age Ageing* 2010;**39**:176–84.
66. **Chodosh J,** Morton SC, Mojica W, *et al*. Meta-analysis: chronic disease self-management programs for older adults. *Ann Intern Med* 2005;**143**:427–38.
67. **de Jong R,** Tak E, Klazinga N, *et al*. The impact on health services utilization in a replication study of two self-management programmes for osteoarthritis of the knee and hip. *Prim Health Care Res Dev* 2008;**9**:64–74.
68. **Wu S-FV,** Kao MJ, Wu MP, *et al*. Effects of an osteoarthritis self-management programme. *J Adv Nurs* 2010;**67**:1491–501.
69. **Allen KD,** Oddone EZ, Coffman CJ, *et al*. Telephone-based self-management of osteoarthritis: a randomized trial. *Ann Intern Med* 2010;**153**:570–9.
70. **Bezalel T,** Carmeli E, Katz-Leurer M. The effect of a group education programme on pain and function through knowledge acquisition and home-based exercise among patients with knee osteoarthritis: a parallel randomised single-blind clinical trial. *Physiotherapy* 2010;**96**:137–43.
71. **Buszewicz M,** Rait G, Griffin M, *et al*. Self management of arthritis in primary care: randomised controlled trial. *BMJ* 2006;**333**:879–82.
72. **Calfas KJ,** Kaplan RM, Ingram RE. One-year evaluation of cognitive-behavioral intervention in osteoarthritis. *Arthritis Care Res* 1992;**5**:202–9.
73. **Crotty M,** Prendergast J, Battersby MW, *et al*. Self-management and peer support among people with arthritis on a hospital joint replacement waiting list: a randomised controlled trial. *Osteoarthritis Cartilage* 2009;**17**:1428–33.
74. **Hansson EE,** Jönsson LM, Ronnheden AM, *et al*. Effect of an education programme for patients with osteoarthritis in primary care–a randomized controlled trial. *BMC Musculoskelet Disord* 2010;**11**:244.
75. **Heuts PH,** De BR, Drietelaar M, *et al*. Self-management in osteoarthritis of hip or knee: a randomized clinical trial in a primary healthcare setting. *J Rheumatol* 2005;**32**:543–9.
76. **Coleman S,** Briffa NK, Carroll G, *et al*. A randomised controlled trial of a self-management education program for osteoarthritis of the knee delivered by health professionals. *Arthritis Res Ther* 2012;**14**:R21.
77. **Keefe FJ,** Caldwell DS, Baucom D, *et al*. Spouse-assisted coping skills training in the management of osteoarthritic knee pain. *Arthritis Care Res* 1996;**9**:279–91.

78. **Keefe FJ,** Caldwell DS, Baucom D, *et al*. Spouse-assisted coping skills training in the management of knee pain in osteoarthritis: long-term followup results. *Arthritis Care Res* 1999;**12**:101–11.
79. **Keefe FJ,** Blumenthal J, Baucom D, *et al*. Effects of spouse-assisted coping skills training and exercise training in patients with osteoarthritic knee pain: a randomized controlled study. *Pain* 2004;**110**:539–49.
80. **Mazzuca SA,** Brandt KD, Katz BP, *et al*. Effects of self-care education on the health status of inner-city patients with osteoarthritis of the knee. *Arthritis Rheum* 1997;**40**:1466–74.
81. **Victor CR,** Triggs E, Ross F, *et al*. Lack of benefit of a primary care-based nurse-led education programme for people with osteoarthritis of the knee. *Clin Rheumatol* 2005;**24**:358–64.
82. **Martire LM,** Schulz R, Keefe FJ, *et al*. Couple-oriented education and support intervention: Effects on individuals with osteoarthritis and their spouses. *Rehabil Psychol* 2007;**52**:121–32.
83. **Weinberger M,** Tierney WM, Booher P, *et al*. Can the provision of information to patients with osteoarthritis improve functional status? A randomized, controlled trial. *Arthritis Rheum* 1989;**32**:1577–83.
84. **Wetzels R,** Van WC, Grol R, *et al*. Family practice nurses supporting self-management in older patients with mild osteoarthritis: a randomized trial. *BMC Fam Pract* 2008;**9**:7.
85. **Ravaud P,** Flipo RM, Boutron I, *et al*. ARTIST (osteoarthritis intervention standardized) study of standardised consultation versus usual care for patients with osteoarthritis of the knee in primary care in France: pragmatic randomised controlled trial. *BMJ* 2009;**338**:b421.
86. **Iversen MD,** Hammond A, Betteridge N. Self-management of rheumatic diseases: state of the art and future perspectives. *Ann Rheum Dis* 2010;**69**:955–63.
87. **Fransen M,** McConnell S. Exercise for osteoarthritis of the knee. *Cochrane Database Syst Rev* 2008;**4**:CD004376.
88. **Hernandez-Molina G,** Reichenbach S, Bin Z, *et al*. Effect of therapeutic exercise for hip osteoarthritis pain: Results of a meta-analysis. *Arthritis Care Res* 2008;**59**:1221–8.
89. **Brosseau L,** MacLeay L, Robinson V, *et al*. Intensity of exercise for the treatment of osteoarthritis. *Cochrane Database Syst Rev* 2010;**2**:CD004259.
90. **Pelland L,** Brosseau L, Wells G, *et al*. Efficacy of strengthening exercises for osteoarthritis (part I): a meta analysis. *Phys Ther Rev* 2004;**9**:77–108.
91. **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.
92. **Bartels EM,** Lund H, Hagen KB, *et al*. Aquatic exercise for the treatment of knee and hip osteoarthritis. *Cochrane Database Syst Rev* 2007;**4**:CD005523.
93. **Green J,** McKenna F, Redfern EJ, *et al*. Home exercises are as effective as outpatient hydrotherapy for osteoarthritis of the hip. *Br J Rheumatol* 1993;**32**:812–5.
94. **Jessep SA,** Walsh NE, Ratcliffe J, *et al*. Long-term clinical benefits and costs of an integrated rehabilitation programme compared with outpatient physiotherapy for chronic knee pain. *Physiotherapy* 2009;**95**:94–102.
95. **Lange AK,** Vanwanseele B, Fiatarone Singh MA. Strength training for treatment of osteoarthritis of the knee: a systematic review. *Arthritis Care Res* 2008;**59**:1488–94.
96. **Ratamess NA,** Alvar BA, Evetoch TK, *et al*. Progression models in resistance training for healthy adults. American college of sports medicine. *Med Sci Sports Exerc* 2009;**41**:687–708.
97. **Chodzko-Zajko WJ,** Proctor DN, Fiatarone Singh MA, *et al*. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc* 2009;**41**:1510–30.
98. **Fransen M,** McConnell S, Hernandez-Molina G, *et al*. Exercise for osteoarthritis of the hip. *Cochrane Database Syst Rev* 2009;**3**:CD007912.
99. **McNair PJ,** Simmonds MA, Boocock MG, *et al*. Exercise therapy for the management of osteoarthritis of the hip joint: a systematic review. *Arthritis Res Ther* 2009;**11**:R98.
100. **Moe RH,** Haavardsholm EA, Christie A, *et al*. Effectiveness of nonpharmacological and nonsurgical interventions for hip osteoarthritis: an umbrella review of high-quality systematic reviews. *Phys Ther* 2007;**87**:1716–27.
101. **Ricci NA,** Coimbra IB. Exercise therapy as a treatment in osteoarthritis of the hip: a review of randomized clinical trials. *Rev Bras Reumatol* 2006;**46**:273–80.
102. **Roddy E,** Zhang W, Doherty M, *et al*. Evidence-based recommendations for the role of exercise in the management of osteoarthritis of the hip or knee–the MOVE consensus. *Rheumatology* 2005;**44**:67–73.
103. **French HP,** Gilsenan C, Cusack T. Gluteal muscle dysfunction and the role of specific strengthening in hip osteoarthritis: a review. *Phys Ther Rev* 2008;**13**:333–44.
104. **Jamtvedt G,** Dahm KT, Christie A, *et al*. Physical therapy interventions for patients with osteoarthritis of the knee: an overview of systematic reviews. *Phys Ther* 2008;**88**:123–36.
105. **Devos-Comby L,** Cronan T, Roesch SC. Do exercise and self-management interventions benefit patients with osteoarthritis of the knee? A metaanalytic review. *J Rheumatol* 2006;**33**:744–56.
106. **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.
107. **Jansen MJ,** Viechtbauer W, Lenssen AF, *et al*. Strength training alone, exercise therapy alone, and exercise therapy with passive manual mobilisation each reduce pain and disability in people with knee osteoarthritis: a systematic review. *J Physiother* 2011;**57**:11–20.
108. **Escalante Y,** Saavedra JM, Garcia-Hermoso A, *et al*. Physical exercise and reduction of pain in adults with lower limb osteoarthritis: A systematic review. *J Back Musculoskelet Rehabil* 2010;**23**:175–86.
109. **Christensen R,** Bartels EM, Astrup A, *et al*. Effect of weight reduction in obese patients diagnosed with knee osteoarthritis: a systematic review and meta-analysis. *Ann Rheum Dis* 2007;**66**:433–9.
110. **Bliddal H,** Leeds AR, Stigsgaard L, *et al*. Weight loss as treatment for knee osteoarthritis symptoms in obese patients: 1-year results from a randomised controlled trial. *Ann Rheum Dis* 2011;**70**:1798–803.
111. **Jenkinson CM,** Doherty M, Avery AJ, *et al*. Effects of dietary intervention and quadriceps strengthening exercises on pain and function in overweight people with knee pain: randomised controlled trial. *Br Med J* 2009;**339**:b3170.
112. **Shea MK,** Houston DK, Nicklas BJ, *et al*. The effect of randomization to weight loss on total mortality in older overweight and obese adults: the ADAPT Study. *J Gerontol A Biol Sci Med Sci* 2010;**65**:519–25.
113. **Riecke BF,** Christensen R, Christensen P, *et al*. Comparing two low-energy diets for the treatment of knee osteoarthritis symptoms in obese patients: a pragmatic randomized clinical trial. *Osteoarthritis Cartilage* 2010;**18**:746–54.
114. **Michie S,** Abraham C, Whittington C, *et al*. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol* 2009;**28**:690–701.
115. **Shaw KA,** Gennat HC, O'Rourke P, *et al*. Exercise for overweight or obesity. *Cochrane Database Syst Rev* 2006;**18**:CD003817.
116. **Wadden TA,** Neiberg RH, Wing RR, *et al*. Four-year weight losses in the Look AHEAD study: factors associated with long-term success. *Obesity* 2011;**19**:1987–98.
117. **Shai I,** Schwarzfuchs D, Henkin Y, *et al*. Weight Loss with a Low-Carbohydrate, Mediterranean, or Low-Fat Diet. *N Engl J Med* 2008;**359**:229–41.
118. **Armstrong MJ,** Mottershead TA, Ronksley PE, *et al*. Motivational interviewing to improve weight loss in overweight and/or obese patients: a systematic review and meta-analysis of randomized controlled trials. *Obes Rev* 2011;**12**:709–23.
119. **Gill RS,** Al-Adra DP, Shi X, *et al*. The benefits of bariatric surgery in obese patients with hip and knee osteoarthritis: a systematic review. *Obes Rev* 2011;**12**:1083–9.
120. **Richette P,** Poitou C, Garnero P, *et al*. Benefits of massive weight loss on symptoms, systemic inflammation and cartilage turnover in obese patients with knee osteoarthritis. *Ann Rheum Dis* 2011;**70**:139–44.
121. **Raja K,** Dewan N. Efficacy of knee braces and foot orthoses in conservative management of knee osteoarthritis: a systematic review. *Am J Phys Med Rehabil* 2011;**90**:247–62.
122. **Cheung RTH,** Chung RCK, Ng GYF. Efficacies of different external controls for excessive foot pronation: a meta-analysis. *Br J Sports Med* 2011;**45**:743–51.
123. **Simonsen EB,** Svendsen MB, Norreslet A, *et al*. Walking on high heels changes muscle activity and the dynamics of human walking significantly. *J Appl Biomech* 2012;**28**:20–8.
124. **Turpin KM,** De VA, Apps AM, *et al*. Biomechanical and clinical outcomes with shock-absorbing insoles in patients with knee osteoarthritis: immediate effects and changes after 1 month of wear. *Arch Phys Med Rehabil* 2012;**93**:503–8.
125. **Nigg BM,** Emery C, Hiemstra LA. Unstable shoe construction and reduction of pain in osteoarthritis patients. *Med Sci Sports Exerc* 2006;**38**:1701–8.
126. **Erhart JC,** Mundermann A, Elspas B, *et al*. Changes in knee adduction moment, pain, and functionality with a variable-stiffness walking shoe after 6 months. *J Orthop Res* 2010;**28**:873–9.
127. **Reilly KA,** Barker KL, Shamley D. A systematic review of lateral wedge orthotics-how useful are they in the management of medial compartment osteoarthritis? *Knee* 2006;**13**:177–83.
128. **Bennell KL,** Bowles KA, Payne C, *et al*. Lateral wedge insoles for medial knee osteoarthritis: 12 month randomised controlled trial. *BMJ* 2011;**342**:d2912.
129. **Scott D,** Kowalczyk A. Osteoarthritis of the knee. *Clin Evid (Online)* 2007;**1121**.
130. **Gaudet M-C,** Feldman DE, Rossignol M, *et al*. The wait for total hip replacement in patients with osteoarthritis. *Can J Surg* 2007;**50**:101–9.
131. **Jinks C,** Ong BN, Richardson J. A mixed methods study to investigate needs assessment for knee pain and disability: Population and individual perspectives. *BMC Musculoskelet Disord* 2007;**8**:59.
132. **Mann WC,** Hurren D, Tomita M. Assistive devices used by home-based elderly persons with arthritis. *Am J Occup Ther* 1995;**49**:810–20.
133. **Fang MA,** Heiney C, Yentes JM, *et al*. Clinical and Spatiotemporal Gait Effects of Canes in Hip Osteoarthritis. *PM and R* 2012;**4**:30–6.

134. **Jones A,** Silva PG, Silva AC, *et al*. Impact of cane use on pain, function, general health and energy expenditure during gait in patients with knee osteoarthritis: a randomised controlled trial. *Ann Rheum Dis* 2012;**71**:172–9.
135. **Abasolo L,** Carmona L, Hernandez-Garcia C, *et al*. Musculoskeletal work disability for clinicians: time course and effectiveness of a specialized intervention program by diagnosis. *Arthritis Rheum* 2007;**57**:335–42.
136. **Keysor JJ,** Jette AM, LaValley MP, *et al*. Community environmental factors are associated with disability in older adults with functional limitations: The MOST study. *J Gerontol A Biol Sci Med Sci* 2010;**65A**:393–9.
137. **Wilkie R,** Peat G, Thomas E, *et al*. Factors associated with restricted mobility outside the home in community-dwelling adults ages fifty years and older with knee pain: An example of use of the international classification of functioning to investigate participation restriction. *Arthritis Care Res* 2007;**57**:1381–9.
138. **Xie F,** Li SC, Thumboo J. Do health-related quality-of-life domains and items in knee and hip osteoarthritis vary in importance across social-cultural contexts? A qualitative systematic literature review. *Semin Arthritis Rheum* 2005;**34**:793–804.
139. **Haak M,** Malmgren FA, Iwarsson S, *et al*. The importance of successful place integration for perceived health in very old age: a qualitative meta-synthesis. *Int J Public Health* 2011;**56**:589–95.
140. **Shea BJ,** Grimshaw JM, Wells GA, *et al*. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol* 2007;**7**:10.
141. **Combe B,** Landewe R, Lukas C, *et al*. EULAR recommendations for the management of early arthritis: report of a task force of the European Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT). *Ann Rheum Dis* 2007;**66**:34–45.
142. **Braun J,** van den Berg R, Baraliakos X, *et al*. 2010 update of the ASAS/EULAR recommendations for the management of ankylosing spondylitis. *Ann Rheum Dis* 2011;**70**:896–904.
143. **de Wit MP,** Berlo SE, Aanerud GJ, *et al*. European League Against Rheumatism recommendations for the inclusion of patient representatives in scientific projects. *Ann Rheum Dis* 2011;**70**:722–6.