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Issue Table of Contents
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Editorial introductions

Editorial introductions.

Epidemiology and health-related services

Evidence-based rheumatology practice.
Krishnan, Laura L; Suarez-Almazor, Maria E

Computer applications in clinical practice.
Mosley-Williams, Angelia; Williams, Carl

Advancements in the surgical and alternative treatment of arthritis.
Lyman, Stephen; Sherman, Seth; Dunn, Warren R; Marx, Robert G

Epidemiology of back disorders: prevalence, risk factors, and prognosis.
Manek, Nisha J a; MacGregor, A J b

Dietary risk factors for rheumatic diseases.
Choi, Hyon K

Ethnic and socioeconomic disparities in health among patients with rheumatic disease.
Odutola, Jennifer; Ward, Michael M

Community Oriented Program for the Control of Rheumatic Diseases: studies of rheumatic diseases in the developing world.
Muirden, Kenneth David

Rehabilitation medicine in rheumatic diseases

Editorial Review

Moving the research agenda in rehabilitative rheumatology: where are we going and how will we get there?
Iversen, Maura Daly

Evolution of team care and evaluation of effectiveness.
Petersson, Ingemar F

The role of exercise in the rehabilitation of idiopathic inflammatory myopathies.
Alexanderson, Helene a,b; Lundberg, Ingrid E b

Outcomes of patients with rheumatoid arthritis receiving rehabilitation.
Li, Linda C a; Iversen, Maura Daly b

Safety of exercise in patients with rheumatoid arthritis.
de Jong, Zuzana; Vliet Vlieland, Theodora P. M

Understanding functioning, disability, and health in rheumatoid arthritis: the basis for rehabilitation care.
Cleza, Alarcos a; Stucki, Gerold a,b

Exercise in fibromyalgia.
Mannerkorpi, Kaisa

Joint injury causes knee osteoarthritis in young adults.
Roos, Ewa M

Current world literature

Bibliography Current World Literature.

List of journals scanned

List of journals scanned.
Editorial introductions

*Current Opinion in Rheumatology* was launched in 1989. It is one of a successful series of review journals whose unique format is designed to provide a systematic and critical assessment of the literature as presented in the many primary journals. The field of rheumatology is divided into 15 sections that are reviewed once a year. Each section is assigned a Section Editor, a leading authority in the area, who identifies the most important topics at that time. Here we are pleased to introduce one of the Journal’s Section Editors for this issue.

**Section Editor**

**Michael Ward, MD, MPH**

Dr. Ward received his medical degree from the University of Illinois and his MPH degree from the University of Michigan School of Public Health. After fellowship training in rheumatology at Duke University Medical Center, he was a fellow in the Robert Wood Johnson Clinical Scholars Program at Stanford University. He served as a rheumatologist in the Veterans Affairs Palo Alto Health Care System and was a faculty member in the Department of Medicine of the Stanford University School of Medicine from 1990 to 2002. He is currently an investigator in the Intramural Research Program at the National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health. His research interests are health outcomes and outcome measurement.
Evidence-based rheumatology practice
Laura L. Krishnan and Maria E. Suarez-Almazor

Purpose of review
This review is intended to update readers on recent developments in the evidence-based practice of rheumatology.

Recent findings
Several new or updated evidence-based practice guidelines have recently emerged. In addition, a large body of evidence upon which to base practice has been addressed in the many systematic reviews and meta-analyses that have been newly published, including nine new or updated Cochrane reviews. Several studies have also investigated adherence to practice guidelines, interventions to improve clinical practice, and quality of care in the field of rheumatology in the past year.

Summary
Evidence-based rheumatology is an ongoing effort, with continuing revision and update of recommendations. It may currently be used to address a wide variety of clinical questions. The initiatives on practice-based research to establish quality indicators and identify areas where rheumatology practice can be enhanced are a welcome addition to health services research in this field.

Keywords
evidence-based medicine, professional practice, rheumatic diseases, rheumatology

Introduction
Evidence-based medicine requires the systematic and rational use of the best available evidence for clinical decision-making. Evidence obtained from the literature must be critically appraised with attention to clinical relevance and validity [1]. Often, evidence-based practice guidelines are developed to assess the evidence and address specific topics in medicine. These guidelines are based upon a systematic review of the literature and are intended to enhance clinical decision-making and improve quality of care [2].

A number of evidence-based guidelines for the practice of rheumatology have been published or updated in the past year. Additionally, a large body of literature evaluating the evidence upon which to base rheumatology practice has been published, covering a wide variety of topics. Other research findings on adherence to practice guidelines, interventions to improve clinical practice, and quality of care in the field of rheumatology have appeared in the recent literature, as well.

Evidence-based practice guidelines
Evidence-based practice guidelines have recently been published or updated on several topics in rheumatology.

Osteoarthritis
Four of the guidelines address one or more aspect of osteoarthritis [3,4**,5*]. Two guidelines address the management of osteoarthritis of the knee [3,4**], one guideline focuses specifically on the role of exercise in the management of osteoarthritis of the hip or knee [5*], and one guideline addresses adult degenerative joint disease of the knee in primary care [6]. The guideline by the American Academy of Orthopaedic Surgeons (AAOS) [3] is an updated version of a 1999 guideline, and the guideline by EULAR is an update of their 2000 recommendations [4**]. The European League Against Rheumatism (EULAR) guideline focuses primarily on specific pharmacologic and other nonsurgical treatments of osteoarthritis of the knee [4**], whereas the AAOS guideline is broken down into two parts. Phase 1 is intended for first-contact physicians and addresses pharmacologic/nonsurgical treatments in less detail than the EULAR guidelines, and phase 2 is intended for musculoskeletal specialists and addresses a range of surgical treatments [3]. Key differences include EULAR’s recommendation in favor of opioid analgesics in cases in which nonsteroidal anti-inflammatory drugs (NSAIDs) are contraindicated or ineffective and its recommendation of agents like glucosamine sulfate and...
chondroitin sulphate (the AAOS guideline concludes that the evidence on these agents is not yet clear), and the AAOS’s inclusion of aspiration and visco-supplementation among the nonsurgical treatment options it addresses. Both guidelines are generally otherwise consistent in their recommendations relating to paracetamol, NSAIDs, cyclooxygenase-2 inhibitors, and corticosteroid injections, and those relating to nonpharmacological treatment options: exercise, appliances, weight reduction, and education. The inclusion of exercise in these guidelines is consistent with the findings of the MOVE consensus, which offers new evidence-based recommendations for exercise in the management of osteoarthritis of the hip or knee [5*]. The MOVE consensus concludes that strengthening and aerobic exercise have the potential to reduce pain and improve function in patients with knee osteoarthritis.

The updated guideline by the Institute for Clinical Systems Improvement (ICSI), a collaboration of health-care organizations, on adult degenerative joint disease (DJD) of the knee is intended for primary care providers and includes a diagnosis/treatment algorithm and criteria for referral to a rheumatologist or orthopedic specialist [6]. The ICSI guideline offers guidance on which patients should be given a same-day appointment, advice that can be given to patients awaiting appointments, the proper indications for radiographs and diagnostic testing in DJD of the knee, treatment strategies for DJD of the knee, and the importance of patient education.

**Low back pain**
Evidence-based guidelines and an accompanying algorithm on adult acute and chronic low back pain have been updated by ICSI [7*]. Most patients who request medical attention for their back pain will improve within 2 weeks. Key recommendations include criteria for offering a patient an appointment within 24 hr, indications for lumbar spine radiographs, the importance of patient education and home self-care, limiting referrals for imaging studies to those with progressive neurologic deficits and minimal improvement of symptoms after 6 weeks, and advising patients to stay active.

**Osteoporosis**
The ICSI has updated an evidence-based guideline on the diagnosis and precautionary treatment of osteoporosis [8*]. The recommendations include discussing risk factors and preventive measures, bone density testing for patients with high odds of osteoporosis, and discussing appropriate pharmacological options for prevention and treatment.

**Ankylosing spondylitis**
The Assessments in Ankylosing Spondylitis Working Group presents a consensus statement on the initiation, monitoring, and discontinuation of antitumor necrosis factor α in patients with ankylosing spondylitis [9*]. Although this consensus statement is not as systematically derived as the previously listed guidelines, it does draw upon published evidence to create its recommendations. Most importantly, infliximab and etanercept are recommended for use in treating patients whose active ankylosing spondylitis cannot be managed well by conventional treatments.

**Systematic reviews and meta-analyses**
Aside from up-to-date evidence-based guidelines, which should incorporate all available research evidence, systematic reviews and meta-analyses are the best sources of information upon which to base clinical practice. The Cochrane Collaboration maintains a database of systematic reviews with the express intention of providing evidence upon which to base health care decisions. Many systematic reviews and meta-analyses, including nine new or updated Cochrane reviews, have been published in the past year, covering a variety of topics.

**Rheumatoid arthritis**
Several of the recently published or updated reviews and meta-analyses address pharmacological treatment of rheumatoid arthritis: short-term low-dose corticosteroids compared with placebo and NSAIDs [10], paracetamol compared with NSAIDs [11], tetracyclines [12], biologic agents [13*], and anakinra [14]. The Cochrane review concerning short-term low-dose corticosteroids compared with placebo and NSAIDs includes 10 studies and a total of 320 patients and concludes that low doses of prednisolone are more effective than placebo or NSAIDs and may be used intermittently in the treatment of rheumatoid arthritis with an acceptably low risk of adverse effects [10]. The Cochrane review concerning paracetamol (acetaminophen) compared with NSAIDs states that although patients with rheumatoid arthritis and researchers seem to prefer NSAIDs, there is no clear evidence of one being superior to the other from the existing published studies, and that a large, double-blind, randomized trial is needed to reach a firm conclusion [11]. The meta-analysis by Stone et al. [12] includes 10 randomized controlled trials (RCTs) and concludes that treatment of rheumatoid arthritis with minocycline is associated with clinically significant improvement in disease activity and few side effects. In a systematic review comparing the addition of different biologic agents – adalimumab, etanercept, and infliximab – with methotrexate treatment, analysis suggests that all three agents have similar efficacy among patients with active rheumatoid arthritis when added to methotrexate [13*]. Lastly, a systematic review of five RCTs of anakinra finds that it can be considered modestly effective in the treatment of rheumatoid arthritis, both alone and administered with methotrexate [14].
Several reviews and meta-analyses address nonpharmacological issues related to rheumatoid arthritis, including occupational therapy [15], Tai Chi [16], hand exercises [17], patient education [18*], diet [19], and anemia [20]. Occupational therapy is found to have a positive effect on functional ability in patients with rheumatoid arthritis on the basis of the results of the six controlled studies and nine uncontrolled studies included in a Cochrane review [15]. The Cochrane review of Tai Chi includes 206 participants from four trials and concludes that Tai Chi does not exacerbate the symptoms of rheumatoid arthritis and benefits range of motion of the lower extremities, particularly the ankles [16]. The systematic review of hand exercises for rheumatoid arthritis finds that there is a need for methodologically sound RCTs to study further the impact of hand exercises on range of motion, although long-term exercise may increase strength [17]. The review by Niedermann et al. [18*] includes studies of both the short-term and long-term effects of patient education for those with rheumatoid arthritis and concludes that while short-term positive effects are consistently demonstrated, long-term changes are not. As a result of a variation in study design and small sample size, the systematic review of the importance of diet in rheumatoid arthritis finds that the evidence is inconclusive, although it does suggest that diet may play a role in susceptibility to rheumatoid arthritis. After completing a systematic review, Wilson et al. [20] present estimates of the prevalence of anemia in patients with rheumatoid arthritis (33–66%) and conclude that resolution of anemia is associated with symptomatic improvement and improved quality of life.

Osteoarthritis

Issues related to the pharmacological treatment of osteoarthritis addressed in recent studies include hyaluronic acid injections [21*,22,23], corticosteroid injections [24,25], topical NSAIDs [26,27*], paracetamol [28*], and valdecoxib [29]. Three studies, two meta-analyses and one systematic review, present findings on hyaluronic acid injections for osteoarthritis of the knee, and all three conclude that hyaluronic acid injections have a modest effect, but that more RCTs of high methodological quality are needed to make definitive conclusions and to investigate different types of hyaluronic acid products (e.g., low molecular weight compared with high molecular weight) [21*,22,23]. Two meta-analyses address corticosteroid injections for knee osteoarthritis, and both conclude that corticosteroid injections produce short-term symptomatic improvement [24,25]. While Arroll and Goodyear-Smith [24] conclude that significant long-term improvement may also occur in patients given corticosteroid injections [24], Godwin and Dawes [25] conclude that the beneficial effect of the injections is not likely to last beyond 4 weeks [25]. The two meta-analyses of the use of topical NSAIDs in the treatment of osteoarthritis and chronic musculoskeletal pain conclude that topical NSAIDs are effective in relieving pain for 2 weeks, but currently, no trial data support their long-term efficacy [26,27*]. The meta-analysis by Zhang et al. [28*] combines data from 10 RCTs to determine that paracetamol is effective for pain relief in osteoarthritis, but not as effective as NSAIDs, although it is safer. One systematic review addresses the safety and efficacy of valdecoxib in osteoarthritis and rheumatoid arthritis, concluding that valdecoxib is as effective as other NSAIDs and is safer [29]. In addition to these studies, one Cochrane review covers pharmacotherapy for patellofemoral pain syndrome and concludes that the evidence for the effectiveness of NSAIDs is limited, and the evidence for glycosaminoglycan polysulfate is conflicting [30]. It further states although the anabolic steroid nandrolone could be effective, its use is too controversial to be recommended.

Nonpharmacological topics in osteoarthritis include laser therapy [31], preoperative education [32], total hip arthroplasty [33], surgery for osteoarthritis of the thumb [34], and unsaponifiables [35]. One Cochrane review examines low-level laser therapy for osteoarthritis and finds that the data conflict across studies, possibly because of different methods of application and methodological problems [31]. Another Cochrane review investigates evidence on education before operation for knee or hip replacement in patients with osteoarthritis and rheumatoid arthritis, finding little evidence that education before operation improves outcomes after operation (pain, functioning, and length of hospital stay), although it has some benefit on anxiety before operation [32]. A systematic review of the surgical approach to total hip arthroplasty in osteoarthritis compares the direct lateral and posterior surgical approaches and concludes that there is insufficient information available currently to determine which approach is superior [33]. Martou et al. [34] present a comparison of surgical approaches to osteoarthritis of the thumb, examining studies of arthrodesis, trapeziectomy with or without biologic/synthetic interposition, osteotomy, and joint replacement, and determine that there is a need for large RCTs of good methodological quality to determine which technique is best. A systematic review of avocado-soybean unsaponifiables for patients with osteoarthritis finds that although most of the trials included suggest efficacy, more rigorous research is needed to reach definitive conclusions [35].

Other topics in the rheumatic diseases

Other systematic reviews conducted in the past year addressed prolotherapy injections for chronic back pain [36], calcium supplementation for bone loss [37], radon therapy for rheumatic diseases [38], and indications for laboratory tests in patients with carpal tunnel syndrome [39]. Although the evidence is conflicting, the Cochrane review does not find the treatment of chronic low-back pain with prolotherapy injections (injections of irritant solutions to strengthen the ligaments of the back) to be
more effective than control injections when used alone, but when they are used along with co-interventions, they are found to be more effective than control injections [36]. One recent Cochrane review presents findings on the effect of calcium supplementation on bone loss in pre-menopausal women and concludes that it has a slight positive effect on bone density and may reduce vertebral fractures, as well [37]. A meta-analysis of radon therapy for rheumatic diseases suggests that radon therapy does have a positive effect on pain, but that more RCTs, especially long-term trials, are needed [38]. Last, a systematic review of indications for tests in patients with carpal tunnel syndrome finds that there is insufficient evidence to support the routine screening of carpal tunnel syndrome patients for concurrent diabetes mellitus, hypothyroidism, or rheumatoid arthritis [39].

**Adherence to practice guidelines**

Adherence to practice guidelines is an important issue to direct development of both future guidelines and interventions to improve adherence to practice guidelines. Recent studies identify how physicians currently practice rheumatology, areas in which guidelines are not being followed, and the impact of current practices.

**Rheumatoid arthritis**

Several studies report adherence to guidelines in rheumatoid arthritis. One study examines self-reported adherence to the American College of Rheumatology-recommended screening tests for adverse events in the use of methotrexate by rheumatologists, as well as their use of screening tests in patients on biologic agents [40**]. This study finds that the guidelines for methotrexate are followed for most baseline and follow-up testing, except in the case of the hepatitis panel and albumin testing, which are ordered less frequently. A majority of the rheumatologists surveyed would agree with guidelines that recommended less frequent liver function testing. In spite of the current lack of guidelines for blood test monitoring of patients on biologic agents, a majority of those surveyed order baseline and follow-up blood tests for patients prescribed biologic agents, although the frequency of follow-up testing varies. A trial by Fransen et al. [41*] measures the impact of rheumatologist adherence to a guideline for the administration of methotrexate, finding that adherence has a beneficial effect on disease activity and does not increase the risk of toxicity. Adherence to the Royal College of Ophthalmology guidelines for monitoring ocular toxicity in patients on hydroxychloroquine is examined in another survey of rheumatologists, concluding that rheumatologists do not consistently follow these guidelines for baseline assessment, monitoring, and referral to ophthalmology [42*].

**Other topics in the rheumatic diseases**

Charalambous et al. [43*] examine practices by rheumatologists and other physicians with respect to the antiseptic technique used for intra-articular steroid injection of the knee. They determine that the use of precautionary measures varies widely and that the American College of Rheumatology guidelines, which advocate wearing gloves during intra-articular steroid injections, are not followed by more than half of those surveyed.

Last, a study in older women with fractures finds that less than half of the patients in the study were treated in accordance with national clinical guidelines for the management of osteoporosis [44*].

**Quality of care**

In the past year, several studies have been published on indicators for measuring the quality of arthritis care, covering rheumatoid arthritis [45**], osteoarthritis [46**], and the use of analgesics in patients with arthritis [47].

**Arthritis**

For rheumatoid arthritis, the 27 indicators determined by the Arthritis Foundation to be valid fall into a variety of categories, including the following: time to referral, history and examination, follow-up, radiographs, disease modifying anti-rheumatic drugs (DMARDs), folic acid, osteoporosis prophylaxis, glucocorticoids, exercise, assistive devices, surgery, baseline/ follow-up studies, methotrexate transaminits, informing patients about risks, reproductive issues, and vaccines [45**]. The 14 quality indicators from the Arthritis Foundation for osteoarthritis cover physical examination, pain/functional assessment, education, exercise, weight loss, assistive devices, pharmacologic therapy, surgery, and radiographs [46**]. The 10 valid quality indicators developed by the Arthritis Foundation addressing safe use of analgesics in patients with arthritis have the following categories: informing patients about risks, gastrointestinal prophylaxis, selection of NSAIDs, and monitoring [47].

Three studies address quality of care in patients with rheumatoid arthritis [48,49* ,50]. Jacobi et al. [48] report areas of inadequate quality identified by patients with rheumatoid arthritis: knowledge of rheumatism among general practitioners and others, and provision of information on medication and treatment among general practitioners and rheumatologists. Another study by Jacobi et al. [49*] finds that patients with rheumatoid arthritis also frequently have unmet demands for health care, including allied health care, orthopedic care, home care, and psychosocial care. A study by Kremers et al. [50] finds that rheumatoid arthritis patients also do not receive optimal general preventive medical services, although because this study lacks a comparison group, it is impossible to say whether they receive more or less preventive medical care than other patients.

One recently published study of patients with osteoarthritis of the knee concludes that these patients also have
unmet needs for information about their disease and about pain management, and that their use of primary care services is high [51]. Last, the results of a survey of patients with osteoarthritis and rheumatoid arthritis reveal that almost all of those surveyed try nonpharmacological treatments (including exercise, appliances, education, and weight management) for their diseases, and most patients continue these treatments after trying them [52].

**Other topics in the rheumatic diseases**

One recently published article presents quality of care indicators for patients with gout [53•]. The 10 valid indicators focus on uric acid-lowering therapy, behavioral modifications, and use of anti-inflammatory agents. A study by Chodosh et al. [54] examines quality of care for elderly patients with chronic pain, a majority of whom had joint or back pain. This study concludes that pain is inadequately managed in these elderly patients, and that the following areas specifically need improvement: screening, follow-up, clinical evaluations, and attention to adverse effects of medications.

**Improving rheumatology practice**

Several studies focusing on testing interventions to improve rheumatology practice have been published in the past year. Some of them focus on general medical management in outpatient care, while others propose algorithms to improve surgical referral in patients with arthritis.

The study by Newman et al. [55•] tests the implementation of an advanced access model into a busy rheumatology practice and demonstrates substantial improvement in access, patient satisfaction, and financial performance as a result.

A RCT of an intervention to improve the treatment of depression using antidepressants and/or psychotherapy sessions in older adults with arthritis shows that the intervention yields improvement in the following areas: pain, functional status, quality of life, and depressive symptoms [56•].

Solomon et al. [57•] present a clinical prediction rule, developed on the basis of the opinions of orthopedic surgeons, for determining which patients with knee problems are likely to benefit from nonarthroplasty surgery. The validity of a hip and knee priority criteria tool as a waiting list scoring system for knee and hip arthroplasty is examined in a study by Conner-Spady et al. [58]. This system appears to have validity as a measure of surgeon-rated urgency.

**Conclusion**

This review of the literature conducted for the past year shows that the development and practice of evidence-based medicine in rheumatology are an ongoing effort, with continuing revision and update of recommendations. The initiatives on practice-based research to establish quality indicators and identify areas where rheumatology practice can be enhanced are a welcome addition to health services research in this field and can result in effective and efficient improvements on the quality of care of patients with rheumatic diseases.

**References and recommended reading**

Papers of particular interest, published within the annual period of review, have been highlighted as:

• of special interest
•• of outstanding interest


A comprehensive guideline for the management of chronic and acute low back pain, including a treatment algorithm, screening tools, and a discussion of the evidence.


A comprehensive guideline for the diagnosis and treatment of osteoporosis, including a treatment algorithm, a health education handout, and a discussion of the evidence.


Epidemiology and health-related services


33 Joles BM, Bogoch ER. Surgical approach for total hip arthroplasty: direct lateral or posterior? J Rheumatol 2004; 31:1790–1796.


This noteworthy study presents the results of a survey of American College of Rheumatology members to examine current opinions and practices related to monitoring protocols for methotrexate and biologic agents, which is of particular importance because of the current lack of monitoring guidelines for biologic agents.


Presents findings on the effect of guideline adherence on the safety and efficacy of methotrexate.


A cross-sectional survey of British rheumatologists that identifies a lack of compliance with national ocular monitoring guidelines for patients on hydroxychloroquine.


This survey of British rheumatologists, orthopedic surgeons, and general practitioners identifies the need for improved aseptic techniques with this procedure, although septic arthritis following steroid injection of the knee appears to be rare.


Presents crucial sets of quality indicators for rheumatoid arthritis, osteoarthritis, and analgesic use, and the methods used for deriving them, based on the scientific evidence and expert consensus.


Presents the comprehensive set of 14 quality indicators for osteoarthritis in detail, including supporting evidence for use in assessing the quality of care for osteoarthritis.


This survey of 679 patients with rheumatoid arthritis identifies areas of health care in which patient demands are not being met and areas in which health care is underused.


Presents a set of 10 quality care indicators for management of gout, derived from a review of the literature and expert evaluation.

Newman ED, Harrington TM, Olenginski TP, et al. ‘The rheumatologist can see you now’: successful implementation of an advanced access model in a rheumatology practice. Arthritis Rheum 2004; 51:253—257. This article presents an innovative model to help measure and eliminate backlog in rheumatology practice that was able to improve access and patient satisfaction.


Solomon DH, Avorn J, Warsi A, et al. Which patients with knee problems are likely to benefit from nonarthroplasty surgery? development of a clinical prediction rule. Arch Intern Med 2004; 164:509—513. This study presents a clinical prediction rule, based on a series of 103 patients and the expert opinions of orthopedic surgeons, that identifies patients likely to benefit from nonarthroplasty surgery in view of accessible characteristics.

Computer applications in clinical practice
Angelia Mosley-Williams and Carl Williams

Purpose of review
The prospects of improved practice efficiencies and better treatment outcomes have recently focused political attention at high levels upon the use of information technology (IT) in routine clinical care in the US, UK and elsewhere. Providers who treat musculoskeletal diseases need to become familiar with emerging governmental policies, IT industry trends, data standards and communication protocols to equip themselves with a basis on which to evaluate and influence the development of these technologies, which in turn will influence the shape of clinical practice.

Recent findings
The articles cited are categorized into the topics of government policy regarding electronic medical records (EMRs); data definitions and databases; computers in outpatient clinical encounters; EMRs; patient self-entry of historical data; computer physician order entry; personal digital assistants; and e-mail, the Internet, and the patient/physician encounter.

Summary
Government agencies in the US, UK, and elsewhere are at various stages in the implementation of national health information infrastructures. US officials are playing a greater role in prompting physicians to use EMRs and in setting standards for EMR systems. A study by the American College of Rheumatology observed, ‘Increasing requirements for provider compliance with quality and outcomes reporting, HIPAA regulations, medical error reduction, including Medicare e-prescribing mandates, and downward pressure on practice revenues will ultimately drive the adoption of EMRs in office practice.’ Nonuse will equate to a non-viable practice. Rheumatologists who would control their own destinies must acquaint themselves with, adopt, and exert influence on the development of these technologies with all deliberate speed.

Keywords
computerized medical records, computerized patient records, medical informatics

Introduction
The prospects of improved practice efficiencies and better treatment outcomes have recently focused political attention at high levels upon the use of information technology (IT) in routine clinical care in the US, UK, and elsewhere. Providers who treat musculoskeletal diseases need to become familiar with emerging governmental policies, IT industry trends, data standards, and communication protocols to equip themselves with a basis on which to evaluate and influence the development of these technologies, which in turn will influence the shape of clinical practice.

This review of publications between September 01, 2003 and September 15, 2004 uses the broad search criteria of computer literacy, computers, microcomputers, software, software design, or user-computer interface, in English only in OVID/Medline. Most articles discuss molecular biology, patient imaging, or medical education. Fewer than 10 citations among a total of 3131 are specific to the clinical practice of rheumatology. Relevant articles are categorized by the topics of government policy regarding IT in healthcare, data definitions and databases, computers in outpatient clinical encounters, electronic medical records (EMRs), patient self-entry of historical data, computer physician order entry (CPOE), personal digital assistants (PDAs), and e-mail, the Internet, and the physician/patient encounter.

Background
The 2001 report by the Institute of Medicine (IOM), Crossing the Quality Chasm, recommended the collaboration of healthcare organizations, clinicians, patients, and purchasers in the redesign of healthcare processes. The report specified the free flow of information, the sharing of medical knowledge, and the use of evidence based decision making. It emphasized the use of outcomes, increased use of patient self-report data and the better use of current information technology in record keeping and information flow.
In the United States in January 2004, the need to computerize health records to reduce costs and improve care gained new emphasis after receiving comment by President Bush in his 2004 State of the Union Address. He created a new subcabinet position, National Health Information Technology Coordinator, in the Department of Health and Human Services (HHS). The IOM published a report on patient safety and the need for the development and dissemination of EMRs in clinical practice [1**]. Joint governmental, medical and IT industry workgroups were formed [2**]. Numerous medical associations and government agencies published important position papers, neither Medline-indexed nor peer reviewed, that advocate for improvements to the national health information infrastructure (NHII).

An era of widespread use of IT by US physicians in routine clinical care to document patient encounters has begun [3**]. This review outlines some database concepts and desirable EMR system functionality that provide a basis for categorization and evaluation of published reports of computer applications and uses.

A database is a collection of information stored in an organized fashion so as to facilitate retrieval. Optimally, that information has multiple occurrences and/or is to be tracked over time. Examples of paper databases are a collection of sticky notes, a novel, a telephone directory, a patient’s paper chart, a file room, and the Library of Congress. An EMR is a software application for the entry, retrieval, and display of patient information into a digital database. Advantages of digital storage are a decrease in the space and cost of storage (virtually none), increased availability of records, greater searchability of records, and the possibility of business process reengineering to achieve greater practice efficiencies such as the use of decision support software with real-time prompts, alerts, and reminders that reduce the likelihood of medical errors.

Though often spoken of as one, a digital database as a repository of clinical information is distinct from the input and display screens of an EMR, the computer system with which humans interact. This is analogous to e-mail being distinct from the computer software program used to generate, send, retrieve, and display it. Databases usually exist independently of the EMRs and may exchange information with any number of front-end or client software programs.

Practice automation systems may contain any of the following types of software applications: practice management (billing, scheduling, insurance, and demographics); EMR; CPOE (including Internet pharmacy); document image management (laboratory reports, letters, x-rays); decision support (practice guidelines, reminders, and prompts); patient–physician e-mail and Internet access to medical knowledge bases (libraries, online archives).

An EMR is the core application of a practice automation system that coalesces the others into a meaningful whole. Rheumatology data should integrate seamlessly into the total patient history. Records should be patient-centered and not specialty-centered or provider-centered. Reports on computer uses in the longitudinal clinical care of patients with nonrheumatologic conditions provide valuable insights.

Operational synergies are realized when information flows seamlessly between various components of the NHII. An example would be the automated near-real-time reporting of cases to the Centers for Disease Control and Prevention for disease surveillance from EMRs. How might such a system have facilitated detection during the US anthrax outbreak of 2001? Hence, data must be interoperable. Standardized data definitions, diagnostic criteria (eg, the American College of Rheumatology (ACR) criteria for rheumatoid arthritis), structure (eg, a controlled—perhaps template-driven—vocabulary versus unstructured prose), and formats (eg, good or bad, 1–10, same–better–worse) in the recording of clinical findings to facilitate accurate database queries and finely specified recalls are crucial. These are not new concepts. They originated with Lord Kelvin [4] and Florence Nightingale [5] in the 19th century, ran to Ernest Codman [6] in the first decades of the 20th century, and were re-emphasized and given modern focus early in the computer age by Alvan Feinstein [7], an oncologist, in the 1960s and James Fries [8], a rheumatologist, in the 1970s. With such searchability, with proper authorization, providers, institutions, and autonomous software agents of the 21st century can access patient records knowing that the terminology and codes used have common meaning in the NHII.

Fries et al. [9] and Meenan et al. [10] independently reported the value of patient self-report data in the evaluation the effectiveness of care and the compilation of outcomes in rheumatology in 1980. Some EMRs have evolved to accommodate this information and to allow direct patient entry of self-report and other historical data.

**Government policy regarding IT in healthcare**

In 2004, HHS published a framework. General strategies for the NHII goals: (1) inform clinical practice, (2) interconnect clinicians, (3) personalize care, and (4) improve population health [11**]. The HHS report announced an unspecified governmental role in promoting EMR adoption and reducing provider investment risks, inclusive of rural and underserved areas. The framework deemed the exchange and interoperability of patient data essential and reported that a feasibility study was underway of private sector certification of ambulatory EMR products based on functionality, security, and interoperability.
Data definitions and databases

The IOM committee report on patient safety defined and gave examples of data standards [12*]. Common computer coding schemes recording and transmitting patient data were deemed essential. Message format standards were proposed: Health Level Seven for clinical data messaging, Digital Imaging and Communications in Medicine for imaging, and the National Council for Prescription Drug Program for retail pharmacy messaging, to name a few. Brief descriptions were given of the Systemized Nomenclature of Human and Veterinary Medicine Clinical Terms for diagnostic codes and Logical Observation Identifiers, Names and Codes for laboratory data.

Computers in outpatient clinical encounters

Physicians use personal computers and handheld devices for many aspects of patient care. Computers are most commonly used for practice management, Internet access to online health information, and e-mail communication with patients and others [3**]. Fifty-eight percent of UK and 90% of Swedish primary care physicians use EMRs. The IOM [1**] and HHS [11**] advocate the use of computerized patient records and interoperable electronic health records within 10 years. Only 17% of primary care physicians in the United States did so in 2002 [13*].

Electronic medical records

Hundreds of products described by their sellers as EMRs are extant. Vendors and applications change with unsettling rapidity. The ACR published the most recent, relevant, and comprehensive survey of EMRs for this readership in 2002. It was a painstaking, labor-intensive, 1-year undertaking by a large subcommittee of the ACR’s Committee on Rheumatologic Care, and was updated in 2003 [3**]. Individual EMR programs were not critiqued. Guidelines were proposed for selecting systems that have the functionality needed to document adequately the care of patients with chronic illnesses. The survey asserted that EMR systems should have the ability to integrate laboratory and imaging results, procedure notes, and inpatient and outpatient clinical documents. Data entry should be quick and accurate to allow input of data at the bedside. Ultimately, such data should be organized and stored to allow retrieval to track outcomes.

The American College of Physicians published newsletters that advocate the use of EMRs [14*,15]. The American College of Cardiology [16**] published a position paper on the benefits of physician use of computers to access online medical databases and clinical guidelines during patient care, to improve communication with referring physicians and patients, and to improve documentation of patient encounters.

Other American College of Physicians newsletters [17,18] assert that EMR systems should be evaluated after the physicians and other users have collectively considered and discussed the desired tasks to be performed using the computer system, the resultant business practices changes, and the effort needed from all stakeholders to make the transition from paper records successful. Purchase should follow the comparison of notes taken during demonstrations of systems that best fit the required tasks at the price that fits the budget.

High initial financial costs, uncertainty of financial payoffs, physician time costs, the paucity of adequate technology, and physician attitudes are potential barriers to adoption of EMRs [19]. However, physicians who published their experiences deploying EMRs thought that they provided a better way to practice medicine. A New York rheumatologist concluded that he saved time and money when he fully automated his office using a collection of software programs that integrated document management from sources such as laboratories, clinic visits, and telephone messages [20]. He achieved a 95% paper-free office. He did not specifically mention the use of a database for longitudinal observations or the compilation of outcomes.

Data, databases, and electronic medical records

An orthopedic surgical practice detailed the development and maintenance of three sequential databases beginning in 1983 using commercially available software [21]. The surgeons sought to improve the quality of patient care by tracking data collected during routine clinical and surgical encounters. The authors decided prospectively which data items to collect and migrated twice to different database programs as surgical technology, computer hardware, and software evolved. Clinical data were collected on paper templates that were scanned into computer storage and later manually transcribed into a computer database.

General surgeons at several Germany universities developed a database using commercially available software and a custom (front-end) application for a data entry system [22]. Wound characterization and treatment guidelines were agreed on prospectively by the 10 surgical wound centers that participated in the outcomes organization, the German Wound Net. Physicians recorded patient demographics and the characteristics of chronic wounds, including photographs, during patient visits. The goal is to collect prospective data on wound dynamics and care.

The data quality in EMRs was improved when computer-savvy generalists in the United Kingdom received feedback and training in data coding facilitated by database use [23].
Patient self-entry of historical data
Clinicians at the San Diego Veteran's Administration Medical Center [24**] and at Wayne State University School of Medicine in Detroit [25**,26*] independently published usability studies for computer-assisted interview systems designed specifically for arthritis patients. At each institution, patients reported little or no difficulty with computer use. In San Diego, 43 patients tested a prototype system for administration of the MDHAQ and patient self-report joint counts. In Detroit, 2964 MDHAQs were collected over a 30-month period.

The chief medical officer of the Oracle Corp (Redwood Shores, CA) summarized the benefits and concerns of patient participation in creating and maintaining EMRs, including privacy considerations and authentication of data [27*].

Computer physician order entry
Physician use of computers to order laboratory results and medications is thought to decrease errors because of poor handwriting. However, only 9.9% of surveyed US hospitals used CPOE [28**]. Social changes are often necessary to implement CPOE successfully. [29*]

Personal digital assistants
One group [30*] held eight focus groups on PDA use in the United States. The opinions were collected of 54 physicians, 33% female and 75% general internists. Half were trainees. Nonusers (17%) were skeptical and uninterested in change or new technologies. Routine users (50%) used multiple applications regularly in clinical settings. Applications for the PDA included point-of-care access to drug information, clinical guidelines, decision aids, retrieval of test results, electronic prescribing and coding, data collection for research, and medical education functions.

An orthopedic surgeon reviewed the variety of PDAs available [31]. He enumerated some security issues associated with their use. The features were detailed of a PDA program he developed to record musculoskeletal histories and physicals, including radiograph results, American Knee Society scores, and surgical data.

E-mail, the Internet, and the patient/physician encounter
Patients at the University of Pennsylvania orthopedic surgery clinic were surveyed regarding computer access and Internet use [32**]. One hundred fifty-four questionnaires of 227 distributed were completed and analyzed. Forty-nine percent of the patients with annual incomes of less than $18,000 did not have a home computer. Most low-income and high-income patients used the Internet daily. Although low-income patients were least likely to use the Internet to seek out health-related information, they were willing to use the Internet in the office waiting room.

Review of 3007 patient–physician e-mail messages of consenting participants at the University of Michigan revealed that the patients used e-mail most commonly to provide personal health information updates and to obtain test results, ask questions, and request prescription renewals. The architecture of the practice’s e-mail system was described [33**]. An editorial followed [34**].

Conclusion
Government agencies in the US, UK, and elsewhere are at various stages in the implementation of national health infrastructures. US officials are playing a greater role in prompting physicians to use EMRs and in setting standards for the EMR systems. As the ACR’s Committee on Rheumatologic Care study noted, ‘Increasing requirements for provider compliance with quality and outcomes reporting, HIPAA regulations, medical error reduction, including Medicare e-prescribing mandates, and downward pressure on practice revenues will ultimately drive the adoption of EMRs in office practice.’ Nonuse will equate to a nonviable practice. Rheumatologists who would control their own destinies must acquaint themselves with, adopt, and exert influence on the development of these technologies with all deliberate speed.

References and recommended reading
Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
** of outstanding interest


This is an excellent reference that provided the framework for the HHS initiatives for an integrated computerized health record that are scheduled to occur in 10 years.


Available at: http://www.rheumatology.org/publications/practiceview. This article provides a good overview of current and future computer uses in rheumatology practices in the United States and an overview of CPR software available in 2003.


Epidemiology and health-related services

11 Anonymous: Executive summary. In The Decade of Health Information Technology: Delivering Consumer-Centric and Information-Rich Health Care. Available at: http://www.hhsgov/onnchit/framework/. This is an excellent reference describing the US government initiatives on an interoperable computerized health record that is scheduled to occur over the period of the next 10 years. It is published by the HHS.


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Advancements in the surgical and alternative treatment of arthritis
Stephen Lyman, Seth Sherman, Warren R. Dunn and Robert G. Marx

Purpose of review
Surgical and nonsurgical treatment of arthritis is a rapidly developing and evolving field. It is vital for clinicians to keep up on the latest advances. This review focuses on clinical trials or large prospective studies over the past year that evaluated orthopedic surgical techniques for the treatment of arthritis and new nonsurgical therapies that may prevent the need for surgical intervention. Increasing attention has also been focused on the relation between surgeon or hospital case load and the quality of outcomes after surgery.

Recent findings
No fewer than 10 studies have been published over the past year evaluating the use of hyaluronic acid (a visco-supplement) or corticosteroid injections as alternative treatments to knee arthroscopy for osteoarthritis of the knee. Joint replacement research has explored minimally invasive and computer-guided or robot-guided joint replacement surgery, the best operative choice for advanced shoulder arthritis (hemiarthroplasty compared with total shoulder replacement), the role of patellar resurfacing during total joint replacement, and the use of bisphosphonates for retention of bone density after joint replacement.

Summary
The increasing attention on high-quality surgical trials should continue to improve surgical options based on sound research for patients with arthritis. Future research should continue to improve the available high-quality research for treatment choices.

Keywords
arthritis, arthroscopy, joint replacement, orthopedics

Introduction
Orthopedic surgical techniques have often been introduced without sound, unbiased research demonstrating the effectiveness of the technique over previous procedures or nonsurgical options. As at least one orthopedic surgeon is fond of saying, ‘Nothing improves your outcome like the lack of a control group.’ Today’s orthopedic surgical outcome research, however, has rapidly evolved into high-quality randomized controlled trials and well-designed and executed prospective cohort studies. These studies provide the best evidence of the effectiveness of a new treatment, be it a surgical intervention or nonsurgical alternative or modification to an existing technique. The purpose of this review is to evaluate the studies that have come out in the past year that may alter surgical options for patients with painful and debilitating arthritis of the extremities.

Alternative treatment of knee osteoarthritis
Several promising alternatives to knee surgery are being promoted for the treatment of knee osteoarthritis. Both hyaluronic acid and corticosteroid injections show some promise for non-surgical treatment of the arthritic knee.

Hyaluronic acid
A common treatment for osteoarthritis of the knee has been knee arthroscopy. A recent randomized, placebo-controlled trial provided evidence that arthroscopic debridement may be no more beneficial than a placebo sham surgery [1], suggesting that knee arthroscopy may be an unnecessary procedure for some patients with knee osteoarthritis. Several studies published over the past year have critically evaluated the role of a visco-supplement, hyaluronic acid, to reduce the pain and disability associated with knee osteoarthritis.

Day et al. [2**] conducted a large, double-blind, randomized, multicenter study of the effectiveness and tolerance of hyaluronic acid injection for knee osteoarthritis. The comparison group was given a saline injection. Hyaluronic acid injection (five injections over 5 weeks) demonstrated a significant decrease in pain and stiffness compared with the placebo group for weeks 6–18 after injection. This well-designed study strongly supports the clinical effectiveness of hyaluronic acid injection compared with placebo. Jubb et al. [3], however, found in a randomized controlled trial comparing hyaluronic acid injection with placebo that there was no difference in the degree of joint...
space narrowing between baseline and 1-year follow-up except among patients with mild knee osteoarthritis. Those mild osteoarthritis patients injected with hyaluronic acid had significantly less joint space narrowing than the mild osteoarthritis patients injected with placebo.

Caborn et al. [4••] found that hyaluronic acid injection (three injections over 3 weeks) provided favorable 12-week and 26-week improvements in pain and function compared with a similarly tolerable dose of triamcinolone hexacetonide (one injection). Significant differences between the two groups were found for a visual analogue pain scale, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) overall score, and WOMAC functional domain score. Leopold et al. [5•] compared hyaluronic acid injection (three injections over 3 weeks) with a single corticosteroid injection for knee osteoarthritis. Significant improvements were seen for both treatment groups at 6 months using the WOMAC. Neither group improved significantly using a modified Knee Society score, and only the hyaluronic acid group significantly improved on the basis of the visual analogue pain scale. Neither group was significantly improved over the other in any of the outcomes measures, however. Tasciotaoglu and Oner [6•] also found that hyaluronic acid injection (three injections over 3 weeks) was not significantly better than corticosteroid injection (three injections over 3 weeks) at 6 months after enrollment, although there was a significant difference between the treatment groups at 3 months, with hyaluronic acid-injected patients having significantly less pain and improved function. This disparity had disappeared at 6 months in this small study of only female patients, however. Overall, it appears that hyaluronic acid injection may offer a modest improvement over corticosteroid injections in the nonsurgical treatment of knee osteoarthritis.

Forster and Straw [7] found in a randomized trial comparing hyaluronic acid injection (five injections over 5 weeks) with arthroscopic lavage that the treatments had similar outcomes at up to 1 year after operation, suggesting that hyaluronic acid injection may be an alternative to knee lavage in patients with knee osteoarthritis. Bayramoglu et al. [8] found no association between weekly hyaluronic acid injections with physical therapy over a 3-week period and physical therapy alone in reducing the severity of knee osteoarthritis. This small pilot study of just 37 patients may have been underpowered to find a significant association.

Lo et al. [9••] conducted a meta-analysis of hyaluronic acid injection for the treatment of knee osteoarthritis. They concluded that hyaluronic acid injection has a small effect compared with a placebo, and publication bias may explain at least part of this effect. Higher-molecular-weight hyaluronic acid injections may be more effective than lower-molecular-weight hyaluronic acid in treating knee osteoarthritis, but the heterogeneity of these studies limits definitive conclusions. Wang et al. [10••] also conducted a meta-analysis and reached similar conclusions. Older patients with advanced knee osteoarthritis did not respond well to hyaluronic acid injection, the use of acetaminophen as an escape analgesic reduced hyaluronic acid effectiveness, and lower-quality studies were more likely to find large benefits to hyaluronic acid injection.

Corticosteroid injections

Raynauld et al. [11••] conducted a placebo-controlled trial comparing intraarticular steroid injections (one every 3 months for up to 2 years) with placebo. Follow-up analysis was conducted at 1-year and 2-year intervals. No differences were found in the degree of joint space narrowing, but patients treated with steroids had significantly less pain and better function than the placebo-controlled group, suggesting that long-term use of steroid injection for treatment of knee osteoarthritis is both safe and effective.

Smith et al. [12] conducted a randomized controlled trial of arthroscopic lavage compared with arthroscopic lavage and corticosteroid injection (single injection after arthroscopy). Only a modest difference in favor of lavage plus steroid was found at 4 weeks after intervention, with the difference disappearing at all subsequent time points, suggesting that lavage and lavage plus steroid are equivalent therapies in the treatment of knee osteoarthritis.

Mini-invasive hip and knee surgery

Studies by Chung et al. [13] and Tria and Coon [14] demonstrated that minimally invasive surgical techniques for total hip replacement (THR) and total knee replacement (TKR) result in less perioperative blood loss, shorter lengths of stay, and smaller surgical scars for both types of surgery than the traditional open surgical techniques. Furthermore, Chung et al. [13] showed that minimally invasive THR reduced the need for walking aids after surgery compared with traditional THR. Tria and Coon [14] showed that minimally invasive TKR increased range of motion after operation compared with traditional TKR. Both of these studies had small sample sizes with short follow-up.

Woolson et al. [15••], however, published a retrospective cohort study of 50 mini-invasive THRs and 85 standard THRs and found no significant differences in surgical time, intraoperative blood loss, transfusion rate, length of stay, or disposition at discharge. The only significant findings were an increased risk of wound complication, acetabular component malposition, and poor fit and fill of femoral components inserted without cement for patients undergoing the mini-invasive THR.

Further research will need to be conducted to determine whether the patients have satisfactory long-term outcomes.
Also, the learning curve for these new procedures must be considered, which may or may not explain the findings of Woolson et al. [15**].

**Surgery for shoulder arthritis**

Edwards et al. [16*] compared total shoulder replacement (TSR) with hemiarthroplasty of the shoulder in a prospective, multicenter cohort study. Patients undergoing TSR experienced a significant improvement compared with patients treated with hemiarthroplasty of the shoulder for both pain and function measurements at 2 years after surgery. Both procedures demonstrated significant improvement in pain and function from measures before surgery to measures after surgery, but because TSR patients had lower baseline scores, they demonstrated significantly more improvement than hemiarthroplasty patients. This significant difference in improvement may be a result of the systematic treatment of patients with poorer function and more pain with TSR rather than hemiarthroplasty. A randomized controlled trial comparing these two procedures would provide better evidence.

Hettrich et al. [17], attempted to identify factors that identified patients who would benefit most from hemiarthroplasty of the shoulder. Patients without evidence of erosion of the glenoid (the surface not treated with hemiarthroplasty compared with TSR), patients without previous surgery, patients with intact rotator cuffs, and patients with diagnoses of osteonecrosis or primary or secondary degenerative joint disease had significant improvement after treatment with hemiarthroplasty of the shoulder. No alternatively treated comparison group was used in this analysis.

**Active and passive computer-assisted surgery**

Chauhan et al. [18] conducted a randomized study demonstrating that component alignment during TKR was significantly improved with the use of computer-assisted arthroplasty compared with a conventional jig-based technique. The clinical relevance of the improved alignment was not analyzed, however, and the computer-assisted technique took significantly longer to perform (13 more minutes on average). Sparmann et al. [19] found the same improvement in alignment in a randomized trial comparing computer-assisted TKR with conventional TKR techniques in a large patient population, but again without any measures of long-term outcome or the relevance of the improved alignment.

Honl et al. [20] demonstrated that computer-assisted THR was superior to conventional THR with regard to alignment, but that long-term follow-up revealed no difference in patient-based measures of outcome. Computer-assisted THR procedures were of significantly longer duration (25 min), 18% were converted from computer-assisted to conventional because of system failure, and dislocation was significantly more frequent in the computer-assisted hips than in the conventionally treated hips. This well-designed randomized controlled trial suggests that the technique will need further refinement before general use is recommended.

**Patellar resurfacing in total knee replacement**

Waters and Bentley [21*] conducted a large randomized trial comparing patellar resurfacing during TKR with not resurfacing the patella during TKR. Patients undergoing patellar resurfacing had significantly lower rates of anterior knee pain, fewer secondary operations, and higher knee scores after operation. In a randomized trial by Mayman et al. [22*], 100 patients were followed for 8–10 years to establish the long-term effects of patellar resurfacing. While there were no significant differences in Knee Society Clinical Rating scores between the two groups, patients who underwent resurfacing had significantly less anterior knee pain with walking and climbing stairs. Patients with a resurfaced patella were also significantly more likely to be extremely satisfied with their TKR. These studies both support the advantages of patellar resurfacing during TKR.

**Bisphosphonates after total knee replacement and total hip replacement**

Wang et al. [23] conducted a randomized controlled trial in which women undergoing TKR were randomized into a group receiving oral alendronate at a dosage of 10 mg/day for 6 months compared with a control group. Bone mineral density was significantly increased in the treatment group and significantly decreased in the control group during the 6 months from surgery to follow-up. This study suggests that alendronate may have a clinically important effect on prosthetic fixation and the risk of fracture around the TKR implantation site.

Yamaguchi et al. [24] found a similar relation between cyclic therapy with etidronate in patients undergoing cementless THR compared with a control group. The treatment group had significantly higher bone mineral density measures than the control group after 12 months.

**Volume–outcome relations in orthopedics**

Many previous studies have demonstrated a relation between surgeon and hospital volume for TKR and THR and outcomes such as mortality, complications, infection, and reoperation rates. Virtually all associations have demonstrated improved outcomes with increased surgical volume. These results have been verified yet again by Hervey et al. [25], who found a linear relation between increasing surgeon volume and decreasing risk of mortality after TKR. This study was unique because it did not use Medicare data to evaluate these relationships. Most previous studies have relied on Medicare data, which eliminate most TKR or THR performed on younger patients. Another recent study by Katz et al. [26*] used Medicare data to
study the volume–outcome relation in TKR patients, but focused on in-hospital complications after TKR. This study found a significant decreased risk of pneumonia and other in-hospital complications (e.g., death, pulmonary embolus, acute myocardial infarction, or deep infection) with increased surgeon and hospital volumes.

Two studies published within the past year have found relationships between surgical volume and shoulder replacement (both TSR and partial shoulder replacement). Jain et al. [27*] found a significant increased risk of complications after partial shoulder replacement performed by low-volume surgeons compared with high-volume surgeons. They also found a significant increased risk of complications after TSR performed at low-volume or mid-volume hospitals compared with high-volume hospitals. Hammond et al. [28*] found a significantly increased risk of long-term complications after partial shoulder replacement performed by low-volume surgeons compared with high-volume surgeons. The increased length of stay was also significantly associated with lower hospital volume for shoulder replacement. Once other factors were controlled for, however, only increased risk of complication and increased length of stay were significantly associated with lower surgeon volume. No significant relationships were found for hospital volume after adjustment for other factors.

**Conclusion**

The findings of the past year should improve patient care for advanced arthritis through improved treatment modalities for knee osteoarthritis, improved designs for total joint replacements, and continued advancements in minimally invasive and computer/robot-assisted surgery. Many gaps still exist in the knowledge base concerning the efficacy and safety of many orthopedic procedures, but the high quality of randomized clinical research conducted over the past year demonstrates that procedures will continue to be studied objectively for both safety and effectiveness. One thing has become increasingly clear: higher-volume surgeons and hospitals have consistently better patient outcomes after total joint replacement.

**References and recommended reading**

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
•• of outstanding interest


This study is an example of a well-designed, well-conducted randomized clinical trial studying nonsurgical treatments for knee osteoarthritis.


This study is another example of a well-conducted randomized trial for the nonsurgical treatment of knee osteoarthritis.


This study was limited by the fact that only female patients were studied, but it still contributes to the literature concerning hyaluronic acid injection for knee osteoarthritis.


This is a well-conducted meta-analysis of the best studies of hyaluronic acid for the treatment of knee osteoarthritis.


This meta-analysis found results similar to those of the article by Lo et al. [9] with a similar study design.


This study is an example of a well-designed, placebo-controlled, randomized trial with adequate sample size.


This study used more scientific rigor than previous reports on mini-incision surgery and found less promising results. Taken with the other recent mini-incision research, this provides an excellent example of how bias can result in overstating the findings.


This is an excellent example of a multicenter prospective cohort design, perhaps the most powerful clinical study design apart from the randomized trial.


21 Waters TS, Bentley G. Patellar resurfacing in total knee arthroplasty: a prospective, randomized study. J Bone Joint Surg Am 2003; 85:212–217. This is a nice example of a large (adequately powered) randomized trial of surgical technique. With more research like this, there would be a noticeable improvement in orthopedic surgical care.


26 Katz JN, Barrett J, Mahomed NN, et al. Association between hospital and surgeon procedure volume and the outcomes of total knee replacement. J Bone Joint Surg Am 2004; 86:1909–1916. This study is an excellent example of the utility of large hospital discharge databases in the study of orthopedic outcomes. Although these studies have many limitations, the sample size available cannot be ignored as a useful tool in orthopedic clinical research.


Epidemiology of back disorders: prevalence, risk factors, and prognosis

Nisha J. Maneka and A.J. MacGregor

Purpose of review
This article reviews some of the advances that have taken place in understanding back disorders, with a particular emphasis on low back pain, as this area has been most represented in the literature in the preceding year (September 2003 to September 2004).

Recent findings
Epidemiological studies continue to provide insights into the prevalence of back pain and have identified many individual, psychosocial, and occupational risk factors for its onset. Psychological factors have an important role in the transition from acute to chronic pain and related disability. Recent advances show that there is a significant genetic effect on severe low back pain in the community. Data emerging from candidate gene studies show an association between lumbar disc disease and mutations of genes encoding the α-2 and α-3 subunits of collagen IX.

Summary
Back pain is among the most common conditions for which patients seek medical care. Interventions based on behavioral and cognitive principles and exercise programs are effective in improving disability in chronic back pain. Although progress has been made in understanding the role of genetic mutations in disorders such as lumbar disc disease, further investigation of the interaction between genetic and environmental factors such as physical stress is needed.

Keywords
back pain, genetics, lumbar disc degeneration, twin study

Introduction
Back disorders encompass a spectrum of conditions, from those of acute onset and short duration to lifelong disorders, and include osteoarthritis, disc degeneration, osteoporosis, and common low back pain. Neck pain is an entity in and of itself. The prevalence of many of these disorders increases markedly with age, and many of the disorders are affected by lifestyle factors, such as obesity and certain types of physical activity. Although the economic and public health effects of back disorders and especially low back pain are enormous [1,2], epidemiologic research into the problem is in a formative stage, especially compared with cardiovascular conditions and cancer. As a result of the increasing number of older people throughout the world, the burden on the individual and society as a whole is expected to increase dramatically [3]. While not a disease, back pain is a major cause of disability, especially in areas where compensation systems take it into cognizance.

Definitions
Low back pain is usually defined as pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal folds, with or without leg pain (sciatica). It is typically classified as being specific or nonspecific. Specific low back pain is defined as symptoms caused by red flags. These harbingers of organic disease that include spinal fractures, cancers, infections, and cauda equina syndrome can be identified and dealt with appropriately. The probability that a particular case of back pain has a specific cause identified on back radiographs is less than 1% [4].

Approximately 90% cases of back pain have no identifiable cause and are designated as nonspecific. A variety of diagnostic labels have been used by health care professionals. Currently, however, no reliable and valid classification system exists for most these cases. Although acute (and under some classifications, subacute) episodes that last up to 3 months are the most common presentations of low back pain – and recurrent bouts of such episodes are the norm – chronic back pain ultimately is more disabling because of the physical impediments it causes and its psychological effects. Chronic back pain has been caught up in medical controversies, especially about what work-up and treatments are appropriate. Many doctors order elaborate studies when nonspecific back pain is presented, including radiographs and magnetic resonance imaging. The result is little guidance to treatment decisions.
Prevalence

Prevalence measures the proportion of the population that experiences low back pain at a given time, which can be at any specified point (point prevalence) or in a past period such as 1 month, 1 year, or a lifetime. Assessing or comparing prevalence studies of back pain and other back disorders can be hampered by lack of agreement on a clear and potentially generalizable definition of low back pain. Furthermore, period prevalence studies may be biased by poor recall and incomplete response. Other methodologic flaws that bias studies include identifying and accounting for differences between sample populations and target populations as well as difficulties in accurately determining the general quality of data. Given these caveats, recently published data continue to confirm that low back pain is a common disorder in Western and developing nations [5–7].

In the US population, the third National Health and Nutrition Examination Survey (NHANES III) (1988–1994) estimated that the 12-month period prevalence of back pain episodes lasting for at least 1 month was 17.8% [8]. In the adult Greek population, the 1-month prevalence of back pain has been estimated as 32%. This figure is somewhat higher than that reported of other population surveys and may reflect the relatively high proportion of the Greek population engaged in manual work such as agriculture [9]. A direct comparison of back pain between the United Kingdom and Germany not only showed differences in prevalence between the two countries (22% compared with 44.9% in women) but also demonstrated marked differences in the prevalence of current back pain within each country or region [10]. West Germans carry a risk of back pain 2.5 to 3.5 times higher than the British, even after adjusting for potential confounders. The authors hypothesize that intercultural differences between the British and Germans in pain perception or pain reporting may be a plausible explanation for the variation where none was expected to occur.

In developing countries with large work forces, prevalence data on back disorders, and particularly back pain, have been reported in the last year. In a nationwide study of 1-year prevalence of musculoskeletal disorders among workers in Taiwan, pain in the lower back and waist was among the most frequently cited symptom, occurring in 18% male workers and 20% of female workers. Workers between the ages of 45 and 64 years had the highest prevalence of back pain in both sexes [6]. The overall prevalence of low back pain lasting more than 1 day among Chinese workers was relatively high: 50% [7]. The prevalence declined considerably as the period of recall shortened, however, from 61% (lifetime) to 20% in the past week. The most frequent occurrence of low back pain was among garment workers, who showed a four-fold increase in comparison with teachers.

Risk factors

Inconsistencies remain in the literature over the relative contributions of physical and psychological risk factors to the occurrence of back disorders and back pain. Relatively little is known about risk factors for the transition from acute to chronic low back pain. Broadly, the variables associated with nonspecific low back pain can be classified as individual, psychosocial, or occupational factors (Table 1). More recently, genetic and bio-mechanical models have contributed to the understanding of the development of back disorders that present as back pain.

Individual risk factors

The presence and severity of low back pain is associated with several socio-demographic factors, among them sex, age, education level, smoking, and occupation [9–11]. Although the prevalence of back pain increases with age, the dose–response relation between age and low back pain is not linear, suggesting that multiple factors are involved [6]. Growing evidence shows that low back pain starts early in life, between the ages of 8–10 years [12,13]. One study of young adolescents and young adults age 12–22 years [14] demonstrated an overall prevalence of back pain of 7% (pain > 30 days during the past year). Young people with low back pain are more likely to suffer from asthma and headache [14]. The same investigators showed a statistically significant association between high birth weight and risk of developing low back pain in male patients but not in female patients [15*], suggesting that factors that predispose to low back pain could operate in the prenatal environment.

Table 1. Risk factors for occurrence of non-specific back pain and chronicity

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Higher rates of incident low back pain have been observed in college football players who have baseline radiographic abnormalities of spondylolysis (80.5%) compared with those with no abnormal radiographs at baseline (32%) over a 1-year period [16]. This finding suggests that an abnormality such as spondylolysis is a significant risk factor for low back pain in high school and college football players.

Psychosocial risk factors
Predictors of new-onset chronic back pain using prospective data in the general household population identified general health and psychosocial factors in both men and women [17]. Psychological variables associated with low back include stress, distress, mood and emotions, cognitive functioning [18*], pain behavior, and depressive disorder. Studies show a strong association between back pain and depressive disorders, but a cross-sectional analysis cannot establish cause and effect [19]. In a prospective study, however, lifetime depressive disorder has been shown to be an independent risk factor for a first-ever report of back pain during a 13-year follow-up period in comparison with those who did not have depressive disorder at baseline (estimated odds ratio of 3.4) [20*]. Back pain is not a short-term consequence of depressive disorder but emerges over periods longer than 1 year. The combination of chronic back pain and major depression is associated with greater disability than either condition alone [19].

Occupational risk factors
Studies on the association between occupational risk factors and low back pain are hampered by the difficulties of measuring specific exposures. Many studies are limited by the absence of more quantitative measurements of manual material handling task parameters, and risk of low back injury may be entirely a result of the design of the workplace as opposed to individual differences among the workers [21]. Self-reported questionnaire-based assessments tend to overestimate physical load on the back from bending and lifting compared with hourly self-reported logs of the same activities. The relative timing of the onset of low back pain and work exposure is also often uncertain. The healthy worker effect (workers with back pain leave a job, resulting in a surviving workforce with healthier backs) may introduce significant bias [7]. Workplace factors, including physical and psychosocial factors and their interaction, are strong determinants of back pain. Psychosocial risk factors at work (perceived high pressure on time and workload, low job control, job dissatisfaction, monotonous work, and low support from coworkers and management) appear to independently increase the risk of hospitalization for back disorders, with a 3.2-fold increase in a low-control job compared with a high-control job [22]. Other factors such as heavy physical work, night shifts, lifting, bending, twisting, pulling, and pushing have often been associated with low back pain [23].

Risk factors for chronicity
The transition from acute to chronic low back pain seems complicated. Many individual, psychosocial, and workplace factors play a role. A recently published systematic review of prospective cohort studies found that psychological factors are associated with increased risk of chronic low back pain [24] and also predict long-term work absence in disabling low back pain [25]. A practical consequence of this research is that international guidelines for the treatment of acute low back pain ask for the assessment of so-called yellow flags or psychosocial risk factors during the first 2–6 weeks of pain onset, provided there are no red flags (physical factors: infections, tumors, fractures, and so forth) [26]. Other important variables for chronicity include baseline duration of pain longer than 1 month, unemployment, and a significant negative event during the previous year [27].

Risk factors: anatomic, bio-mechanical aspects of the spine, and genetics
Greater understanding has been gained from cadaver and animal models of the role of biomechanics and biomarkers in the evolution of disc degeneration and back disorders (Table 2). Genetic factors also have contributed enormously to the understanding of back disorders and back pain.

Although radiographic disc degeneration and facet joint arthritis increase in prevalence with increasing age [4,28], disc space narrowing appears to be more strongly associated with back pain than other radiographic features [28].

The mechanisms and pathways for the degenerative process in the intervertebral disc are not well understood. Genetic, structural, and biochemical changes have been implicated and may be powerful determinants of the degenerative process [29]. In a population-based cohort of healthy women, glucose, insulin growth factor binding protein 1, and calcium hemostasis factors have been shown to be associated with a reduction in the likelihood of disc space loss [30]. The relatively avascular disc tissue depends on key nutrients such as glucose and anabolic...
actions of growth factors such as insulin growth factor binding protein 1, which are mediated through calcium channels. These findings help toward the development of models allowing prediction, for instance, of the interactions between metabolite concentrations and cellular activity and of the influence of the mechanical environment (i.e., loading and deformation) on nutrient transport [31–33]. This in turn provides the potential for evaluating the effects of genetic alterations in collagen. Together with mechanical testing, these techniques could be expanded to study structure–function relationships of disc tissue and chondrocyte function [29,34]. Histologic composition of herniated disc material appears to correlate with clinical symptoms such as pain [35].

Another major cause of development of pain and radicular symptoms in lumbar degenerative disease is hypothesized to be pressure on the nerve tissue from the ligamentum flavum, and facet joints [36]. Pathologic findings such as calcification of the ligamentum flavum seem to reflect more severe clinical back symptoms in the elderly patients [37]. Facet joint osteoarthritis of the lumbar spine is associated with anterior and posterior synovial cysts, which in some cases contribute to symptoms of radiculopathy (anterior cysts) and back pain (posterior cysts) [38]. Lumbosacral transitional vertebra seem to increase the risk of early degeneration in the upper disc but protect the lower disc, and do not appear to be associated with low back pain among middle-age men [39]. The term lumbosacral transitional vertebra refers to a fusion of the transverse process of the lowest lumbar vertebra to the sacrum. The frequently observed lumbar spine Schmorl nodes are associated with back pain in healthy women even after adjustment for age and degenerative disc disease [40].

Genetic risk factors: twin studies

The importance of genetic factors in degenerative diseases of the spine has been appreciated only relatively recently. In 1999, Sambrook et al. [41] conducted a classic study among adult female twins (172 monozygotic and 184 dizygotic) from a UK national volunteer registry. Magnetic resonance images of the cervical and lumbar spine were evaluated for features of disc bulge, loss of disc signal, disc herniation, and osteophytes. In both the cervical and the lumbar spine, approximately 75% of the variation in degenerative change could be accounted for by genetic variation within the sample. Both the severity of the changes and their extent (assessed through the number of levels that were involved) showed a genetic basis. The result took into account the confounding influence of age, body mass index, occupational manual labor, exercise, and smoking history. A later analysis of the same group of twins has shown that the distribution of Schmorl nodes is also predominantly explained by genetic factors, indicating heritable contribution to the degenerative process at its earliest stages [40].

The extent to which genetic susceptibility also might explain the experience of back and pain itself is more difficult to resolve. The data are conflicting. In the UK twin study, full pain histories were taken from a group of 1064 twins (the sample included those who had undergone magnetic resonance imaging examinations in the initial study) [42]. Using a set of increasingly stringent definitions of pain, significant heritable influences were demonstrated for back pain, ranging from 52–68%. Contrasting results are presented in an analysis of data from the Danish National Twin Cohort, however [43]. The main finding in the Danish study was a modest genetic effect on 1-month prevalence of back pain among men older than 70 years, but interestingly, this was not found among women. The differences between these two studies may reflect differences in definition (the Danish study restricted the definition of pain to that experienced in the preceding month, while the UK study took into account lifetime prevalence), the differences in the age distribution of the two samples, and the differences in geographical location representing different background levels of genetic and environmental variation. In the full analysis of the data from the UK twins [42], there was considerable genetic overlap between the reporting of back pain and the genetic determinants of psychological well-being. Thus, psychological and behavioral variables, past experiences of pain, patterns of learning, and cultural factors may all need to be included to develop an adequate genetic model of back pain.

Candidate gene studies

The pathophysiological mechanisms that underlie disc degeneration and pain perception have provided the focus for several studies attempting to identify the influence of individual candidate genes. Potential candidates include aggrecan, the vitamin D receptor gene, and metalloproteinase 3. The last year has seen particular attention focused on collagen IX gene and the interleukin-1 gene cluster, for which significant associations with degenerative change and back pain have been identified.

Type IX collagen is found in the nucleus, annulus, and vertebral endplates. It is believed to provide mechanical support for tissues by acting as a bridging molecule. It is a hetero-trimeric protein consisting of three genetically distinct chains. Sequence variation in the α-2 chain of collagen IX (identified by the Trp2 allele) has been associated with dominantly inherited lumbar disc disease [44]. A similar sequence variation has been found in the COL9A3 gene coding for the α-3 chain of type IX collagen (Trp3 allele) [45]. The latter allele has been shown to be associated with a three-fold increased risk of sciatica and represents the first common genetic factor for lumbar disc disease [45]. The Trp3 allele has also been associated with radiographic features of Scheuermann disease [46].
Inflammatory cytokines have a well-recognized contribution to the generation of back pain. Interleukin-1 in particular contributes to disc degeneration by inducing enzymes that destroy proteoglycan and is involved in the mediation of pain. In recent studies, Solovieva et al. [47,48] have demonstrated an association between interleukin-1 polymorphisms and features of disc degeneration on magnetic resonance imaging in male Finnish workers. The polymorphisms were associated with a 2.5-fold increased risk of back pain, and an association was also seen with the intensity and duration of pain together with the degree of functional limitation.

Association studies in genetic epidemiology are notoriously difficult to replicate, and the seemingly promising results of candidate gene studies that have emerged in recent years must be interpreted with some caution [49]. For collagen IX, it is noteworthy that the association with TTP3 allele has not been replicated in the Greek population [50]. Evidence also suggests that the association may be mediated by obesity and thus confined to particular at-risk groups [51]. Nevertheless, the fact that candidate genes can be identified at all for a phenotype as complex as back pain provides support for the notion that the genetic factors have a dominating role.

**Prognosis**

The literature regarding the long-term course of low back pain is confusing because of variations in definitions of low back pain as well as a lack of distinction between outcome parameters. Various outcome measures have been studied (pain, disability, sick leave, and medical consultations). A recent review to investigate the long-term course of incident and prevalent cases of low back pain showed that the reported proportion of patients who still experienced pain after 12 months was 62% (range, 42–75%), dispelling the popular notion that up to 90% of low back pain episodes after 12 months was 62% (range, 42–75%), dispelling the notion that the generation of back pain. Interleukin-1 polymorphisms and features of disc degeneration on magnetic resonance imaging in male Finnish workers. The polymorphisms were associated with a 2.5-fold increased risk of back pain, and an association was also seen with the intensity and duration of pain together with the degree of functional limitation.

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Low back pain can interfere with activities ranging from the basic activities of daily living to many work-related functions. It might seem obvious that pain determines disability in patients. This relation is not supported by clinical data, however. In patients with acute and subacute low back pain, clinically relevant improvements of pain may lead to unnoticeable changes in disability or quality of life [55]. Therefore, these variables should be assessed separately when evaluating the effect of any form of treatment for low back pain. It has been recommended that outcome assessment in the evaluation of treatment of spinal disorders include the following five domains: back specific functions, generic health status, pain, work disability, and patient satisfaction [56].

When work-related back pain is considered, type of treatment, response to therapy, severity of injury, and type of job are factors influencing the duration of disability. Economic, social, and legal factors also influence recovery. For example, longer duration of work disability as measured by workers’ compensation is a powerful predictor of recurrence of low back pain; therefore, early return to work contributes to better outcomes [57].

An important component of the biophychosocial model of low back pain management is exercise. Exercise is thought to reduce fear-avoidance behavior and facilitate functional improvements despite ongoing pain, and results are largely maintained at follow-up [58–60]. Graded behavior intervention reinforces the concept that ‘hurt does not mean harm’ [61*]. In other words, one can have pain and still function. Early mobilization programs can reduce duration of sick leave over 3 years and result in economic gains for society [62,63]. Cognitive intervention and exercise program may be just as effective in improving disability in patients with chronic back pain and disc degeneration compared with patients undergoing lumbar fusion surgery [64].

Other important determinants of the outcome of low back pain beyond activity modification include attitudes and perceptions of the patients. Patients are affected by their surroundings and receive recommendations from family, friends, and health care providers. In the general population’s perception, the myths of low back pain are very much alive [65]. For example, as many as 50–60% of the Norwegian population believe in the importance and benefit of radiographs and other imaging tests [65] and consequently have expectations for such services. Population beliefs have an important impact on how the health professionals regard the condition [66] and determine the kind of education given to patients.

Prognosis is also influenced by drug therapies (analgesics, muscle relaxants), patient educational materials, and even mattresses. The *Treat Your Own Back* book may have...
Considerable efficacy in helping readers decrease their own low back pain and reduce the frequency of their recurrent episodes [67]. After the study by Kovacs et al. [68••], clinicians may be confident in recommending a mattress of medium firmness rather than a hard bed for patients with chronic back pain.

Guidelines are playing an increasingly important role in evidence-based practice for acute low back pain in an effort to improve outcomes. Clinical guidelines have been developed and published in many countries around the world [69]. Unfortunately, good guidelines alone do not guarantee that they will be used in daily practice, and their implementation may need to be reinforced [70]. As electronic medical record technology improves and is adopted, ideally it will provide a platform for guideline dissemination and implementation.

Conclusion

Low back pain is an integral part of most human lives and causes different degrees of suffering and disability. The exact cause of pain cannot be identified in most instances. The natural history of low back pain seems in general to be favorable, but the consequence of long-term or permanent disability is of concern. Fear-avoidance has been shown to be part of the disabling pathway in chronic low back pain. Cognitive interventions, designed to remove fear and uncertainty and to give the patient the confidence that the back is robust even if it hurts, seem promising. Recent research advances have yielded understanding about the molecular mechanisms that may be involved in disorders such as lumbar disc disease, and important steps have been taken toward understanding the genetic modifiers.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

• of special interest
•• of outstanding interest


Epidemiology and prevention

43 A classic twin study suggesting a significant role of genetic factors on severe low back and neck pain.
68 A high-quality randomized trial providing empirical evidence for efficacy of a popular cost-effective management strategy for back pain.
Dietary risk factors for rheumatic diseases
Hyon K. Choi

Purpose of review
Recent scientific data illuminate the dietary link to rheumatic disorders. This review summarizes recently published articles on the dietary link to rheumatoid arthritis, gout, and osteoarthritis.

Recent findings
A prospective study suggests that higher intakes of meat and total protein as well as lower intakes of fruit, vegetables, and vitamin C are associated with an increased risk of inflammatory polyarthritis or rheumatoid arthritis. Several studies suggest that the Mediterranean-type diet or its main components may have protective effects on the development or severity of rheumatoid arthritis. A recent prospective study investigated several purported dietary factors for gout and confirmed some of the long-standing suspicions (red meats, seafood, beer, and liquor), exonerated others (total protein, wine, and purine-rich vegetables), and also identified potentially new protective factors (dairy products). Recent double-blind, randomized, placebo-controlled studies suggest that antioxidant vitamins (vitamin E, vitamin C, β-carotene, and retinol) do not halt the progression of symptomatic knee osteoarthritis, as was previously suggested.

Summary
Because diet is an unavoidable universal exposure for people, even a small effect that can be achieved by dietary manipulation may produce a large impact on the population's health. As the evidence on the role of dietary factors in rheumatic disorders grows it becomes increasingly important for clinicians and investigators in the field of rheumatology to familiarize themselves with the relevant data and appropriately apply them to clinical and public health practice.

Keywords
diet, epidemiology, nutrition, rheumatic, risk factors

Introduction
‘Does my diet affect my arthritis?’ The question is familiar to many rheumatologists, but solid data that address it have been sparse. Recently scientific data are emerging that serve to illuminate the dietary link to rheumatic disorders. Because diet is an unavoidable universal exposure for people, even a small effect that can be achieved by dietary manipulation may produce a large impact on the population’s health.

Establishing a casual link between dietary factors and disease requires both the elucidation of underlying pathogenetic mechanisms and the illustration of the link in human studies, in which epidemiologic research plays a major role. Epidemiologic research on dietary risk factors may begin with ecologic correlational studies, although the role of these studies in making causal inference is limited as a result of the potential for confounding that is often difficult to measure and adjust for in these studies (e.g. genetic disparity or factors associated with industrialization among compared countries). To be able to more directly investigate dietary risk factors for the development of rheumatic disorders, investigators typically need incident information based on follow-up of a population unaffected by the condition at baseline. When the rheumatic disease of interest is relatively common, as are osteoarthritis (OA), gout, and rheumatoid arthritis (RA), a cohort study design can produce a sufficient number of incident cases over a reasonable follow-up period to allow analyses of the suspected risk factors. The case-control design is more efficient for studying rarer outcomes (e.g. systemic vasculitis) that would not accrue in reasonable numbers even in large cohort studies with long follow-up. Although important practical limitations are associated with interventional studies (e.g. randomized trials), these studies are expected to provide more direct causal inference for suspected dietary links.

In summarizing recently published data on the dietary link to rheumatic disorders in this review, each topic below discusses the potential underlying mechanisms, the epidemiologic data, and available interventional studies.

Rheumatoid arthritis
Meat and protein, omega-3 fatty acids, fish oil, olive oil, the Mediterranean diet, and other dietary factors have been linked to the risk of RA.

Meat and protein
Red meat may have pro-inflammatory properties by providing a dietary source for arachidonic acid, a fatty acid
involved in the production of pro-inflammatory eicosanoids [1]. An ecologic study compared data from eight countries on the prevalence of RA in female participants related to national dietary supply [2]. The study reported fat from meat and offal to be strongly associated with the prevalence of RA ($r^2 = 0.877, P < 0.001$). Partison et al. [3*] recently performed a prospective nested case-control study linking dietary information from a 7-day food diary collected in the European Prospective Investigation of Cancer cohort (EPIC) with 88 incident cases of inflammatory polyarthritis identified in the Norfolk Arthritis Register (NOAR). Both crude and energy-adjusted analyses showed a statistically significant positive association between red meat intake and the risk of inflammatory polyarthritis. However, that association became statistically borderline after adjustment for smoking and fruit intake, although total meat and protein intake remained associated with the risk of inflammatory polyarthritis. When the analysis was restricted to patients with definite RA, the strength of the association with meat intake did not change [3*]. The analysis was not adjusted for potentially important confounders such as fish oil or omega-3 fatty acids, and some of the results are not easily reconcilable with those of other reports [4]. Nevertheless, these data suggest a potential link between intake of meat or total protein and the risk of inflammatory polyarthritis or RA and call for further research on the topic.

Omega-3 fatty acid, fish oil, olive oil, and the Mediterranean diet
The Mediterranean-type diet is characterized by less red meat and more fish, in addition to olive oil as the principal source of fat, an abundance of plant food (fruits, vegetables, whole-grain cereals, nuts, and legumes), poultry consumed in low to moderate amounts, and moderate consumption of wine. Studies have suggested that the main components of traditional Cretan diet may have protective effects on the development or severity of RA. For example, omega-3 fatty acids have been shown to have anti-inflammatory effects, including significant reductions in the release of inflammatory cytokines (e.g. interleukin 1 from monocytes, leukotirene from neutrophils) that are thought to be involved in the inflammatory processes of RA [5]. Olive oils are rich in oleic acid (18:1n9), which can be metabolized to eicosatrienoic acid with anti-inflammatory properties, similar to n3 polyunsaturated fatty acids from fish oils [6*,7]. Ecologic studies previously reported a low prevalence of RA in northwestern Greece, where the consumption of olive oil is high, and RA tended to be milder in the Faeroe Islands, where consumption of fish and whale is high [8,9]. Linos et al. [7,10] conducted two separate case-control studies based on Greek populations and showed that olive oil consumption is inversely associated with the risk of RA. Cooked vegetable consumption was also inversely associated with the risk of RA [7]. Shapiro et al.[11] conducted a case-control study based on a western Washington population and reported that the consumption of broiled or baked fish was associated with a decreased risk of rheumatoid arthritis (odds ratio [OR] for ≥2 servings of broiled or baked fish per week, compared with <1 serving, 0.57 [95% CI, 0.35–0.93]).

These observational study findings of dietary risk factors for RA are consistent with those from several double-blind randomized trials based on patients with existing RA. These trials collectively showed modest anti-inflammatory benefits of omega-3 fatty acid supplementation, including reduced morning stiffness, tender joint counts, and use of nonsteroidal anti-inflammatory drugs [12–24]. Furthermore, a recent 3-month randomized trial of patients with active RA demonstrated that the traditional Cretan diet resulted in a reduction in inflammatory activity (including reduction of C-reactive protein levels), an increase in physical function, and improved vitality, whereas an ordinary omnivorous diet did not [6*]. The well-documented cardiovascular benefits of Mediterranean diets may add substantial therapeutic benefits in RA management, given the increased risk of cardiovascular disease in patients with RA [4,25–28].

Fruits, vegetables, and vitamin C
The EPIC-NOAR case-control study also investigated the potential role of antioxidants in the risk for inflammatory polyarthritis (n = 73 incident cases) [29*]. The authors found that lower intakes of fruit, vegetables, and vitamin C were associated with an increased risk for the development of inflammatory polyarthritis [29*]. The adjusted odds ratio for the development inflammatory polyarthritis between the upper and lower tertiles of vitamin C intake (with the upper tertile as the referent) was 3.3 (95% CI, 1.4–7.9) and the corresponding odds ratio for intake of fruits and vegetables was 1.9 (1.0–4.0). Vitamin E, β-carotene, retinol, or selenium was not associated with the risk [29*].

Coffee and tea
The Mini-Finland Health Survey Cohort (a prospective study of ~7000 persons, including 69 with rheumatoid-factor-positive RA) first reported a potential link between coffee intake and risk of RA caused by an unknown mechanism (relative risk [RR] of 2.2 [95% CI 1.13–4.27] for those drinking 4 or more cups of coffee daily compared with those drinking fewer than 4 cups daily) [30]. The Iowa Women’s Health Study (a prospective cohort study of 31,336 women including 158 with incident RA) investigated the role of caffeinated and decaffeinated coffees and tea and found that decaffeinated coffee, but not caffeinated coffee, is positively associated with RA incidence (RR for ≥4 cups/day vs none, 2.58, 95% CI 1.63–4.06) [31]. Tea consumption was inversely associated (RR for >3 cups/day vs none, 0.39, 95% CI 0.16–0.97) [31]. The hazardous role of decaffeinating solvents and the
anti-inflammatory/antioxidant properties of tea were speculated to be potential mechanisms behind these associations [31–33]. However, these findings were soon refuted by the Nurses’ Health Study (a prospective cohort study of 83,124 persons, including 480 with incident RA), which showed no associations with these beverages (RR between ≥4 cups/day and no consumption: 1.1 [95% CI, 0.5–2.2] for decaffeinated coffee and 1.1 [0.8–1.6] for caffeinated coffee; RR 1.1 [95% CI 0.7 to 1.8] for >3 cups/day vs none for tea) [34•]. Thus, the potential link between these beverages and the risk of RA remains unclear at this point.

**Vitamin D and dairy products**

Vitamin D has been shown to suppress the development and severity of RA in a murine model, although its effects on the human immune system have been more speculative [3•]. A study based on 152 incident RA cases in the Iowa Women’s Health Study showed an inverse association between intake of vitamin D or milk products and the risk of RA [35•]. However, the recent EPIC-NOAR study seems to refute these findings by showing a weakly positive association between dairy consumption and the risk [3•]. Further studies are necessary to clarify this potential link.

**Gout**

Purine-rich foods, dairy products, certain proteins, and alcoholic beverages have all been found to have an influence on gout.

**Purine-rich foods, dairy products, and protein intake**

Various purine-rich foods and a high-protein intake have long been thought to be risk factors for gout, but the associations had not been prospectively confirmed [36,37]. Metabolic experiments in animals and humans demonstrated the urate-raising effect of the artificial short-term loading of purified purine [38–41]. By contrast, the possibility that the consumption of dairy products has a role in protecting against gout has been raised by previous studies [42,43]. Recently, the relation between these purported dietary risk factors and incident gout was prospectively examined over 12 years in 47,150 men (the Health Professionals Follow-up Study) with no history of gout at baseline [44••,45••]. During the 12 years, there were 730 confirmed incident cases of gout. Men in the highest quintile of meat intake had a 41% higher risk of gout than did those in the lowest quintile, and men in the highest quintile of seafood intake had a 51% higher risk than did those in the lowest quintile [45••]. However, purine-rich vegetable consumption was not associated with an increased risk of gout. Furthermore, men in the highest quintile of dairy intake had a 44% lower risk of gout than did those in the lowest quintile, and this inverse association was limited to low-fat dairy consumption. Although total and animal protein intake were not significantly associated with the risk of gout, men in the highest quintile of vegetable protein had a 27% lower risk of gout than did those in the lowest quintile, and men in the highest quintile of dairy protein intake had a 48% lower risk of gout than did those in the lowest quintile [45••]. Dairy protein may exert its urate-lowering effect without the concomitant purine load contained in other protein sources such as meat and seafood, given that dairy products have a low purine content [43,46].

A study of uric acid levels (as a surrogate outcome) measured in the Third National Health and Nutrition Examination Survey (1988–1994) was related to dietary factors to assess the mechanism of the association between diet and gout [47•]. Using data from 14,809 participants (6932 men and 7877 women) aged 20 years and older, the relation between intake of purine-rich foods, protein, and dairy foods and serum uric acid levels was examined. Serum uric acid levels increased with increasing total meat or seafood intake and decreased with increasing dairy intake. After adjustment for age, the differences in uric acid levels between the extreme quintiles of intake were 0.48 mg/dL for total meat (95% CI, 0.34–0.61; P for trend <0.001), 0.16 mg/dL for seafood (95% CI, 0.06–0.27; P for trend, 0.005), and −0.21 mg/dL for total dairy intake (95% CI, −0.37−−0.04; P for trend, 0.02). After adjustment for other covariates such as age, sex, body mass index, serum creatinine, hypertension, alcohol use, and diuretic use, the differences between the extreme quintiles were slightly attenuated but remained significant (all P values for trend <0.05). Total protein intake was not associated with serum uric acid level in multivariate analyses (P for trend, 0.74) [47•].

**Alcoholic beverages**

The association between alcohol consumption and risk of gout has been suspected since ancient times. However, the association had not been prospectively confirmed. Ethanol intake has been shown to increase serum uric acid level via both decreased urate excretion and increased production [48–53]. In the Health Professionals Follow-up Study, increasing alcohol intake was associated with increasing risk of gout (a dose-response relation) [44••]. In comparison with men who did not drink alcohol, the multivariate relative risk of gout in men who did consume alcohol was 1.32 (95% CI 0.99–1.75) for alcohol consumption 10 to 14.9 g/day, 1.49 (1.14–1.94) for 15 to 29.9 g/day, 1.96 (1.48–2.60) for 30 to 49.9 g/day, and 2.53 (1.73–3.70) for 50 g/day or more (P for trend <0.001) [44••]. Among individual alcohol beverages, beer consumption showed the strongest independent association with the risk of gout (multivariate RR per 12-oz serving per day, 1.49; 95% CI, 1.32–1.70). Liqueur consumption was also significantly associated with gout (multivariate RR per drink or shot per day 1.15; 95% CI, 1.04–1.28), but wine consumption was not (multivariate RR per 4-oz serving per day, 1.04; 95% CI, 0.88–1.22). These findings confirm the
long-believed relation between alcohol intake and gout and also suggest that certain nonalcoholic components that vary across these alcoholic beverages play an important role in the incidence of gout. Beer is the only alcoholic beverage acknowledged to have a large purine content, which is predominantly guanosine, a readily absorbable nucleoside [54,55]. The effect of ingested purine in beer on blood uric acid may be sufficient to augment the hyperuricemic effect of alcohol itself, producing a greater risk of gout than liquor or wine. It remains unclear whether there are other nonalcoholic offending factors, particularly in beer, or perhaps instead protective factors in wine that mitigate the effect of alcohol on the risk of gout [44**].

The association between intakes of beer, liquor, and wine and serum uric acid levels was also examined by use of the same data from the Third National Health and Nutrition Examination Survey described above [56*]. The mean serum uric acid level increased with increasing total alcohol intake (P values for trend <0.001). After adjustment for age, the difference in serum uric acid levels, compared with no intake, increased with increasing beer or liquor intake (P values for trend <0.001), but the association was inverse with increasing wine intake (P for trend <0.001). After mutual adjustment for the individual alcoholic beverages in addition to other risk factors, the differences remained significant for beer (0.46 mg/dL for each additional serving; 95% CI, 0.32–0.60; P for trend <0.01) and for liquor (0.29 mg/dL; 0.14–0.45; P for trend <0.01). For wine, however, such adjustment eliminated the inverse association (0.04 mg/dL for each additional serving; 95% CI, −0.20–0.11; P for trend, 0.6) [56*]. These findings closely agreed with the observed associations between these alcoholic beverages and incident gout observed among men in the Health Professionals Follow-up Study [44**]. These results suggest that moderate consumption of wine may not increase serum uric acid levels as do other alcoholic beverages.

**Osteoarthritis**

Some studies suggest that reactive oxygen species, which are generated by cells within joints possibly causing oxidative damage to various macromolecules, may have a role in the pathogenesis of osteoarthritis [57,58]. The Framingham Osteoarthritis Cohort study previously showed that persons with higher vitamin C and E and β-carotene intake might be less likely to have progressive knee OA [59]. However, a 6-month, double-blind, randomized, placebo-controlled study of vitamin E 500 IU/day showed no benefit for any of the outcome measures in symptomatic knee OA [60]. In a recent 2-year, double-blind, placebo-controlled trial, 136 patients with knee OA according to the American College of Rheumatology clinical and radiographic criteria were randomized to receive vitamin E (500 IU) or placebo [61]. Tibial cartilage volume was measured by MRI at the beginning and end of the study. Loss of medial and lateral tibial cartilage was similar in study participants treated with vitamin E and placebo. There were no significant differences between the vitamin E–treated and placebo-treated groups in improvement of symptoms from baseline. Similarly, dietary levels of other antioxidants (vitamin C, β-carotene, and retinol) had no effect on cartilage volume loss [61].

**Conclusion**

As reviewed here, the data on dietary risk factors in rheumatic disorders are growing. Established large cohorts have increasingly served as an excellent source for addressing these questions, which would have been difficult to study from other sources. Although some of these findings are preliminary, others represent confirmation of long-suspected, biologically well-established links. Overall, the available published reports examining the association between diet and rheumatic disorders are still limited, compared with those for more common medical conditions such as cardiovascular disorders. More research is needed to drive robust conclusions that may lead to sound recommendations. The public health implication of dietary recommendations should take into account other potential benefits and risks associated with the respective dietary factors, because many of these factors have health effects beyond their influence on rheumatic disorders. Also, a dietary strategy that is effective for primary prevention may not always translate into an effective secondary prevention strategy among patients with existing rheumatic disorders. Nonetheless, as the evidence on the role of dietary factors in rheumatic disorders grows, it becomes increasingly important for clinicians and investigators in the field of rheumatology to familiarize themselves with the relevant data and apply them appropriately to clinical and public health practice.

**Acknowledgment**

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**References and recommended reading**

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- • of outstanding interest

Dietary risk factors


This prospective study suggests that lower intakes of fruit, vegetables, and vitamin C are associated with an increased risk of inflammatory polyarthritis or rheumatoid arthritis.


This large prospective study refutes the previously suggested link between intakes of coffee or tea and the risk of RA.


This prospective study suggests an inverse association between intake of vitamin D or milk products and the risk of RA.


This large prospective study confirms the long-suspected link between alcohol intake and risk of gout and also suggests a variable impact of different alcoholic beverages on the risk.


This large prospective study comprehensively investigated several purported dietary factors for gout and confirmed some of the long-standing suspicions, exonerated others, and also identified potentially new protective factors.


This National Survey—based study addressed the relation between different alcoholic beverages and serum uric acid levels.


Ethnic and socioeconomic disparities in health among patients with rheumatic disease
Jennifer Odutola and Michael M. Ward

Purpose of review
To describe recent studies of differences in the occurrence and outcomes of rheumatic diseases and differences in treatment by ethnic group or socioeconomic status.

Recent findings
African Americans and Hispanics in the United States have consistently been found to have higher prevalences of arthritis and other rheumatic conditions than whites, and also generally have more activity limitations in the setting of rheumatic disease. Variations in disease occurrence by socioeconomic status have not been studied extensively. African Americans with osteoarthritis were less likely than whites to be treated with narcotic analgesics. Rates of total knee or hip arthroplasty were found to be substantially lower among African Americans and Hispanics than among whites in the United States, and lower among those of low socioeconomic status in the United Kingdom. Ethnic differences in use of arthroplasty have been associated with less willingness of African Americans to have surgery, which has been related to perceptions of uncertain benefits of surgery. Poverty and ethnicity had important associations with the activity of systemic lupus erythematosus, whereas socioeconomic status was a more important predictor of mortality in these patients. Treatment adherence was similar in African American and white patients with systemic lupus erythematosus, but barriers to adherence differed by ethnic group.

Summary
Ethnic disparities in health have been more extensively studied than socioeconomic disparities. Most studies only describe the disparities, but several studies have begun to investigate potential reasons for the disparities.

Keywords
African American, health disparities, Hispanic, socioeconomic status

Introduction
As defined by the First National Institutes of Health Working Group on Health Disparities, health disparities are differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific population groups in the United States [1].

As is the case for many chronic diseases, there are marked differences in the incidence, severity, processes of care, and health outcomes among patients with arthritis and musculoskeletal conditions of different ethnic and socioeconomic groups. For example, when access to care of patients with disabilities or chronic conditions was examined as part of a longitudinal national survey, inequities in access were found for persons with arthritis. Respondents in the poorest health and with the lowest incomes were the least likely to receive each of the health services examined [2]. Potential barriers to health care include lack of medical insurance, lack of trust between patients and their providers, differences in risk perception among groups, patient preferences for treatment, and bias or prejudice in the delivery of care.

One of the goals of the Healthy People 2010 initiative is to eliminate health disparities [3]. Measuring disparities and identifying the factors that promote disparities are the first steps toward ensuring equitable care. This review focuses on recent studies of ethnic and socioeconomic disparities in the occurrence of illness and manifestations of disease, and in access to care among patients with rheumatic diseases. It also describes studies that attempt to identify the causes of these disparities.

Rheumatic conditions in general
Disparities in prevalence and outcomes
Trends in death from arthritis and other rheumatic conditions in the United States between 1979 and 1998 show marked disparities by age, sex, and race. Annual age-standardized death rates were higher among women than men and higher among African Americans than persons of other ethnic groups in all years studied. For example, in 1998, the age-standardized death rate was 3.3 per 100,000 in whites and 5.21 per 100,000 in African Americans [4]. The ethnic difference in rates decreased only slightly since 1979. It is not clear how much of this difference could be attributable to differences in socioeconomic status, because this study did not adjust for socioeconomic status.
A population-based study of 200 Hispanic Americans, 201 African Americans, and 200 non-Hispanic whites reported a high prevalence of nonspecific rheumatologic symptoms, such as morning stiffness (32% in shoulder girdle, 31% in hip girdle), muscle tenderness (9%), and body aching (11%) in the population 75 years and older [5]. African Americans had the highest prevalence of chronic rheumatic symptoms, whereas Hispanic Americans had the lowest. Ethnic differences diminished when the analyses controlled for comorbidity, anxiety, and depression, suggesting that these factors accounted for the ethnic differences in symptoms. However, income and education level were not associated with the presence of chronic rheumatologic symptoms in these patients.

In a cross-sectional study based on data from Asset and Health Dynamic Survey Among the Oldest Old, self-reported arthritis was more common among African Americans and Hispanic older adults than among non-Hispanic whites. When rates were adjusted for socioeconomic status, the disparity in arthritis prevalence between African American and non-Hispanic whites was partly eliminated, because arthritis was associated with less education, less wealth, and lower income. However, adjustment for socioeconomic status did not affect the difference in arthritis prevalence between Hispanics and whites. Hispanics also reported higher prevalences of limitations in activities of daily living than did non-Hispanic whites, despite adjustment for the frequency of arthritis and comorbid medical conditions [6].

A cross-sectional study of patients with rheumatoid arthritis found that Hispanics had significantly higher levels of depressive symptoms than non-Hispanics [7]. This association was found to be mediated by acculturation, the degree to which an individual was incorporated into the mainstream Anglo culture of the United States. Higher depression scores were observed among less acculturated patients. Differences in mental health were not explained by differences in arthritis severity. This finding is significant, because previous studies have identified depression as an important factor affecting persons with rheumatoid arthritis, with depressed patients having higher levels of pain, more disability, and increased use of health services [8].

**Disparities in treatment**

Mikuls et al. [9] examined the association of ethnicity with the use of both conventional and complementary and alternative medicines (CAMs). In this study, ethnicity was not a significant determinant of receiving care by a rheumatologist or prescription arthritis medicines, including narcotics. However, whites used CAMs more frequently and were more likely to have visits to a primary care physician for arthritis care. Higher education levels were also associated with CAM use and care by a rheumatologist.

In a United Kingdom-based retrospective study of ethnic differences in response to disease-modifying drugs among patients with inflammatory arthritis, people of South Asian ethnicity stopped therapy with disease-modifying medications sooner than North Europeans [10]. Possible explanations included problems with effective communication, cultural differences in expectations, and responses to illness.

Cultural beliefs of an ethnic group may influence their ability to communicate adequately with physicians and subsequently with their access to care. Native American populations have been reported to have higher prevalences of inflammatory arthritis and connective tissue diseases. In a single-site qualitative study, in-depth interviews were conducted with 56 Native Americans of various tribes living in Southern California. Overall, 70% of those with pain had discussed symptoms of joint pain with a doctor. Respondents commented that Native Americans generally do not readily ask for help, discuss pain, or disclose the intensity of a painful episode. Although most eventually sought medical care, the authors concluded that the severity and effect of chronic arthritis appeared to be underrecognized and therefore not optimally treated [11].

**Osteoarthritis**

**Disparities in prevalence and outcomes**

In the Johnston County Osteoarthritis Project, a community-based survey in rural North Carolina, African American men and women had more severe knee osteoarthritis, and were more likely to have bilateral osteoarthritis, than whites [12]. The same association was found for radiographic hip osteoarthritis in African American men with lower socioeconomic status. African American men with less than 12 years of formal education were 65% more likely to have radiographic hip osteoarthritis and twice as likely to have bilateral radiographic hip osteoarthritis compared with white men of similar educational attainment [13].

A recent study of 300 African American and white elderly patients with symptomatic knee or hip osteoarthritis reported differences by ethnicity in patients’ descriptions of the quality of their chronic knee or hip pain [14]. Global quality of life ratings correlated negatively with some of the quality of pain factors for whites, but there were no correlations between any quality of pain factors and the global quality of life ratings for African American patients, suggesting ethnic or cultural differences in the effect of symptoms on quality of life.

**Disparities in treatment**

Disparities in the treatment of osteoarthritis can be seen in both medical and surgical approaches. In a study conducted in a US Department of Veterans Affairs medical center, there were significant ethnic differences in
prescribing patterns. African American patients with osteoarthritis were more likely to be prescribed nonselective nonsteroidal anti-inflammatory drugs compared with white patients, whereas cyclo-oxygenase 2 inhibitors and narcotics were prescribed more often to white patients [15*]. The largest relative difference occurred in the annual days’ supply of medications, in which African Americans had significantly lower supplies of acetaminophen, acetaminophen combined with codeine, and acetaminophen combined with oxycodone. The conclusion of this study was that these prescribing patterns may place African American patients at higher risk of gastrointestinal toxicity because of decreased use of selective cyclo-oxygenase 2 inhibitors, and inadequate pain relief because of decreased use of analgesics.

A similar study at the Durham, North Carolina, Veterans Affairs medical center examined prescription patterns of opiates in 3061 osteoarthritis patients [16]. Again, African American patients were less likely to be prescribed opiates than whites, and the mean annual supply and the maximum morphine equivalent dose were lower among African Americans. These studies were conducted in the Veterans Affairs medical system, making it unlikely that medication copayment was a barrier to use. These studies did not explore potential reasons underlying this difference in prescription practice.

**Joint arthroplasty**

**Disparities in treatment**

Several recent studies have highlighted differences in the rates of surgical treatment for osteoarthritis of the knee and hip by ethnicity, with higher rates observed for non-Hispanic white males and females [17*•18,19]. Rates of knee arthroplasty among Medicare recipients in 1998 to 2000 (per 1000 population) were 5.97 for non-Hispanic white women, 5.37 for Hispanic women, and 4.84 for African American women [17*]. Among men, these rates were 4.82, 3.46, and 1.84, respectively. This study adjusted for geographic region but not for individual measures of socioeconomic status. However, Escalante et al. [18] reported similar differences in rates that were independent of access to health care and socioeconomic status. Hispanic patients with Medicare received total hip arthroplasty at a lower rate than non-Hispanic patients, a difference not attributable to lack of health insurance [20]. Similarly, a population-based study of persons age 70 years and older reported lower prevalences of arthritis-related joint replacement among Hispanics (0.97%) and African Americans (0.98%) than among whites (1.48%) [21]. These disparities remained after controlling for socioeconomic status and medical insurance status.

Trends in hip and knee arthroplasty in English National Health Service hospitals also showed a substantial gradation in surgery rates by socioeconomic status. The most deprived fifth of the population (defined by the deprivation index) had rates that were 25 to 33% lower than the least deprived groups, implying inequity in the provision of arthroplasty, a situation echoed in the United States [22].

Inequity in waiting times for joint arthroplasty has also been studied. In a British study, there were significant differences in waiting time for an appointment with a surgeon and waiting time for hip arthroplasty according to social, geographic, and health care system factors. Publically funded patients were more than 12 times more likely to wait more than 6 months for surgery compared with privately funded patients, even after adjusting for symptom severity [23]. A similar study in Alberta found no differences in waiting times for joint arthroplasty by education level [24].

**Reasons for disparities**

Disparities in treatment may result from differences in the perception of symptoms, preferences for different types of interventions, familiarity with the treatment, or personal observations. In a study of perception of symptoms of osteoarthritis, there were no differences between African American and white veterans in the reported degree of pain or functional difficulties, given the same degree of radiographic osteoarthritis. This finding suggests that a difference in perception of symptoms does not explain the ethnic disparity seen in the use of arthroplasty [25]. Ibrahim et al. [26] compared older African American and white men with chronic knee or hip pain on perceptions of global quality of life. They found that African Americans were significantly less likely than whites to rate their quality of life as excellent or very good. This difference remained after adjusting for other demographic, clinical, and psychosocial variables. If perception of quality of life was a strong motivating factor to seek arthroplasty, one would expect that African Americans would be more likely to seek this option. This suggests that the ethnic disparities in the use of arthroplasty may not be explained by differences in quality of life, or that other factors inhibit use of arthroplasty by African Americans with osteoarthritis despite lower quality of life.

African American patients express less willingness to consider joint replacement compared with white patients [27,28]. This difference was attributed to differences in expectations of the hospital course and in pain and function after surgery. Disparities in the use of arthroplasty by socioeconomic status may not be similarly explained by less willingness in patients of lower socioeconomic status to consider arthroplasty compared with those of higher socioeconomic status [29].

One study examined whether social network experience and perceptions of benefit of arthritis treatments influenced the decision to seek diagnosis and treatment.
In this study, 42% of African Americans and 65% of whites reported knowing someone who had surgery for hip or knee pain. African Americans were less likely than whites to report that surgery had helped the person they knew. Knowing people who had joint replacement was also related to higher educational attainment and socioeconomic status. These findings suggest a decreased perception of the benefit of surgical treatment among the African Americans.

Patients’ beliefs may also play a significant role in the utilization or underutilization of a service. A structured interview among 94 African American patients with knee pain found a preference for natural remedies, negative expectations of surgery, belief about God’s control, preference for continuing in their current state, and a fear of surgery and death (“I don’t want to be cut”) [31•]. The authors concluded that programs that are culturally sensitive to the negative perceptions of surgery in this community might improve patients’ attitudes and beliefs about their arthritis and its surgical treatment, ultimately leading to more appropriate use of knee arthroplasty. Written material distributed to patients considering knee arthroplasty may not cover some issues of concern to women and ethnic minorities, such as candidacy for surgery, job issues, and physician trust [32].

African Americans are more likely than whites to perceive various traditional and complementary care modalities as effective, but are less likely to perceive arthroplasty as effective [33]. African American patients with osteoarthritis were also more likely to perceive prayer as helpful and to have used prayer for their arthritis, reflecting differences in health-related attitudes and beliefs that may influence the use of surgery [34].

In a group of white, Asian, and Afro-Caribbean patients in the United Kingdom, lupus nephritis was more common among Afro-Caribbean patients. There was no association with occupation, income, or residence status, suggesting this difference may be a result of genetic or intrinsic host factors rather than socioeconomic status [37•]. Differences in outcomes of nephritis were not examined.

In the LUMINA study, permanent organ damage, measured with the Systemic Lupus International Collaborating Clinics Damage Index, accrued more rapidly in Hispanic patients [39]. Mortality within 5 years of study onset was higher among nonwhites, but the difference was not significant. Poverty rather than ethnicity was strongly associated with mortality in multivariable analyses, with those having incomes below the US poverty line four times more likely to die than those with higher incomes [40].

Differences in SLE manifestations have been noted among Hispanics of different countries of origin [41]. Calvo-Alen et al. [41] reported that compared with persons from northern Spain, Hispanic Americans had higher SLE activity and more organ damage. These results contrast somewhat with the findings of a study in New Mexico that showed similar levels of SLE activity in Hispanic and white patients [42]. However, in this study, Hispanic patients had used corticosteroids more often (59% taking prednisone compared with 38% of whites) and had higher prevalences of arthritis and hypocomplementemia.

A national population-based study of the association of education level with mortality in patients with SLE reported that among whites, higher levels of education were associated with lower mortality caused by SLE [43]. Conversely, higher levels of education were not associated with lower mortality caused by SLE among African Americans or Asian/Pacific Islander women. This finding contrasted with the association between higher education levels and lower all-cause mortality in all ethnic groups. This difference suggested underascertainment of deaths caused by SLE in ethnic minorities with lower levels of education. This underascertainment could reflect the underdiagnosis of SLE in this population of patients.

Reasons for disparities

Treatment nonadherence is a factor that may contribute to the disparity seen in many rheumatic conditions. Adherence was studied in 68 African-American patients and 54 white patients with SLE by Mosley-Williams et al. [44]. The groups did not differ on the frequency with which they reported failing to take their medications, and African Americans missed significantly fewer of their expected visits. The two ethnic groups did not differ on their trust in hospitals or physicians. Potential barriers to medication adherence among African Americans included more depression, poorer short-term memory, concern about future medication effects, and need for child or elder care. In African Americans, more symptoms and fewer comorbid conditions were also associated with failing to take medications, a finding that was unexpected. Among whites, the only factor associated with failure to take medications was perceiving the treatment as being less effective. Predictors of missing scheduled appointments were

Systemic lupus erythematosus Disparities in manifestations and outcomes

Ethnic variation in the presentation and severity of systemic lupus erythematosus (SLE) has been widely studied, with several recent studies adding to this literature [35]. The LUMINA investigators reported a higher cumulative incidence of lupus nephritis among nonwhite patients, with African Americans having a higher frequency than Hispanics [36]. Lower education level and poverty based on current income, rather than accumulated wealth, were among the most important correlates of lupus activity [37•].

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depression among African Americans and having less trust in one’s physician among whites. The authors concluded that adherence may not be as different between the two ethnic groups as previously thought, but that potential barriers operate differently in different ethnic groups. In the search for interventions to improve adherence, ethnic-specific interventions may be needed.

Conclusion
Recent studies of health disparities in rheumatic diseases have focused on descriptions of the disparities, although some studies have begun to investigate the much more difficult challenge of understanding the reasons for the disparities. More research in this area may suggest interventions that can be tested to reduce disparities. Most studies have also focused on ethnic differences in health rather than on socioeconomic differences. Given the close interconnections between ethnicity and socioeconomic status in contemporary society, these two aspects should be studied simultaneously and equally rigorously so that the specificity of associations will be understood and interventions will be applied to the most appropriate groups.

References and recommended reading
Papers of particular interest, published within the annual period of review, have been highlighted as: • of special interest
** of outstanding interest

17 Skinner J, Weinstein JN, Soper SM, et al. Racial, ethnic and geographic disparities in rates of knee arthroplasty among Medicare patients. N Engl J Med 2003; 349:1350–1359. A study drawing on 60.5 million person-years of observation in a Medicare population suggests the rate of surgical treatment for osteoarthritis of the knee varies dramatically according to sex, race or ethnic group, and region
32 Beliefs and experiences of African Americans are important underlying factors in the underutilization of total knee replacement.

Health disparities Odutola and Ward 151
Epidemiology and health-related services


African American ethnicity, poverty, and younger age correlate with increased disease activity in the LUMINA cohort.


Purpose of review
The Community Orientated Program for the Control of Rheumatic Diseases (COPCORD) is based on collecting community data on rheumatic complaints and disability. After identifying significant problems, a search for disease risk factors is made, and control and treatment measures are recommended. This review covers the results of surveys in five countries—China, Brazil, Kuwait, Vietnam, and Australia—published in the last 18 months.

Recent findings
Musculoskeletal pain is a major health problem in all surveys undertaken in both developed and developing countries. Knee and low back pain are the most frequent complaints, and osteoarthritis is the most common arthritic disease identified, particularly affecting the knees. The prevalence of rheumatoid arthritis is generally lesser in these studies compared with published surveys of white patients. However, the prevalence of gout varied widely, possibly because of changes in lifestyle and racial factors. Septic arthritis and rheumatic fever were rarely seen except in an Australian aboriginal community, pointing to improvement in standards of living and health care, at least in the urban settings, according to the Vietnamese authors.

Summary
Population data are required on musculoskeletal complaints as a basis for decisions on health control and treatment programs. Surveys in five countries have identified the frequency of especially knee and low back pain, the prevalence of knee osteoarthritis, and the wide variability in the prevalence of gout, partly because of lifestyle and thus potentially correctable risk factors. Self-medication with potent pharmaceutical products in countries where doctors’ prescriptions are not required is a recognizable health hazard.

Keywords
developing countries, epidemiology, osteoarthritis, rheumatoid arthritis, rheumatic diseases

Abbreviations
COPCORD Community Orientated Program for the Control of Rheumatic Diseases
WHO World Health Organization

Introduction
The Community Orientated Program for the Control of Rheumatic Diseases (COPCORD) has been a response to the call by the World Health Organization (WHO) for increased research and educational activities into the causes and consequences of chronic diseases, in particular rheumatic diseases. It was launched in 1981 in Geneva at a meeting with delegates from WHO and the International League of Associations for Rheumatology. For WHO's cooperation, an emphasis was needed (initially at least) on rural communities in developing countries, where most the world’s population resides. The COPCORD projects as they have developed are not so much about rheumatoid arthritis and systemic lupus erythematosus but consider more broadly rheumatic complaints, disability, and community needs. There was to be less emphasis on hospital-based statistics and medicine, with a focus on existing resources. However, the program needed to be applicable not just to rural communities in developing countries but also to the urban scene in more industrially and technically developed countries.

The COPCORD model, simply put, is based on collecting community data on rheumatic complaints and disability. Then, after the identification of significant problems, a search is made for disease risk factors. Improved health care results from an education phase. The primary and ultimate objective is the community control of rheumatic diseases by both prevention and management of complaints and disability [1,2].

Early COPCORD surveys
Community-based surveys began in a rural area in the Philippines [3], followed by a larger survey in Indonesia covering both rural and urban areas [4]. Subsequent surveys were performed in Malaysia, Australia, China, Thailand, India and elsewhere in Asia, and Central and South America [2]. COPCORD figures indicate that rheumatic pain is a major public health problem in all areas surveyed. For example, in Indonesia [4], joint, neck, and back pain...
affected 24% of the rural and 32% of the urban population in subjects 15 years or older. That complaints are important in functional terms was shown by the fact that 70% of people with rheumatic complaints had to stop work because of the disability. An unexpected COPCORD finding was the high prevalence of gout in rural Java [5]. The dramatic finding of frequent, severe tophaceous gout has been confirmed in other regions of Indonesia and is clearly a major public health problem [2,6].

Based on the epidemiologic data required, it was apparent that the primary health care of patients with rheumatic diseases was inadequate, and this was complicated by self-medication of potent drugs without the requirement of prescriptions in developing countries. Such drugs included corticosteroids [2,6].

Recent COPCORD surveys
In the last 18 months, studies using the COPCORD protocol have been published from five countries: China, Brazil, Kuwait, Vietnam, and an Australian aboriginal community in Northern Queensland [7–8].

Shanghai, China
Communities were selected randomly within Shanghai City, and adults older than 15 years completed the Chinese translation of the standard COPCORD questionnaire in a cross-sectional survey. The primary question sought current musculoskeletal ‘pain, tenderness, swelling or stiffness’ within the last 7 days, with pain from trauma excluded. From the target population of 7603, 6584 were actually surveyed (response rate, 86.6%). The protocol positive responders were physically examined by a rheumatologist and, as required, laboratory tests and radiographs were arranged. The age-standardized and sex-standardized prevalence rate of rheumatic symptoms at any site occurred in 13.3% (95% CI, 12.5–14.1%). The highest frequencies were found in the knee, lower back, and shoulder. Consistent with the very low prevalence rate of hip osteoarthritis among Chinese [9], the prevalence rate of hip problems in this study was very low. The knee pain standardized rate was 7.0% (CI, 6.4–7.6%), similar to the Shanghai COPCORD study of 10 years before [10], but much lower than a Beijing survey, with a figure of 30% [11]. Possible reasons for this disparity were discussed by Wigley [8] in an accompanying editorial, but no clear conclusions were reached.

The standardized rate for rheumatoid arthritis was 0.28% (CI, 0.15–0.41%). This was lower than in 25 studies in whites, at 0.73% [12], although it was similar to the International League of Associations for Rheumatology—China study (0.22% for south China and 0.34% for the north) [11]. The COPCORD survey in Indonesia gives results comparable with the recent China study, with a prevalence of 0.2% and 0.3% in urban subjects 15 years and older [13]. Gout occurred in 22 subjects, with an adjusted rate of 0.22% (CI, 0.11–0.33%). This was slightly higher than the rate reported by Chen et al. [10] in Shanghai 10 years before. This change was thought to be caused possibly by changes in lifestyle as a result of the rapid economic improvement in Shanghai in recent years. In the Pacific region, racial predisposition to gout is also a key causative factor.

Symptomatic knee joint osteoarthritis without radiographic evidence for all patients was estimated at 4.1% (CI, 3.6–4.6%) and was more common in women, at 6.2%, compared with men, at 1.9%.

Brazil
The study in Brazil was a cross-sectional urban-based study of 3038 people older than 16 years from a wide spectrum of socioeconomic levels [14]. The authors indicated that their justification for this study was that in that region of Brazil, ‘we currently do not have a profile of the prevalence of various musculo-skeletal diseases.’ Following COPCORD principles, rheumatologists examined subjects with pain or tenderness in the bones, joints, or muscles over the period of the last 7 days in the absence of trauma. Pathology tests and radiology were performed in some patients to confirm diagnoses. A total of 940 subjects (30.9%) had musculoskeletal symptoms, and 85.5% of those with symptoms underwent the clinical evaluation. Osteoarthritis was the most prevalent condition, affecting 4.14%, and these were symptomatic cases mainly of spine and knee joints. Almost 85% were female, and other characteristics were dominantly nonwhite ethnicity, relatively greater age, and a low socioeconomic status. Fibromyalgia was identified in 2.5% of the population, mainly in women, and there was also a predominance of people from low socioeconomic levels. Rheumatoid arthritis occurred in 14 subjects, or 0.46% of the population (CI, 0.25–0.77%), and systemic lupus erythematosus in three subjects, or 0.098% (CI, 0.02–0.25%). Standard ACR criteria were used for diagnosis of these conditions.

The only significant difference in these figures noted from the earlier and larger Indonesian COPCORD survey [4] was the identification of fibromyalgia in a significant proportion of the Brazil subjects. This could be related to the prominence given to the fibromyalgia classification criteria [15] subsequent to the Indonesian surveys.

Kuwait
The validated Arabic COPCORD questionnaire was used in 2500 randomly selected Kuwaiti households in Kuwaiti nationals age 15 years and older. A total of 7670 adults (response rate, 88%) were interviewed, and 2057 subjects reported musculoskeletal pain not related to trauma. The age-adjusted and sex-adjusted prevalence of pain was 35.7% for females and 20.2% for males. However, only
238 of the 2057 subjects with pain were available for examination by a rheumatologist, so the prevalence of specific diagnoses remains speculative. Based on the results from the questionnaires, knee and the lower back were the most frequent sites for musculoskeletal pain, and risk factors identified were being elderly, overweight, and female; a nonworking status; and physical inactivity. Cultural factors were reported to contribute, and the authors commented that ‘most elderly married Kuwaiti women spend most of their time at home without engaging in any outdoor exercise’ [16].

Vietnam
In this survey, subjects from a total population 16 years and older from “representative urban communes” completed the “Vietnamese adjusted” COPCORD core questionnaire. From the 2119 people surveyed, 14.5% reported musculoskeletal pain during the previous 7 days. More than 90% of the positive responders were examined by a rheumatologist, and laboratory tests and radiology were performed “to clarify” the diagnoses. ACR diagnostic criteria were used. Knee and low back were the most common sites for pain, and, as in other surveys of this type, complaints increased with the age of responders.

Osteoarthritis was the most common rheumatic disease, at 4.1% of the population, and was similar in prevalence in the Brazil survey [17]. More than half the cases involved the knee joints, and functional disability in standing and squatting was mentioned.

Rheumatoid arthritis occurred in 0.28% of the population, similar to other Asian COPCORD surveys but lower than in white populations [12]. The prevalence of gout was 0.14%. This is low in comparison with the Indonesian COPCORD of 0.8% (the prevalence in men was 1.7%) [5]. Also, unlike in the Indonesian surveys, gouty tophi and impaired renal function were not seen in the Vietnamese cases. Fibromyalgia was not mentioned; however, soft tissue rheumatism occurred in 3.4% and nonspecific musculoskeletal pain in 3.2%, so some cases could possibly have been differently classified. Of interest was the comment that infectious diseases such as tuberculosis, suppurative arthritis, and rheumatic fever were not found. This contrasts with a 1980 population study in Vietnam that, for example, identified tuberculosis in 3.1% of the population [18]. The conclusion reached by the authors is that the standard of living and health care in urban Vietnam have improved significantly.

Australian aboriginal community in North Queensland, Australia
This COPCORD survey was conducted in an isolated community of aboriginal people living in the northern part of the state of Queensland. The resident population of this community 15 years and older numbered 1309 people, and 80% (847 people) completed the standard COPCORD questionnaire, because English was the subjects’ first language. The mean age was 35 years, with a range from 15 to 86 years. A total of 281 subjects, representing 33%, reported rheumatic symptoms within the previous 7 days. Back pain affected 12.5%, knee pain 11.2%, and shoulder pain 8.9%. Of the 281 with complaints, 263 were examined by two physicians; however, it seemed likely that neither were rheumatologists. This could possibly explain why a diagnosis was not made in 81 cases or 31% of subjects with musculoskeletal complaints [19].

Osteoarthritis was diagnosed on clinical grounds (no radiographs were taken) in 47 cases, for a point prevalence of 5.5% (CI, 4.0–7.1%). No case was identified as having rheumatoid arthritis; however, four cases were diagnosed as having psoriatic arthritis. Apart from these cases having a psoriatic rash, no other clinical details were mentioned. The basis for the diagnosis thus remains uncertain.

In contrast, gout was diagnosed in 32 people, and 28 of this group were men. Tophi was seen in five cases, but only two cases were currently receiving treatment with allopurinol. Cases of gout were associated with being overweight and regularly drinking alcohol. Unfortunately, serum uric acid levels were not able to be measured, although, surprisingly, some cases had uric acid crystals demonstrated on joint aspiration. The gout prevalence overall in this community was 3.8% (CI, 2.5–5.1%). This is higher than even in the Indonesian COPCORD survey [5], but lower than in a small survey of the New Zealand Polynesian Maori population, with a prevalence of 6.4% [20]. Two cases of rheumatic fever with persistent arthralgias were identified, and a case of septic arthritis that had persistent symptoms despite ‘adequate treatment’ was also diagnosed. Unfortunately, rheumatic fever remains a public health problem in aboriginal communities in Australia [21]. The authors also identified significant numbers of people affected by trauma, including sports injuries and falls. Lifestyle factors such as alcohol use, smoking, and obesity contribute to illness and a subsequent reduction in life expectancy.

Conclusion
COPCORD is a WHO-based initiative whose initial aims centered on epidemiologic surveys of musculoskeletal pain and disability in communities in developing countries. Newly completed surveys from five countries are described in this review. Musculoskeletal pain has been shown to be a major health problem in all surveys. Knee and low back pain are the most frequent complaints, and osteoarthritis is the most common arthritic disease identified. The prevalence of rheumatoid arthritis is generally less in these studies compared with published surveys of white patients. Gout remains a major problem in several countries, and the prevalence varies widely,
possibly because of changes in lifestyle and racial factors. For a disease that should be readily treatable, therapeutic programs are frequently inadequate. Also, self-medication with potent drugs (including corticosteroids) without a doctor’s prescription has been identified in several COPCORD studies [2,6] and is a cause for concern. Septic arthritis including tuberculosis and rheumatic fever were rarely seen except in an Australian aboriginal community, pointing to improvement in standards of living and health care, at least in the urban settings, according to the Vietnamese authors [17*].

Two final points can be made. First, COPCORD data will assist decision-making efforts in the health care system [14] and will help in the appropriate selection and application of resources. Second, COPCORD as well as demonstrating that the major worldwide problems of rheumatic complaints and disability are not just relevant to the elderly populations of developed countries, has played an educational role in itself. Personnel in COPCORD in these surveys have included primary health care workers, nurses, and nonrheumatologic practitioners. The author was asked one day by a nurse in a Philippine village [3], ‘Why are you interested in people with aches and pains? Do you mean something can be done for them?’ If COPCORD can alter this attitude of stoic acceptance, even in just the surveyed areas, it has achieved something substantial.

Acknowledgments
Many people have contributed to the development and successes of COPCORD worldwide. However, the author would like to thank especially John Darmawan, Hans Valkenburg, and Richard Wigley for their major contributions.

References and recommended reading
Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
** of outstanding interest

8 This is a well-planned and organized study using COPCORD principles and reviewing potential risk factors for several rheumatic conditions.
14 One of the first COPCORD surveys to highlight the prevalence of fibromyalgia in the data.
Gout in Vietnam remains of low prevalence compared with some neighboring countries. Overall improvement in health has reduced the incidence of tuberculous and rheumatic fever.
These are exciting times for patients and health professionals involved in Rheumatology rehabilitation. The millennium began with the formal launch of the Bone and Joint Decade (BJD) at the headquarters of the World Health Organization in Geneva, Switzerland establishing an international, multi-disciplinary campaign to evaluate and implement effective strategies to prevent and treat musculoskeletal disorders and trauma. The overarching goal of the BJD is to enhance the health-related quality of life for people with musculoskeletal disorders throughout the world [1]. The Bone and Joint Decade’s international agenda outlines four specific goals that have prompted innovative strategies and a re-evaluation of health professional education and health services care delivery. I would like to discuss some aspects of the evolution of rehabilitation care and research in rheumatology and to use the BJD’s goals as a framework to identify new areas of research and health education in rheumatology rehabilitation. For brevity, I will concentrate my discussion on rheumatoid arthritis, although many of the concepts I will present are applicable to the more than 100 rheumatic conditions.

How have we advanced the understanding of musculoskeletal disorders through research on treatment? Early research on exercise regimens for patients with arthritis focused more attention on establishing the safety, rather than the efficacy of exercise, as it was commonly believed that exercise caused joint damage and exacerbated symptoms [2]. Over the past 40 years, research studies have repeatedly demonstrated the effectiveness of aerobic exercise, strength training and its variants for patients with rheumatoid arthritis (RA) [3-6]. The theoretical basis for exercise focuses on reducing joint pain that can lead to joint stiffness, soft tissue contracture, diminished muscle strength and endurance and loss of independence. The evidence clearly demonstrates that regular prolonged exercise improves aerobic capacity, increases muscle force production from 27%–57%, joint mobility, functional ability and mood by as much as 57%, without apparent increases in joint symptoms or disease activity [4-6]. Regular physical activity also lowers blood pressure and reduces cardiovascular risk [7], both of which are useful in patients with RA since they are at higher risk of cardiovascular disease.

Given what is known about exercise what frontiers can we conquer? The opportunities are endless. There are still many facets of exercise prescription to examine. While exercise of short duration may reduce impairments, enhance function and decrease disability, little is known of the long-term effects of exercise on joint integrity particularly in patients with uncontrolled synovitis [5,8,9]. Even less is known about the benefits and drawbacks of repeated joint loading on articular cartilage and joint function [8,9]. Advances in medical imaging techniques provide researchers with a quantifiable technique for measuring cartilage loss and joint changes. These techniques are being incorporated into clinical trails of exercise to examine long-term consequences of exercise on joint integrity [8-10]. As imaging techniques rapidly evolve and increase in sophistication, we may be able to precisely measure the impact of exercise on articular surfaces. While numerous studies of exercise interventions demonstrate positive effects, systematic reviews of exercise trials [11,12] highlight the variability in patient selection, exercise frequency and intensity, types of exercise (land-based versus water exercises) and modes of delivery (supervised versus unsupervised). Thus, clinicians are left wondering about the best parameters for prescription and how to tailor the exercises to patients to maximize the outcomes. Obviously, more research is needed to define parameters of exercise prescription and appropriate applications in subgroups of patients.

How do we translate research data we have into strategies to improve treatments for patients with RA? Dissemination of information is fundamental to enhancing knowledge and changing practice patterns and must be directed at providers and patients to ensure optimal outcomes.
I will focus first on information dissemination to health care providers and then turn my attention to patient education.

After years of evidence demonstrating the benefits of exercise, health care providers' opinions and beliefs about the useful of exercise for patients with rheumatoid arthritis still vary [13]. In fact, in one study approximately 58% of rheumatologists in a tertiary care arthritis clinic believed aerobic exercises were not useful for patients with RA and less than 25% of patients received an exercise prescription or referral to physical therapy [13,14]. In 2002, recognizing the importance of exercise, The American College of Rheumatology included recommendations for strengthening and aerobic conditioning regimens in their updated guidelines for the management of patients with rheumatoid arthritis [15].

What is the impact of these recommendations on practice? The jury is still out. Evidence-based clinical practice guidelines (EBCPGs) are available to clinicians and researchers covering a variety of musculoskeletal conditions, including rehabilitation techniques for patients with RA [16,17]. These guidelines systemically aggregate published evidence, expert opinions and views of stakeholders [18] to inform clinical practice, influence patient outcomes and reduce costs of care.

While EBCPGs are designed to synthesize information and translate this information into practice, there are still issues with EBCPGs that require further investigation. For example, few studies have addressed the question of how to implement clinical practice guidelines into the clinical setting and what strategies can be used to facilitate adoption of EBCPGs into routine clinical practice. Another issue raised but not formally studied is the question of longevity of EBCPGs. Shekelle and colleagues [19] address the uncertainty of when and how to review EBCPGs in their assessment of the current validity of 17 EBCPGs published by the Agency for Healthcare Research and Quality and conclude that more than three-fourths of the guidelines need updating. They recommend a 3-year review period to ensure validity of the guidelines.

Another concern deals with the education of medical professionals and updating of curricula. This year, the United States BJID instituted a new initiative entitled ‘Project 100’ to address the content of the musculoskeletal curriculum in medical schools. The goal of ‘Project 100’ is to review and develop the content of musculoskeletal health in medical education in an effort to graduate clinicians with a greater competence for treating and evaluating patients with musculoskeletal conditions [1].

Turning attention to the consumer of medical care, the patient, the Bone and Joint Decade emphasizes the need to empower patients to make decisions about their care. We need to ask: how informed are patients about the benefits of exercise and what role can and should they play in decision-making about their care? Which patients are accessing information? What sources are they using? Patient education takes many forms. In the new millennium, more and more patients are seeking online resources to address questions and formulate a plan of care. Yet, websites are not closely monitored for the accuracy of their information and as websites proliferate, it becomes more difficult for patients to identify which sites are valid sources of information.

Empirical data support the notion that patients model behavior and are influenced by the opinions and attitudes of their physicians during clinical encounters [13]. Experienced patients with RA are also more likely to advocate for exercise as part of disease self-management [20]. Again, dissemination of information is the pivotal element in promoting health and preventing arthritis-related disability. The question remains, what is the best method of disseminating information and who is going to fund large educational campaigns? The Bone and Joint Decade is taking action. The Decade’s team of interdisciplinary health professionals is creating and promoting educational campaigns to address the broad spectrum of musculoskeletal conditions faced in the world today. Harnessing resources of their partner organizations, they have strengthened their ability to provide quality, comprehensive educational information to adults, children and industries across the globe. Providing education to patients and providers creates a fertile environment for open dialogue about rehabilitation and its role in complementing medical management.

Rheumatology rehabilitation is no longer in its infancy. It is a fertile area for research and health care delivery assessment. This issue of Current Opinion in Rheumatology highlights several important and emerging areas of clinical research, models of care delivery and a framework for evaluating outcomes unique to the field of rehabilitation. Each review provides new insights and areas for investigation.

References


Evolution of team care and evaluation of effectiveness
Ingemar F. Petersson

Purpose of review
This paper describes the evolution and modern development of rheumatologic team care, reviews and defines methods of evaluation and assessment of rheumatologic team care, summarizes recent research, and discusses possible future directions for the refinement of and research in rheumatologic team care.

Recent findings
The modern concept of multiprofessional team care for patients with rheumatic diseases has been evolving over more than 50 years. Research interest in rheumatologic team care is increasing, as is evidenced in international congresses and research networks addressing team care. Over the past decade, several studies of the effects and effectiveness of multiprofessional team care have been published. Few recent publication, however, have focused on team care because of a lack of optimal methods for studying team care and a lower priority for research in this area.

Summary
Team care in the care, treatment, and rehabilitation of patients with rheumatologic diseases has a long and strong tradition in many countries. The role of team care is clinically relevant, and interest in the evidence-based evaluation and development of team care is growing. The International Classification of Functioning, Disability, and Health is a useful framework for examining the effects and effectiveness of team care. There is also a need for research and development with other outcome measures to analyze the different factors acting within team care. Furthermore, more specific studies of the effectiveness of team care are needed.

Keywords
evaluation, multidisciplinary, outcome measures, rheumatic diseases, team care

Introduction
In the early 20th century, team care had already become an important part of modern rehabilitation methods, especially for chronic diseases [1]. To meet the complex and multifaceted problems facing patients and families, team care has provided a broad competence of skills by gathering health professionals with differing expertise in a team around the patient [1]. Well-organized team care is a synergistic entity; its effects are greater than the sum of individual contributions from team members [2]. Although more specific pharmacologic or surgical treatments are available today to manage the symptoms of rheumatic diseases, there is still a great need for structured, multiprofessional interventions [3,4].

Over the past decade, different networks in team care development and research in rheumatic diseases have evolved, mainly in Europe and North America. Through studies and experience shared at various multiprofessional meetings, health professionals have elucidated the potentials, strengths, and weakness of evaluation in team care. The evaluation of team care focuses on the outcomes used, the types of interventions and settings, and the selection of research techniques. As is discussed below, some progress in this area has been achieved through the international workshops on team care (the CARE conferences) as well as through health professional sessions in the major scientific conferences [5–7].

Evolution of team care for rheumatic diseases
Like many other clinical treatment forms, team care is rapidly changing.

Historical background
The development of modern rheumatologic team care started more than 50 years ago when neither patients with rheumatologic conditions nor other patients could benefit from a more specific and effective pharmacologic or surgical treatment. The basic concept behind team care was to use the skills of all relevant health professionals to meet with the multitude of problems experienced by patients. This included difficulties in activities of daily living as well as how to deal with painful, wrenched joints and overwhelming fatigue. At that time, the team care concept was new and highly patient centered [1,2]. Some of the very early team care development took place in Scandinavian countries (mainly Sweden and Finland) [1,2]. Specialized rheumatology departments at the university hospitals in Lund and Stockholm, Sweden, and specialized hospitals
for rheumatic diseases like the Spenshult Hospital for Rheumatic Diseases in Sweden, owned by the Swedish Rheumatism Association, and the Rheumatism Foundation Hospital in Heinola, Finland, took part in this development. During the 1980s and 1990s, there was a rapid development in the pharmacologic and surgical treatment of patients with rheumatic diseases [8,9]. As a result, patients who formerly had a very low potential for rehabilitation could benefit even more from team-based multiprofessional care and rehabilitation [10,11]. Team care is used in most medical areas today, and rheumatologic team care concepts have been adopted by other team care groups. The synergistic effect of the team members has been evaluated. Some studies have been performed in psychiatric teamwork and have been published only as non-English reports.

**Modern team care**

As with many medical and health care procedures, published reports on the evolution and evaluation of effectiveness of early rheumatologic team care are few compared with the published data on pharmacologic treatment. However, there is overwhelming clinical evidence from daily practice and patients’ perspectives that team care is both necessary and effective. Also, over the past decade, several studies have demonstrated the effectiveness of multiprofessional care, especially for patients with rheumatoid arthritis [4]. Thus, team care in various forms is still an important feature of Western health care systems.

Modern rheumatologic team care has been the topic of two international workshops: the CARE conferences, the first one held in Nordwijk, the Netherlands, in September 2001, and the second at Spenshult Hospital, Halmstad, Sweden, in September 2003 [5,6]. Another CARE conference (CARE III) is planned for Toronto, Canada, in May 2005 [5–7].

**Evaluation of effectiveness**

The effectiveness of team care can be described in different terms and with different methods. One approach is to describe the real-world experiences from a structured follow-up of team care. Descriptive data from this kind of follow-up in Sweden showed that a multidisciplinary structured day care program for 3 weeks in 87 patients with newly diagnosed and long-standing rheumatoid arthritis yielded statistically and clinically significant changes on a group level in both self-reported function as determined by the Health Assessment Questionnaire (HAQ), a performance test of function in the upper and lower extremities as determined by the Signals of Functional Impairment (SOFI), and patients’ assessment of pain and disease severity and disease activity as measured by the Disease Activity Score (DAS). The mean changes on a group level after 3 weeks were for the HAQ –0.14 (from a baseline value of 1.15), for the SOFI –2.6 (from a baseline value of 7.7), and for the DAS –0.43 (from a baseline value of 3.36). The improvements were of similar range in patients with shorter (<2 years) and longer disease duration [12]. Although this was an observational study and not a controlled trial, the data suggest a measurable and significant change over time in outcomes that are relevant for the team and patients and thus illustrate the effectiveness of team care.

In controlled trials in Holland, the effectiveness of team care for patients with rheumatoid arthritis was shown over the short term (2–3 weeks) and the long term (3 years) for inpatient and outpatient care [3,13]. These trials were reviewed in the March 2004 issue of *Current Opinion of Rheumatology* [4]. These studies showed that for patients receiving inpatient care, the HAQ values decreased on a group level from 1.23 at baseline to 1.09 after 2 weeks, to 1.04 after 52 weeks, and to 0.91 after 104 weeks of follow-up. The corresponding figures for disease activity (as measured by the physician, on a scale of 0–3) were 2.2, 2.1, 1.5, and 1.3, respectively. No new studies of major importance have been published in this area, to this author’s knowledge. Thus, the data indicate the effectiveness of team care for patients with rheumatoid arthritis in observational studies and in controlled trials. The aim of this overview is to review recently published data on the evolution of team care and on the effectiveness of rheumatologic team care.

**Recent findings**

Recent data on team care are sparse; however, some studies are worth mentioning.

**Team care evolution and development**

Different kinds of team care and non-pharmacological care have been studied.

**Nonpharmacologic treatment for patients with arthritis**

Recent data highlight the fact that many patients, both with osteoarthritis (98.8%) and with rheumatoid arthritis (97%), use nonpharmacologic treatments, even though such treatments are not always recommended by health professionals [14•]. Also, most patients continue to use these treatments either as a complement to the treatments prescribed by health care providers or instead of recommended treatments, indicating their effectiveness – at least from the patients’ perspective.

**Vocational rehabilitation**

Researchers in the Netherlands recently evaluated the value of team-based multiprofessional vocational rehabilitation in patients with rheumatic diseases [15•]. They surveyed 65 patients taking part in the program (response rate 91%) and found that this approach gave a high degree of interpersonal approach with the patients and that the professional knowledge of the rheumatologic team was
highly valued by the patients. However, in this setting there were, from the patients’ perspective, problems with waiting times for the results and applications of the results in the reports presented by the team.

Rehabilitation in adolescents
In a recent report, the British Pediatric Rheumatology group pointed out the need for education and information in the transition and care of patients with juvenile rheumatic diseases as they enter adolescence [16•]. The British Pediatric Rheumatology group sent questionnaires to nearly 1000 key health professionals and found that a significant number reported a need for education in translational issues. Because rheumatologic care in adolescents most often is team based, the need for education and information seems to be relevant for the whole team.

The team CARE conferences
At the first CARE conference, fewer than a hundred researchers in team care from Europe and North America met [5]. Four main questions for further research were derived:

Which questions are relevant for rheumatologic care research?
Which elements in the team care process are relevant for evaluation?
Which research designs, patient selection criteria, and study outcomes are relevant in team care research?
Which strategies are relevant for implementation?

In CARE II, some of the same people met as well as some new people [6]. One important feature of this conference was that the participants met and focused on the items listed above to stimulate further collaborative work in research and development. Also, different methodologic issues as well as new topics and areas of interest for team care research were discussed. These included the following:

How do we include patients’ perspectives in team care research?
How do we relate future work on outcome measures relevant for team care research to the work of the Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) procedures for outcome measures in clinical trials of team care?
How should we validate the effects of care and rehabilitation for people with musculoskeletal disorders?
How do we create and continuously update a common research agenda?

Evaluation and outcomes framework
Through the core sets of the International Classification of Functioning, Disability and Health (ICF), new aspects of the outcomes in rehabilitation and rehabilitation research were developed [17]. The ICF model includes different aspects of Body Function and Body Structure, Activity, and Participation. These aspects, in turn, are influenced by the Health Condition (Disorder or Disease) as well as by Environmental and Personal Factors. The framework of the ICF is now launched, and studies are emerging using the ICF as the basis for measuring outcomes after rehabilitation interventions.

It is still too early to state definitely which methods of evaluation are the most effective, but there will be a need for a spectrum of evaluation methods. These should include different research approaches (quantitative and qualitative), standardized and well-validated measures, and internationally agreed-upon core sets of measures and outcomes for the evaluation of team care in rheumatoid arthritis and other arthritides [18–24].

Evaluation of effectiveness
In team care research, management strategies should be classified by the type of interventions rather than by the clinical discipline that traditionally provides the treatment. The value of research designs in addition to the nonrandomized controlled trial should be considered for team care research. Regarding relevant research questions, the CARE II group recognized the strength of the evidence supporting some elements of team care, such as exercise and patient education, and emphasized that future research should focus on interventions in which the evidence was either weak or inconclusive [6]. CARE II also identified the need to measure variables that contribute to physical functional disability and work-related disability in the evaluation of team care. Some of these variables include pain, fatigue, psychologic well-being, and function-related health status. Current measures do not, however, capture several areas of activity limitation and participation restriction (and improvements) experienced by patients. With respect to study designs, qualitative, quasi-experimental, and observational study designs should be used in generating preliminary evidence and evaluating long-term effectiveness. The nature of many aspects of rehabilitation and care research is such that a traditional randomized controlled trial is not feasible in many cases. CARE II acknowledged the complexity of factors associated with the successful implementation of team care. Furthermore, it stressed the importance of the patient’s perspective in the evaluation and implementation of care models.

Team-based rheumatologic rehabilitation and follow-up
In a long-term cohort for more than 10 years in Swedish patients with early rheumatoid arthritis, the team approach was used in the regular (twice a year) follow-up [25]. Over 10 years, only 3% of the original 183 patients left the follow-up program. The low dropout rate has made this cohort relevant to the evaluation of long-term
outcome in rheumatoid arthritis, and one reason for the minimal loss to follow-up could be the team approach.

In a study of a new instrument on self-reported function of the lower extremities in patients with inflammatory rheumatic diseases, the Rheumatoid and Arthritis Outcomes Score (RAOS), the effects of 3-week inpatient multiprofessional team care in 119 patients in Sweden were also studied [21]. This study demonstrated significant improvements on all measures of function (HAQ and RAOS) and health status (as measured by short form 36) on a group level. The effect size for measures of pain, function, quality of life, and fatigue ranged from 0.6 to 0.8 [26].

Conclusion
Rheumatologic multiprofessional team care has a long tradition as a major component of health care service for patients with rheumatic diseases. There is a constant evolution of the forms of interventions, the structure and function of the team, the framework for evaluation, and the flexibility and effectiveness of the team. More flexible team functions can better meet the demands of both the patients and the continuously changing health care systems, which are under constraints in resources. The patients’ perspectives have always been a part of team care and should be so even more in the future. The development of new research strategies continues to show promise in further elucidating the optimal type of team care and its effects and effectiveness.

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References and recommended reading
Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
** of outstanding interest
The role of exercise in the rehabilitation of idiopathic inflammatory myopathies
Helene Alexanderson and Ingrid E. Lundberg

Purpose of review
The objective of this review is to provide an update on exercise and clinical assessment in the idiopathic inflammatory myopathies.

Recent findings
Polymyositis, dermatomyositis and inclusion body myositis are rare conditions with muscle weakness as a common prominent feature. Earlier, these patients were discouraged from active exercise due to a fear of increased muscle inflammation with recommendations to rest, perform range of motion exercises and in some cases, isometric exercises. However, beginning in the 1990s, studies reported reduced disability in patients with chronic polymyositis/dermatomyositis following resistive mild/moderate to intensive muscular training and aerobic endurance training, without signs of increased muscle inflammation. Patients with active, recent onset disease seem to benefit from mild/moderate muscular exercise without signs of increased muscle inflammation. There is no evidence of increased muscle inflammation following exercise in inclusion body myositis. However the beneficial effects are unclear as one study report increased muscle strength, while the other could not achieve impairment reduction.

Summary
Studies evaluating active exercise in IIM support the notion of safety and benefits. However, large multi-center studies are needed to fully establish the safety and benefits of different types of exercise. Data indicate that active exercise, adapted to disease activity and disability should be included in the rehabilitation of patients in all stages of IIM. The newly developed and validated outcome measures for patients with polymyositis and dermatomyositis help assess the effects of interventions on disease activity and disability in clinical trials and in clinical practice. However, there are no sensitive and valid outcome measure for patients with inclusion body myositis.

Keywords
dermatomyositis, exercise, idiopathic inflammatory myopathies, inclusion body myositis, outcome measures, polymyositis, rehabilitation

Abbreviations
FI Functional Index
FI-2 Functional Index-2
HAQ Health Assessment Questionnaire
ICF International Classifications of Functioning, Disability, and Health
IIM idiopathic inflammatory myopathies
IMACS International Myositis and Clinical Studies Group
MAP Myositis Activities Profile
MMT manual muscle testing
NHP Nottingham Health Profile
s-CK serum levels of creatine kinase
SF-36 Short Form Health Survey
VRM voluntary repetition maximum

Introduction
The idiopathic inflammatory myopathies (IIM) are rare, chronic inflammatory muscle disorders categorized as polymyositis, dermatomyositis, and inclusion body myositis. The shared prominent clinical features in these conditions are slowly progressing muscle weakness, decreased muscle endurance, or muscle fatigue [1*]. Aerobic fitness may often be reduced, affecting patients’ activity performance and health-related quality of life [2].

High doses of corticosteroids together with complementary immunosuppressive agents constitute the generally recommended medical treatment for patients with polymyositis or dermatomyositis [3,4]. Despite an initial favorable effect of pharmaceutical treatment, most patients experience long-standing disability [5]. The reasons for the persisting disability despite aggressive immunosuppressive treatment are unknown. Potential causes of muscle weakness include chronic muscle inflammation, use of corticosteroids, and physical inactivity.

Regular physical activity and exercise result in positive health outcomes such as improved neuromuscular adaptation, improved muscle function, and reduced risk of osteoporosis. Aerobic exercise also reduces the risk of cardiovascular disease. The American College of Sports...
Exercise in idiopathic inflammatory myopathies

Alexanderson and Lundberg 165

Medicine has published general recommendations for physical activity and exercise (Table 1) [6,7]. Because patients with rheumatic disease are at increased risk for cardiovascular disease, regular physical activity is important in their treatment to reduce disability, to reduce morbidity in cardiovascular disease, and to enhance function [8**]. Until recently, however, patients with inflammatory myopathies were encouraged to avoid physical activity and exercise because of fear that exercise would aggravate muscle inflammation. In 1993 the first case reports of the safety and beneficial effects of exercise were reported in patients with polymyositis and dermatomyositis [9,10]. Since 1993 a few more reports have been published on exercise in patients with inflammatory myopathies. Although the studies are few and sample sizes are small, these studies suggest a role for exercise in the rehabilitation of patients with inflammatory myopathies and will be discussed in this review.

Why are the studies of exercise in these patients limited? Inflammatory myopathies are rare disorders, and valid, reliable outcome measures were not available for these patients until recently. In recent years an international collaboration, the International Myositis and Clinical Studies Group (IMACS), has been formed to propose outcome measures for use in clinical trials [11]. These outcome measures are based on assessments of three dimensions: disease activity, disease damage, and health-related quality of life. A presentation of outcome measures in patients with inflammatory myopathies will also be reviewed.

International Classifications of Functioning, Disability, and Health

Several models for describing health and disability have been presented since Nagi [12] proposed the disablement model [13,14]. The World Health Organization has published the International Classifications of Functioning, Disability, and Health (ICF), providing a widely used unified and standardized language and framework for the description of health and health-related status [15]. The structure of these classifications offers an opportunity to measure health and health conditions on different levels (Fig. 1). Functioning is the umbrella term encompassing all body functions and structures, the activities we do in daily life (activity), and how we participate in society (participation). Disability is the umbrella term for the impacts of a health-related condition such as impaired body functions and structures (impairment), limitations on our ability to perform activities of daily life (activity limitation), and restrictions on our ability to participate in society (participation restriction) (Fig. 1). Both functioning and disability can be divided into capacity and performance. Capacity refers to what we can perform in a clinical setting under standardized circumstances; performance is what we can do in our daily life in different environments (Fig. 1). These different levels interact with one another and also with environmental and personal factors. This structure provides a definition of health and enhances the possibility of grasping the total implications of a disease in an individual. In this review the ICF structure is used to describe clinical features, outcome measures, and exercise effects in patients with inflammatory myopathies (Fig. 2).

Clinical features

The predominating clinical features in patients with polymyositis or dermatomyositis are mainly related to muscle problems but also involve the lung and heart.

Impairment

The most frequently reported problems are impaired muscle strength and endurance or muscle fatigue, myalgia, and decreased aerobic capacity. Dermatomyositis also present with characteristic skin rash. The distribution of

<table>
<thead>
<tr>
<th>Physical activity for health benefits</th>
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<tbody>
<tr>
<td>Purpose: establish a habit of regular physical activity to promote health</td>
</tr>
<tr>
<td>Mode: aerobic activity</td>
</tr>
<tr>
<td>Frequency: most days of the week</td>
</tr>
<tr>
<td>Intensity: 40–60% max VO2 = 60–80% MHR = RPE = 3–4 (light and moderate activities)</td>
</tr>
<tr>
<td>Duration: 30 minutes accumulation of moderate activity during the day</td>
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Exercise Training for Physical Fitness

| Purpose: Increase cardiovascular and muscular through regular physiologic overload |
| Exercise training for cardiovascular fitness |
| Mode: Aerobic activity |
| Frequency: 3–5 days/week |
| Intensity: 50–70% max VO2 = 60–80% MHR = RPE = 3–6 (moderate to vigorous activities) |
| Duration: 20–60 minutes continuous |

Exercise training for muscular fitness (strength and endurance)

| Mode: Resistance exercise (free weights, machines, elastic bands) |
| Frequency: 2–3 days/week |
| Volume: 8–10 exercises; 8–12 lifts of a load that can be lifted correctly and produce local fatigue in 8–12 repetitions; 1–3 sets as tolerated |

RPE, rating of perceived exertion (0–10); MHR, age-predicted maximal heart rate 220—age; max VO2, maximal oxygen uptake.

Data from Pate et al. [8] and Minor and Sanford [7].
muscle weakness is mostly localized to proximal muscle groups such as those in the hip, shoulder girdle, and thighs but can affect distal muscle groups in a symmetric fashion [16,17]. In most cases the muscle weakness, if untreated, progresses slowly over months and affects muscle strength and muscular endurance [18]. Patients with polymyositis or dermatomyositis also have a significantly lower maximal oxygen uptake than do healthy individuals [5]. Myalgia is not extensively addressed in the literature. In a study of 107 patients in all stages of disease, with polymyositis and dermatomyositis, associated malignancies, and juvenile dermatomyositis, whose mean age was 44 years, 58% described having muscle pain at rest and 42% experienced exercise-induced pain [16,19]. Patients with inclusion body myositis have predominant weakness of the quadriceps and distal muscle groups of the limbs, often with a pronounced muscle atrophy [20]. Felice et al. [21] reported significantly better grip strength in the dominant hand than in the nondominant hand, which suggests that activity could delay progression of muscle weakness in inclusion body myositis. Individuals with right-hand dominance have been found to have between 6% and 10% more grip strength in the dominant hand than in the nondominant hand, whereas there seems to be no difference between hands in individuals with left-hand dominance [22,23]. It is, however, unclear whether these differences are clinically relevant. Furthermore, additional aspects such as pain, sensibility, mobility, and cosmetics are important for general hand function [24].

Activity limitation and participation restriction
Patients with polymyositis and dermatomyositis experience difficulties in many aspects of daily living, such as grasping or holding objects, maintaining a standing position, climbing stairs, running, washing hair, transporting everyday commodities, keeping in touch with friends and relatives, and coping with work [25]. Activity limitation gradually increases regardless of age and disease course in polymyositis and dermatomyositis. Corticosteroid-related complications such as avascular necrosis and osteoporosis significantly increase activity limitation [26]. Muscle weakness and impaired muscle function, a main feature of these diseases, is a factor leading to activity limitation and restrictions. Very little is known about the contribution of myalgia, fatigue, or decreased cardiovascular fitness to activity limitations in patients with polymyositis or dermatomyositis. In one study, ratings of the Nottingham Health Profile (NHP) were compared between patients with polymyositis or dermatomyositis and patients with rheumatoid arthritis, osteoporosis, or osteoarthritis and healthy individuals. Patient groups scored 42 to 84% significantly poorer health in all domains – Energy, Pain, Emotion, Sleep, Social, and Physical – than did healthy individuals [27]. The myositis patients scored 6 to 57% significantly poorer than did patients with rheumatoid arthritis, osteoporosis, or osteoarthritis in the domains Energy, Social, and Physical but 26 to 39% significantly better than patients with rheumatoid arthritis and osteoarthritis in the domain Pain [27]. Sultan et al. [28] observed similar results for patients with polymyositis and dermatomyositis, noting significantly poorer health, assessed with the Short Form Health Survey (SF-36), than in healthy individuals. The impact on activity limitation and participation restriction in patients with inclusion body myositis is unknown.

Outcome measures
Because of the limited data on exercise in patients with inflammatory myopathies, we recommend using outcome
measures of safety and effects when testing new exercise regimens in these patients.

Impairment: safety

The most common surrogate marker of muscle inflammation is serum levels of creatine kinase (s-CK), but the use of s-CK alone as a measure of muscle inflammation has some limits with regard to sensitivity and specificity [29]. Other more specific methods include MRI, which is costly, and muscle biopsy, an invasive method [30]. The IMACS group proposes a core set consisting of six dimensions: patients’ and physicians’ global assessment of disease activity on a Likert or visual analogue scale, muscle strength measured by manual muscle testing (MMT), physical function measured by the Health Assessment Questionnaire (HAQ), serum levels of muscle enzymes, and assessment of extramuscular involvement as the outcome measure for disease activity in polymyositis and dermatomyositis. Future studies, however, are needed to assess the sensitivity of the IMACS core set.

Impairment: beneficial effects

Most exercise studies conducted in patients with inflammatory myopathies focus on impairment, with MMT as the primary measure of impairment. A limitation of MMT is that it measures muscle strength and not muscle endurance. Another limitation is the issue of inter-rater reliability, especially when patients with low degrees of impairment are measured [31]. Computerized devices to assess isometric and isokinetic muscle strength have been used in clinical trials with adult inflammatory myopathies but were not validated in this sample. These measures are costly and require trained personnel. Because patients with polymyositis or dermatomyositis experience predominately reduced muscle endurance, this dimension of impairment is equally important to measure. In 1996, the first disease-specific test of muscle impairment, the Functional Index (FI) in myositis, was developed and evaluated for some aspects of validity and also intra-rater and inter-rater reliability [17]. The FI measures the number of repetitions in 11 muscle groups and thus to some extent measures muscle endurance. This index has been used in clinical practice and in a few clinical trials in Europe. The FI has excellent reliability but has not been evaluated for content and construct validity and has been found to have ceiling effects in measuring low to moderate impairment. Therefore, the FI was modified into the Functional Index-2 (FI-2) which is being tested for content and construct validity and reliability (Alexanderson et al, 2003, unpublished data). The FI-2 measures muscle endurance rather than strength, given that it had a higher correlation to isokinetic muscle endurance than to muscle strength or other constructs. Given one learning occasion, FI-2 had a good to excellent inter-rater and intra-rater reliability. In clinical trials, the FI-2 can be used to measure only the dominant side, thus requiring only 5 to 20 minutes to perform the test, depending on degree of impairment.

Activity limitation/participation restriction

Strength and endurance in individual muscle groups may not be the most relevant or important outcome measures from the patient’s perspective. Thus, outcome measures assessing activity limitation and participation restriction should be included in exercise studies (Fig. 2). In clinical trials measuring activity limitation in patients with inflammatory myopathies, the HAQ is the most commonly used instrument. The HAQ was developed for patients with arthritis and has not been validated for adult patients with IIM. Furthermore, it is not sensitive enough to detect changes after a rehabilitation program in patients with rheumatoid arthritis. Thus, a disease-specific outcome measure is needed to assess activity limitation in patients with myositis. Recently, we developed a self-administered questionnaire, the Myositis Activities Profile (MAP) for adult patients with polymyositis or dermatomyositis [25]. The MAP contains four subscales and four single items measuring activity limitation and participation restriction, with excellent test-retest reliability. The MAP was also sensitive in detecting changes after short-term exercise [unpublished data]. The MAP was validated in a Swedish population, so translation and validation to other cultures is necessary for its use in other populations. The generic instruments SF-36 and NHP are multidimensional and include some domains corresponding to activity/participation of the ICF, whereas other domains do not. In this review, the SF-36 and the NHP will be defined as measures of activity limitation/participation restriction. These two measures have proved to be useful in patients with polymyositis or dermatomyositis [27,28]. Progress toward a set of valid and reliable outcome measures has been achieved for patients with polymyositis or dermatomyositis, but there is still a lack of sensitive, valid, and reliable outcome measures for patients with inclusion body myositis.

Possible mechanisms causing disability

The mechanisms causing impairment in patients with polymyositis or dermatomyositis have not been clarified.

Polymyositis and dermatomyositis

Muscle atrophy may account for a component of muscle weakness, but in most patients with polymyositis or dermatomyositis, muscle biopsy shows few signs of atrophy, even in the presence of profound muscle weakness and fatigue [32,33]. Infiltrating inflammatory cells are thought to play a major role in producing direct cytotoxic damage on muscle fibers and in the development of disease symptoms. Recent studies, however, demonstrate a striking
lack of correlation between the degree of muscle weakness and the degree of infiltrates in muscle tissue [32–34]. Through investigations of muscle function and molecular expression in muscle tissue from patients with polymyositis or dermatomyositis in different phases of disease, our research team has demonstrated that phenotypic changes of muscle fibers and microvessels are common features in the muscle tissue of myositis patients with muscle weakness and muscle fatigue, regardless of the presence of inflammatory infiltrates. Reduced numbers of capillaries in patients with dermatomyositis and thickened endothelial cells expressing pro-inflammatory molecules such as interleukin-1 and adhesion molecules in both polymyositis and dermatomyositis suggest that such distinct molecular changes, rather than the inflammatory infiltrates per se, could have a role in causing muscle impairment [32,33,35]. Researchers report reduced levels of ATP and phosphocreatine in affected muscles of patients with polymyositis and dermatomyositis, compared with those in healthy control individuals, and an inefficient utilization and regeneration of ATP and phosphocreatine during exercise and recovery [36]. Pfleiderer et al. [37*] recently reported a disturbed ratio of inorganic phosphate to phosphocreatine after short submaximal exercises in adults with polymyositis and dermatomyositis. These observations suggest that metabolic disturbances in muscle could contribute to the muscle weakness. The observed changes in microvessels could affect microcirculation and cause local tissue hypoxia, which could explain the decreased muscle endurance and fatigue [38]. In healthy individuals, exercise can improve muscle circulation and increase capillary formation. Whether this is also an effect of exercise in patients with myositis has not been investigated, but it forms a rationale for studies on exercise as part of treatment for these patients.

Inclusion body myositis
Patients with inclusion body myositis experience severe muscle atrophy in affected muscle groups, which could explain the muscle weakness in these patients. Mitochondrial abnormalities, such as ragged red fibers or heterogeneous deletions of mitochondria DNA, could also contribute to impairment [39–42]. It has been speculated that abnormal accumulation of cholesterol or other Alzheimer-related proteins or oxidative stress may have a significant role in muscle impairment in these patients [43*]. Patients with inclusion body myositis have a lower resting spectrum of ADP, but not during exercise recovery, indicating that the observed mitochondrial abnormalities are a secondary phenomenon and are unlikely to play a significant role in the pathogenesis of inclusion body myositis [44,45].

Exercise in patients with idiopathic inflammatory myopathies
Until recently, active physical exercise was controversial in patients with inflammatory myopathies because of fear that it would exacerbate muscle inflammation. Thus, both efficacy and safety surveillance have been important outcome measures in exercise studies in these patients. Strength training and aerobic conditioning have been assessed. Furthermore, patients may respond differently to exercise depending on disease activity, disease damage, medication, and degree of disability. During the past decade, 10 published studies have evaluated the safety and benefits of resistive exercise in patients with IIM: 7 in polymyositis or dermatomyositis, 2 in inclusion body myositis, and 1 including all three (Table 2). Seven studies included patients with chronic disease, 2 studies included patients with inflammatory active disease, and 1 study included patients with chronic or active disease.

Polymyositis and dermatomyositis: muscular training
The first two case reports published in 1993 used short-term exercise periods in six patients with both chronic and active polymyositis and dermatomyositis. One study reported improved muscle strength after a 6-week isometric strength training program by use of a Cybex device [10]. The other case report included five patients with active disease who participated in alternating 2-week periods of submaximal muscular training and more passive range-of-motion exercise programs. Safety and benefits were analyzed individually for each patient. Increases in peak isometric strength and reduction of activity limitation during periods of active exercise varied from 22 to 40% and from 4 to 42%, respectively [9]. Both studies reported unchanged s-CK levels after the exercise periods. A discrepancy exists between s-CK levels and degree of inflammatory infiltrates and muscle impairment [29,46]. For this reason, Alexanderson et al. [47] used a more careful approach to evaluate muscle inflammation. The researchers combined muscle biopsies, MRI, and s-CK levels to evaluate muscle inflammation after a 12-week home exercise program. This open study was performed in 10 patients with chronic polymyositis or dermatomyositis. Patients performed an easy to moderate resistive 20-minute home exercise program in addition to a 15-minute walk five days a week during 12 weeks. There were no signs of increased muscle inflammation according to analysis of muscle biopsy specimens, MRI, or s-CK levels, and the group improved significantly by 15 to 17% reduced impairment, assessed by the FI, and 23% reduced activity limitation/participation restriction (SF-36) (Table 2) [47]. This home exercise program was also evaluated in 11 patients with recent-onset active polymyositis and dermatomyositis [48]. Ten patients had signs of active muscle inflammation in analysis of muscle biopsy specimens, MRI, or s-CK levels before starting the exercise program. After 12 weeks of exercise there were no signs of increased inflammation, and the group improved significantly, with 12 to 16% reduced impairment and 25 to 45% reduced activity limitation/participation restriction (Table 2) [48]. Twenty-two patients with polymyositis or dermatomyositis
and 3 patients with inclusion body myositis, in all stages of their disease, participated in a 3-week exercise and patient educational program [49]. The patients subjectively reported participating in either individual physical therapy-supervised exercise, group gymnastics in a keep-fit club or in a pool, pain-revealing treatment, or outdoor walking. Overall s-CK levels remained unchanged, and the group improved significantly by a mean 4% reduced impairment assessed by the FI. Another study evaluated a 3-week submaximal muscular endurance program together with spa treatments in 9 patients with chronic disease and 10 patients with active muscle inflammation [50]. Both groups improved significantly in isometric muscle strength, with mean 37% and 46% increase in the active group and chronic group, respectively. Improvement in fatigue and aerobic fitness was also reported, and s-CK levels remained unchanged in both groups [50]. We performed an intensive 7-week muscular training program in patients with chronic stable polymyositis or dermatomyositis. The program included resistive exercise in five muscle groups on the load of 10 voluntary repetition maximum (VRM) performed in three sets. This resulted in significantly reduced impairment, improved muscle strength (10–15 VRM), and improved endurance (FI-2) without signs of increased muscle inflammation measured by the physician's global assessment of disease activity, muscle biopsies, or s-CK levels [unpublished data].

Polymyositis and dermatomyositis: aerobic exercise
A small randomized controlled trial reported improved maximal oxygen uptake and isometric muscle strength after a 60-minute aerobic cycling and step-up exercise program on 60 to 70% of maximal heart rate compared with a sedentary control group after both 6 weeks and 6 months [51,52].

Inclusion body myositis: muscular training
Patients with inclusion body myositis can perform a muscular training program on the load of 5 VRM during 5 weeks without increased s-CK levels [53]. Significant reduction of impairment was noted, with 25 to 120% improved muscle strength assessed by 3 VRM, whereas isometric peak torque remained unchanged. The above-described 12-week home exercise program could also be used by these patients.

Table 2. Overview of published studies evaluating safety and benefits of different exercise regimens in patients with idiopathic inflammatory myopathies

<table>
<thead>
<tr>
<th>Regimen</th>
<th>Study and design</th>
<th>Patients (n)</th>
<th>Diagnosis</th>
<th>Disease activity</th>
<th>Training duration (wk)</th>
<th>Load/intensity (% of max)</th>
<th>Outcome safety</th>
<th>Results</th>
<th>Outcome benefits</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular training</td>
<td>Hicks JE et al. [10]</td>
<td>1</td>
<td>PM</td>
<td>Chronic</td>
<td>6</td>
<td>60%</td>
<td>s-CK</td>
<td>n.c.</td>
<td>Isometric peak torque</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Escalante et al. [9]</td>
<td>5</td>
<td>PM/DM</td>
<td>Active</td>
<td>8</td>
<td>NR</td>
<td>s-CK</td>
<td>n.c.</td>
<td>Isometric peak torque, modified HAQ</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Spector et al. [53]</td>
<td>5</td>
<td>IBM</td>
<td>Chronic</td>
<td>12</td>
<td>5 VRM</td>
<td>s-CK</td>
<td>n.c.</td>
<td>Isometric peak torque 3 VRM</td>
<td>n.c</td>
</tr>
<tr>
<td></td>
<td>Alexanderson et al. [47]</td>
<td>10</td>
<td>PM/DM</td>
<td>Chronic</td>
<td>12</td>
<td>NR</td>
<td>Muscle biopsy, MRI, s-CK</td>
<td>n.c.</td>
<td>SF-36 Muscle endurance, (FI)</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Alexanderson et al. [48]</td>
<td>11</td>
<td>PM/DM</td>
<td>Active</td>
<td>12</td>
<td>NR</td>
<td>Muscle biopsy, MRI, s-CK</td>
<td>n.c.</td>
<td>SF-36 Muscle endurance, (FI)</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Heikkila et al. [49]</td>
<td>22</td>
<td>PM/DM/IBM</td>
<td>Chronic/active</td>
<td>3</td>
<td>NR</td>
<td>s-CK, pain</td>
<td>n.c.</td>
<td>Isometric peak torque, HAQ</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Varju et al. [50]</td>
<td>19</td>
<td>PM/DM/IBM</td>
<td>Chronic/active</td>
<td>3</td>
<td>NR</td>
<td>s-CK, pain, fatigue</td>
<td>n.c.</td>
<td>Muscle endurance, (FI)</td>
<td>n.c</td>
</tr>
<tr>
<td></td>
<td>Arnardottir et al. [54*]</td>
<td>7</td>
<td>IBM</td>
<td>Chronic</td>
<td>12</td>
<td>NR</td>
<td>Muscle biopsy, fatigue</td>
<td>n.c.</td>
<td>n.c</td>
<td>n.c</td>
</tr>
<tr>
<td>Aerobic exercise</td>
<td>Wiesinger et al. [51]</td>
<td>14</td>
<td>PM/DM</td>
<td>Chronic</td>
<td>6</td>
<td>70%</td>
<td>s-CK</td>
<td>n.c.</td>
<td>VO2 max, Isometric peak torque, HAQ</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Wiesinger et al. [52]</td>
<td>13</td>
<td>PM/DM</td>
<td>Chronic</td>
<td>6 mo</td>
<td>70%</td>
<td>s-CK</td>
<td>n.c.</td>
<td>VO2 max, Isometric peak torque, HAQ</td>
<td>+</td>
</tr>
</tbody>
</table>

PM, polymyositis; DM, dermatomyositis; IBM, inclusion body myositis; VRM, voluntary repetition maximum; s-CK, serum creatine kinase; HAQ, Health Assessment Questionnaire; n.c., not changed; FI, functional index in myositis; VO2 max, maximal oxygen uptake.
patients without signs of increased muscle inflammation in muscle biopsy specimens and s-CK levels, and no objective impairment reductions could be detected [54*]. No patient experienced increased impairment; by contrast, some patients reported subjectively reduced activity limitation.

Possible mechanisms behind exercise improvements

The mechanisms by which exercise improves muscle performance may be several. In healthy individuals, increased muscle strength is thought to occur as a result of neural adaptation, muscle fiber hypertrophy, and increased capillary density. Few studies have addressed this question in patients with inflammatory myopathies. In the exercise study that included patients with inclusion body myositis, wherein the clinical effects were limited, there was no change in muscle size as estimated by repeated MRI [53]. In our own study of patients with chronic polymyositis and dermatomyositis, we determined an increased percentage of the slow twitch, oxygen-dependent type I fibers in muscle biopsy specimens after 12 weeks of home exercise, together with a significant increase of mean fiber area and improved muscle endurance [unpublished data].

Conclusions

Although published studies evaluating exercise therapy in patients with inflammatory myopathies are few and include small sample sizes, they still support the notion that exercise can be used without increased muscle inflammation. Furthermore, improved muscle function and aerobic capacity can be achieved with exercise. Thus, active exercise adapted to disease activity and disability may be recommended in the rehabilitation of patients with chronic as well as inflammatory active IIMs. Further research is needed in the form of multicenter randomized controlled trials to establish the efficacy of different exercise regimens, particularly in patients with recent-onset polymyositis or dermatomyositis and those with inclusion body myositis. It is important to follow up the patients regularly and to use valid and reliable assessments encompassing all levels of the ICF from a patient perspective in future clinical trials and in clinical practice. For patients with inclusion body myositis, there is still a major need for valid and sensitive outcome measures.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
** of outstanding interest


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Exercise in idiopathic inflammatory myopathies

Alexanderson and Lundberg


This publication provides data supporting metabolic disturbances in patients with polymyositis and dermatomyositis.

38 Ceia G, Bendahan D, Manners D, et al. Reduced oxidative phosphorylation and proton efflux suggest reduced capillary blood supply in skeletal muscle of patients with dermatomyositis and polymyositis: a quantitative 31P-magnetic resonance spectroscopy and MRI study. Brain 2002; 125:1635—1645.


This paper provides a recent update of possible mechanisms causing impairment in patients with inclusion body myositis.


This publication is the second-ever study to evaluate the safety and effects of active exercise in patients with inclusion body myositis. Muscle biopsies were used in addition to s-CK levels for assessment of safety.
Outcomes of patients with rheumatoid arthritis receiving rehabilitation
Linda C. Li\textsuperscript{a} and Maura Daly Iversen\textsuperscript{b}

**Purpose of review**
Rehabilitation, including physical therapy and occupational therapy, complements drug therapy in the management of symptoms in patients with rheumatoid arthritis. Approximately 26% of patients with rheumatoid arthritis receive a referral for rehabilitation by rheumatologists. This review summarizes findings on the effectiveness and economic outcomes of physical therapy and occupational therapy in managing rheumatoid arthritis.

**Recent findings**
Studies evaluating the outcomes of various service delivery models for physical therapy and occupational therapy demonstrate improvements, especially in physical function, among people with rheumatoid arthritis. A recent pilot study examining the primary therapist model also suggests that the primary therapist model may be a viable option for delivering rheumatoid arthritis rehabilitation services. However, the evidence on other alternative models such as the physical therapy/occupational therapy practitioner model is limited. Only a few economic evaluations have been performed, and among those, none examine the cost-effectiveness of different service models.

**Summary**
Systematically interpreting the findings of service delivery models in rehabilitation is challenging because of the wide range of interventions and outcome measures used. A thorough understanding of the value of different rehabilitation models will require the guidance of a sound evaluation framework. Future clinical trials should consider including a component for evaluating cost-effectiveness. Such knowledge can contribute to evidence-informed resource allocation.

**Keywords**
cost-effectiveness, effectiveness, occupational therapy, physical therapy, rehabilitation, rheumatoid arthritis

**Abbreviations**
ACR American College of Rheumatology
CBT cognitive behavioral therapy
HAQ Health Assessment Questionnaire
PTM primary therapist model
RCT randomized controlled trial
VAS visual analogue scale

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**Introduction**
Increasing constraints on health care expenditures are a major driving force behind the search for efficient ways for managing chronic diseases such as rheumatoid arthritis. The American College of Rheumatology (ACR) recently published clinical guidelines for rheumatoid arthritis \cite{1}. The ACR recommends the use of physical therapy and occupational therapy as an adjunct to drug treatment. The literature suggests that 26% of patients with rheumatoid arthritis were referred for physical therapy and/or occupational therapy after a rheumatologist visit \cite{2}. This was supported by a recent study on patient–rheumatologist communications in which half of patients who received an exercise prescription were referred to physical therapy \cite{3}. A variety of models have been used for delivering physical therapy and occupational therapy, including the traditional physical therapy/occupational therapy model, the primary therapist model \cite{4}, and the physical therapy/occupational therapy practitioner model \cite{5,6}; however, only a few studies evaluate the effectiveness of service models.

This review summarizes findings of the effectiveness and economic consequences of comprehensive physical therapy and occupational therapy for rheumatoid arthritis published in the past 2 decades. Because of the wide range of problems experienced by people with rheumatoid arthritis, comprehensive physical therapy and occupational therapy was defined as a combination of therapy interventions provided by physical therapists and occupational therapists. Hence, studies that evaluated a single specific intervention, such as exercise, use of wrist splint, or patient education, were excluded.

**Traditional therapy model**
Usually, patients who require rheumatoid arthritis rehabilitation receive treatment from a traditional physical therapist and/or an occupational therapist. Ambulatory facilities and home care agencies in North America most
commonly use the traditional model for rheumatology care. Under this model, therapists work in a discipline-specific environment, with little overlap between professional roles. A patient who requires physical therapy and occupational therapy interventions will receive treatment from two different health professionals. Most studies on comprehensive physical therapy and occupational therapy for arthritis are based on the traditional model.

**Occupational therapy**

Movat et al. [7] conducted one of the earlier studies on the effectiveness of three follow-up regimens (3 months of occupational therapy home visits, general practitioner care, and routine hospital outpatient follow-up) for patients with rheumatoid arthritis. The study did not find any significant intergroup differences in disease activity and functional measures, although 88% and 87% of patients in the occupational therapy group and the hospital outpatient group, respectively, rated the care they received above average.

Two randomized controlled trials (RCTs) subsequently compared comprehensive occupational therapy with an education program. Gerber et al. [8] and Furst et al. [9] evaluated the effectiveness of a 6-week workbook-based occupational therapy education program (n = 16) versus traditional occupational therapy (n = 9). Participants were in their mid-50s and had an average disease duration of 7.5 years, and 86% were women. Patients in both groups could choose to attend sessions individually or in groups of two to four. Adaptive aids and splints were provided when needed. Patients in the workbook group attended standardized education sessions for 1.5 hours a week over a period of 6 weeks. Those in the traditional group attended one to three occupational therapy education sessions ranging from 50 minutes to 2 hours. All groups were led by an occupational therapist; however, the therapist’s experience in rheumatology was not described. The result showed that 50% of patients in the workbook group versus 22% in the traditional group achieved a better balance of rest (measured with an activity record); however, the result was not statistically significant (P = 0.10). In addition, 50% in the workbook group demonstrated greater improvement in physically active time than the traditional group (50% vs 11%; P = 0.07).

In a later study, comprehensive occupational therapy (n = 28) was compared with cognitive behavioral therapy (CBT; n = 24) and a waiting list control group (n = 19) [10]. The mean age of participants was 57 years, and the mean disease duration was 15.6 years. Approximately 68% were women, and 78% were in ACR functional class II. The CBT and occupational therapy groups attended 10 weekly sessions. A rheumatologist provided the first four sessions on the medical management of rheumatoid arthritis. Patients in the occupational therapy group also received information on energy conservation, joint protection, and adaptive devices and were taught range of motion exercises. Those in the CBT group received additional training in coping strategies and goal setting in the remaining six sessions, reinforced with homework assignments. It was unclear whether the CBT was provided by an occupational therapist. Both CBT and occupational therapy groups were successful in improving disease-specific knowledge (measured with a novel Rheumatoid Arthritis Knowledge Test) compared with the control group (P < 0.01); however, only CBT resulted in moderate changes in pain coping behavior (measured with Pain Coping Inventory; effect size = 0.5; P < 0.01; mean scores unavailable). Both interventions failed to demonstrate significant change in patients’ physical, psychological, or social health status compared with the control group. The investigators attributed these results to the progressive course of rheumatoid arthritis in the study participants. Findings of this study should be interpreted with caution because some vital information is missing.

Helewa et al. [11] evaluated the efficacy of a 6-week comprehensive home-based occupational therapy program provided by a rheumatology-trained occupational therapist versus the waiting list control group. The occupational therapy program consisted of a thorough evaluation of disease activity and level of function. Based on the assessments, patients were then provided with one or more of the following treatments: (1) education on joint protection, positioning, and proper footwear; (2) use of splints, foot orthoses, and adaptive aids; (3) use of mobility devices; (4) advice on leisure activities; (5) psychosocial counseling; and (6) stress management. Participants were in their mid-50s and had a mean disease duration of 14.1 years, and approximately 87% were women. Statistically significant improvements in the pooled index scores (consisting of active joint count, grip strength, erythrocyte sedimentation rate, morning stiffness, and functional change) were reported in the treatment group (0–6 weeks = 0.17 ± 0.6), whereas no significant change was found in the control group (0–6 weeks = −0.07 ± 0.61). The difference between groups was statistically significant (P = 0.04). These findings match those from a recent systematic review on comprehensive occupational therapy that reported benefits in patients’ physical function, although the level of evidence was weak [12] (level 3 evidence according to the criteria of van Tulder et al. [13]).

It should be noted that the mean disease duration of the patients in the studies discussed to this point was 2 years or more. In a new clinical trial, Hammond et al. [14] studied patients with early rheumatoid arthritis (disease duration <10 months; mean age, 55.5 years) receiving comprehensive occupational therapy versus usual medical care. The comprehensive occupational therapy group received four 1-hour individual occupational therapy sessions.
Further, they attended 2 hours of group sessions consisting of comprehensive information about rheumatoid arthritis, self-management methods, and counseling from a senior rheumatology occupational therapist. Assistive devices and referral to community resources were provided as needed. Training of the therapists included a 5-day program in rheumatology occupational therapy, written materials, and observation of the program delivered by experienced therapists. This study failed to demonstrate significant differences in any of the disease activity, physical, functional, and psychosocial measures between groups, although a significantly higher percentage of patients in the occupational therapy group practiced self-management methods at 6 months, including activity modification (occupational therapy = 52%, usual care = 38%; \( P < 0.01 \)), hand exercises (occupational therapy = 65%, usual care = 12%; \( P < 0.001 \)), and arm exercises (occupational therapy = 28%, usual care = 13%; \( P < 0.001 \)). This trend was maintained at 12 and 24 months. The lack of effect in health outcomes suggests that treatment needs and responses among patients with early rheumatoid arthritis may differ from those with advanced disease. Further understanding of the trajectory of rheumatoid arthritis and the timing of intervention and evaluation are needed to advance the knowledge of rehabilitation outcomes in people with early rheumatoid arthritis.

**Physical therapy**

The effectiveness of comprehensive physical therapy for treating rheumatoid arthritis of the hands was examined in two studies. Hawkes *et al.* [15] evaluated three intensive physical therapy treatment regimens in which participants received exercise plus one of the following treatments: (1) wax baths (20 minutes), (2) ultrasound to the palmar and dorsal aspect (3 minutes each) of each hand, or (3) ultrasound followed by a faradic hand bath (15 minutes). All 30 patients received 3 weeks of treatments, 5 days a week. Grip strength (measured with a modified sphygmomanometer), joint size (measured with a specialized tape measure), pain (measured with a visual analogue scale [VAS]), disease activity (measured with the Ritchie articular index), range of motion (measured with a tape measure), and functional activities (measured with a standardized checklist) were assessed at baseline and weekly for 3 weeks. The results showed no significant difference in outcomes over time except for the functional activity scores. *Post hoc* analysis revealed that groups 1 and 2 scored significantly higher in the weekly measures than group 3 (\( P = 0.02 \) and 0.05, respectively). The study did not provide any information on patient characteristics. Further, it offered little insight into the value of these treatment regimens compared with no treatment.

In a more recent RCT, Buljina *et al.* [16] evaluated a 3-week physical therapy program (15 treatment days), including radon baths (37°C, 20 minutes each day), therapeutic heat or cold, faradic hand baths (15 minutes), wax bath (50°C, 20 minutes), and hand exercise (20–30 minutes), against the no treatment control. Seventy-five percent of the participants were women, and they had a mean age of 48.2 years and disease duration of 5.2 years. At discharge, the physical therapy group (\( n = 50 \)) demonstrated significant improvements in pain (51.2%; \( P < 0.005 \)), number of tender hand joints (52.3%; \( P < 0.005 \)), activities of daily living (32.5%; \( P < 0.005 \)), and range of motion (14.4%; \( P < 0.01 \)), whereas all measures in the control group (\( n = 50 \)) deteriorated.

The efficacy of comprehensive physical therapy provided in a home setting was studied by Bell *et al.* [17]. One hundred fifty patients (80% women; mean age = 56 years; mean disease duration = 7.5 years) were randomly assigned to receive treatment from a rheumatology-trained physical therapist or to a waiting list control group. The physical therapy intervention consisted of a full assessment of disease activity, education on disease management and community resources, and goal setting. Patients received at least 3 hours of treatment or four physical therapy visits. At 6 weeks, the treatment group demonstrated statistically significant improvements in the duration of morning stiffness (reduction of 68.8 ± 133.5 minutes vs 8.3 ± 181.7 minutes in the control group; \( P = 0.04 \)), self-efficacy (13.5 ± 16.3 vs 5.8 ± 18.4; \( P = 0.02 \)), and disease knowledge (2.8 ± 3.8 vs 1.1 ± 3.5; \( P = 0.01 \)). All patients were offered treatment at the end of the study, and similar improvements were observed in the former control group. These improvements were maintained at 1 year [18]. The findings suggest that a short-term home-based physical therapy intervention delivered by rheumatology-trained therapists can improve patient outcomes.

The cost-effectiveness of traditional physical therapy or occupational therapy in treating patients with rheumatoid arthritis has not been studied. The only economic evaluation in this area was a cost analysis comparing home versus ambulatory services provided by rheumatology-trained physical therapists in Ontario, Canada [19]. Approximately 85% of patients in this study were women, and they had a mean age of 61.4 years and a mean disease duration of 12.2 years. The total costs per case (including treatment costs and costs incurred by patients) were CAN$211 (~US$165) for the home setting and CAN$184 (~US$144) for the clinic setting. Despite the saving in total costs, the portion borne by patients increased from 28.3% for home visits to 64.1% for clinic visits, mainly because of travel expenses. One of the limitations of this study was the assumption that outcomes of the two service settings were similar because of a lack of literature suggesting otherwise; however, this might not be the case in reality. Therefore, further evaluations will be required to examine the cost-effectiveness of both treatment settings.
Primary therapist model

The use of the primary therapist model (PTM) began in psychiatric care and in the treatment for substance abuse in the 1980s; however, the model received relatively little attention in the rehabilitation sector until the 1990s [20]. PTM has been used for arthritis management in Ontario, Canada, since the mid-1990s, at which time special rheumatology and cross-disciplinary training was made available to therapists with a physical therapy or occupational therapy background [21,22]. The trained primary therapists function as multiskilled health professionals working in consultation with or with referral to peers or other services when necessary [23]. They assume the roles of case managers and health care providers rather than generic physical/occupational therapists [24]. This way, primary therapists may use their colleagues in a consultative fashion rather than transferring the case to the other discipline for completion of the rehabilitation regimen [4].

In a recent pilot study, Li et al. [25] evaluated the effectiveness of the PTM. Twenty-four patients (66.7% women; mean age = 59.4 years; mean disease duration = 8.3 years) were randomly assigned to receive treatment from a primary therapist in addition to medical care, or usual medical care alone. The average length of primary therapist treatment was 6 weeks (mean number of visits with a physical therapy-trained therapist = 2.7; occupational therapy-trained therapist = 1). The first 10 enrolled patients (PTM = 6, usual care = 4) completed all core clinical measures—the Health Assessment Questionnaire (HAQ), VAS for pain, and Arthritis Community Research and Evaluation Unit Rheumatoid Arthritis Knowledge Questionnaire—at baseline, discharge, and 6 months. The investigators did not perform statistical tests because hypothesis testing was not an objective of this feasibility study. A trend was observed in the primary therapist group in all measures at discharge and 6 months, with the HAQ demonstrating the highest percentage of improvement (baseline to discharge = 47.1%; baseline to 6 months = 54.4%). A relatively modest improvement was also found in the HAQ in the usual care group (baseline to discharge = 7.1%; baseline to 6 months = 16.7%); however, there was a slight deterioration in the pain at 6 weeks (−4.2%) and in rheumatoid arthritis knowledge at 6 months (−5.3%). All patients also completed the EuroQol instrument (EQ5-D and EQ-VAS). In the PTM group (n = 11), a trend toward improvement over time was found in both the EQ-5D utility measure (baseline to discharge = 3.6%; baseline to 6 months = 35.4%) and the EQ-VAS (baseline to discharge = 14%, baseline to 6 months = 20.5%). The usual care group (n = 13) also demonstrated a gain at 6 weeks for both scales (utility = 24.4%; VAS = 14.2%). However, although the utility score improved nearly 50% between baseline and 6 months, only a modest 9% gain was found using the VAS.

Detailed information on health resource use was collected from all patients in this pilot study [25**]. In the 6-month period, patients in the PTM group reported a higher use of blood tests (7.3; range, 3–14; vs 4.7; range, 0–8 in the usual care group), but a slightly lower number of rheumatologist visits (4.4; range, 1–10; vs 5.5; range, 0–9). The latter finding might be related to the education provided by primary therapists, leading to an increase in patients’ confidence in managing the day-to-day symptoms caused by rheumatoid arthritis. This evaluation suggests that the PTM may be a viable option for delivering rehabilitation services for people with rheumatoid arthritis. Further evaluation on its effectiveness and cost-effectiveness has been completed and will be published in the near future.

Physical therapy/occupational therapy practitioner model

Inspired by the rheumatology nurse practitioner model [26,27], rehabilitation professionals are beginning to develop their own practitioner model. Only two publications were found describing a single case study on the physical therapy practitioner model [5,6]. Campos et al. [5] reported the development of a 1-year academic and clinical training program for a physical therapy practitioner in a rheumatology pediatric clinic. After passing a series of written and oral examinations, the practitioner was able independently to assess and manage children with mild to moderate arthritis at the outpatient clinic. Patient satisfaction was high in both physician-led and physical therapy practitioner-led clinics (both had an average rating of 4 out of 5 on the Group Health Association of America’s Consumer Satisfaction Survey) [6]. To the current authors’ best knowledge, the effectiveness of this model has not been rigorously evaluated, and this area should be addressed in the future research.

Conclusion

Studies on the effectiveness of the traditional physical therapy/occupational therapy model have demonstrated some benefits in patient outcomes, especially when treatment was delivered by rheumatology-trained therapists. There are a few shortcomings in the research studies in rheumatoid arthritis rehabilitation. First, interpreting the findings in a systematic manner is challenging because of the wide range of treatments and outcome measures used in these studies. Second, the evidence on the alternative rehabilitation service models is scarce. Third, there are very few economic evaluations, and among those, none examine the cost-effectiveness of different service models. This information is particularly important for facility administrators when making decisions about resource allocation.

A thorough understanding of the value of different rehabilitation models will require the guidance of a sound evaluation framework. For this purpose, the Medical Research Council in the United Kingdom has developed a evaluation...
References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

• of special interest
** of outstanding interest


Safety of exercise in patients with rheumatoid arthritis
Zuzana de Jong and Theodora P. M. Vliet Vlieland

Purpose of review
Patients with rheumatoid arthritis benefit from long-term moderate or high-intensity exercises. Moderate or high-intensity exercises were found to improve aerobic capacity, muscle strength, functional ability, and psychological well-being, and slow the age-related and sex-related decrease in bone mineral density of the hip. Despite these positive findings, there is also concern about its risks. Studies on the effects of exercise on disease activity and joint damage are reviewed.

Recent findings
Studies on the effects of moderate or high-intensity exercise in rheumatoid arthritis demonstrate either decreased or stable disease activity. From the few available studies that address exercise and radiologic progression of the small joints, results indicate that exercises are safe for the joints of hands and feet. However, a recent study suggests caution in prescribing long-term high-intensity weight-bearing exercises to patients who have significant radiologic damage of large joints, as some patients might develop additional damage.

Summary
Moderate or high-intensity weight-bearing exercises are safe with respect to disease activity and radiologic damage of the hands and feet. In the absence of sufficient data on exercise and radiologic progression of the large joints, patients with significant radiologic damage of the large joints should not be encouraged to participate in moderate to high-intensity weight-bearing exercise unless individualized to protect affected joints. A broader dissemination of the effectiveness and safety of moderate and high-intensity exercise for patients with rheumatoid arthritis is needed among rheumatologists, physical therapists, and patients.

Keywords
exercise, joint damage, rheumatoid arthritis

Introduction
Regular exercise is encouraged among healthy populations to prevent widespread morbidities such as cardiovascular diseases, osteoporosis, and obesity. Patients with rheumatoid arthritis are, as a consequence of their disease and its treatment, at risk of decreased physical capacity and functional ability and at increased risk for cardiovascular morbidity and mortality compared with their healthy counterparts [1,2]. In addition, these individuals are more at risk of osteoporosis and osteoporotic fractures, especially hip fractures, which have a high morbidity [3,4]. Thus, persons with rheumatoid arthritis may benefit from regular exercise of intensity sufficient to produce cardiovascular effects. Exercise programs designed to prevent cardiovascular diseases, obesity, and osteoporosis in healthy subjects generally consist of moderate to high-intensity exercises. These exercises are commonly defined according to their ability to maintain or improve cardiorespiratory fitness (i.e., 60–85% of maximum heart rate) or muscle strength (i.e., 50–80% of a maximal voluntary contraction). Additional goals of exercises may be related to body composition and flexibility. Intensity of exercises can also be classified according to the energy expended during a particular activity, measured in metabolic equivalents (i.e., 3 or 4 to 6 metabolic equivalents for moderate and >6 metabolic equivalents for high-intensity activities).

It has long been questioned whether patients with rheumatoid arthritis could benefit from this level of exercise intensity. Since 1985 [5], a large number of controlled and uncontrolled studies have been conducted to investigate whether moderate to high-intensity exercise programs might be valuable in the management of rheumatoid arthritis. These studies are summarized in several reviews on exercise and rheumatoid arthritis [6–8,9]. The consensus of these systematic reviews is that persons with rheumatoid arthritis demonstrate improved aerobic fitness, muscle strength, joint mobility, functional ability, and mood with exercise. These relatively consistent positive findings were obtained despite large variations among studies, including differences in sample size and study design (patient characteristics; duration, intensity, and frequency of exercise programs; and endpoints). In general, it is difficult to compare the intensities of exercise programs across studies because of the variable definitions used to describe intensity.

Effect of exercise on disease activity
Most published clinical trials of exercise investigated the effects of moderate to high-intensity exercises on disease activity.
activity in persons with rheumatoid arthritis with relatively stable disease. Three recent studies are particularly interesting because of the characteristics of the study sample or the duration of follow-up. Whereas most trials included patients with relatively stable rheumatoid arthritis, Van den Ende et al. [10] examined the effects of intensive exercise in a randomized controlled trial of patients with active rheumatoid arthritis admitted for a disease flare. Thirty-four patients were allocated to an intensive exercise program consisting of supervised isokinetic and isotonic strength training and bicycling on a home trainer for 15 minutes at 60% of the age-predicted maximum, three times a week, plus conservative exercises composed of supervised range of motion (ROM) and isometric exercises. Thirty patients received conservative exercises only. The improvement of disease activity, as measured with the Disease Activity Score (DAS), over the 24-week follow-up period was similar in both groups, with a trend toward a slightly greater improvement in the intensive exercise group.

Häkkinen et al. [11] designed a randomized controlled trial comparing the long-term effects of a home-based strength training program with conventional training. The 2-year strength training program consisted of dynamic strength training exercises for the upper and lower extremity, abdomen, and back, to be performed two times a week for 45 minutes. In addition, subjects were encouraged to participate in recreational sports activities two to three times a week. The conventional training program consisted of ROM and stretching exercises performed twice a week. Seventy patients with early rheumatoid arthritis, none of whom had taken glucocorticosteroids or disease-modifying antirheumatic drugs, were enrolled, and therapy with disease-modifying antirheumatic drugs was instituted. Compared with the baseline DAS, disease activity decreased in both the strength training group (baseline DAS, 4.4 ± 1.1; 2-year DAS, 2.2 ± 1.2) and the conventional training group (baseline DAS, 4.9 ± 1.1; 2-year DAS, 2.7 ± 1.2). The investigators reported a statistically significant difference between the two groups in favor of the strength training group. After 5 years, decreased disease activity was still present in both groups; however, it is unclear whether the difference between the two groups persisted [12*].

de Jong et al. [13**] compared the effectiveness and safety of a 2-year intensive weight-bearing exercise program using a randomized controlled trial. Subjects allocated to the intensive exercise program exercised in groups two times a week for 75 minutes per session using the Rheumatoid Arthritis Patients in Training program. Subjects allocated to the usual care group received physical therapy if thought necessary by the attending physician. Three hundred patients with stable disease and no prostheses of weight-bearing joints were enrolled. In both groups, disease activity as measured by the DAS decreased, with no differences in improvement between the two groups over the total duration of the study of 2 years (change score between baseline and 24 months, −0.9 [SD 1.2] and −0.9 [SD 1.1] in the intensive exercise and usual care groups, respectively).

Some authors hypothesize that the positive effect of exercise on disease activity may be explained by the process of autosynovectomy [14–17], an alternation in concentration of circulating neuropeptides [18,19], more aggressive treatment of rheumatoid arthritis, or gradual changes in the performance of the examiners with regard to joint status assessment [13**].

Effect of exercise on joint damage
Data on the effect of intensive exercise on joint damage, as measured by radiography, in patients with rheumatoid arthritis are scarce. Two studies describe the effects of exercise on radiographic damage of the small and large joints. In a nonrandomized controlled trial by Nordemar et al. [20], the effectiveness and safety of a supervised, long-term (4–6 years) exercise program performed once every other week were compared with usual care in 52 patients with moderately active rheumatoid arthritis. Summed radiographic scores of lower extremity joints (small and large) that had ever shown arthritic features were analyzed at baseline and after 4 to 6 years of follow-up. The authors concluded that radiologic progression in the clinically affected joints was less pronounced in the exercise group than in the control group.

Stenström et al. [21] examined the effectiveness and safety of a 4-year intensive dynamic water-based exercise program (once a week, 40 minutes, in groups of five persons) with usual care in 60 patients with rheumatoid arthritis in a nonrandomized controlled trial. Patients in the intensive dynamic exercise group performed ROM exercises; dynamic and static muscle strengthening exercises; and activities for muscle endurance, coordination and balance, aerobic capacity, and relaxation. Many exercises were performed at an intensive (>170% of resting pulse) level. Those in the usual care group received physical therapy (local, passive treatment, suspended ROM exercises, static muscle training, and traditional pool exercises) when needed. Radiographic evaluation of the hands, wrists, shoulders, feet, and knee joints was performed and reported as a summed Larsen score. At the end of the trial, no differences in changes of the Larsen scores existed between the groups.

Exercise and radiologic damage of the small joints
Ten years ago, Hansen et al. [22] randomized 75 patients to four different exercise programs (A, B, C, and D) and a control group (E) to study the long-term effects (2 years) of various training programs. All patients in the four exercise program groups were given written instructions and
participated in a daily 15-minute overall training program followed by 30 minutes of conditioning training, e.g., swimming, cycling, or jogging. The minimum training frequency was defined as three times a week, with a maximum of 90 minutes daily and 330 minutes a week. Patients in group B met weekly with a physical therapist and performed the 15-minute standard program followed by 15 minutes of conditioning training (70% of maximum pulse rate) and 15 minutes of relaxation. Patients allocated to group C were trained weekly in groups of a maximum of five persons and otherwise followed the same program as the patients in group B. The patients in group D received training similar to that of subjects in group C but used the hot water pool instead of bicycles for conditioning training. Patients in control group E were not informed about the training program. The data indicated that radiographic damage of the hands and feet progressed equally over time in all groups. However, no effects were found on any of the clinical endpoints, including aerobic fitness and muscle strength.

Radiographic progression of the hands and feet was also investigated in the two aforementioned recent trials of long-term exercise programs [11,12*,13**,23*]. In the study by Häkkinen et al. [11,12*], it was demonstrated that a home-based strength training program does not affect the rate of damage of the small joints. In that study, the median (IQR) Larsen scores of hands and feet (range, 0–100) in the strength training group were 0 (0–1), 0 (0–2), and 0 (0–3), and in the conventional training group, 0 (0–3), 2 (0–5), and 2 (0–4) at baseline and at the 2-year 5-year check-ups, respectively (P = 0.286).

In the study by de Jong et al. [23*] it was demonstrated that patients participating in long-term high-intensity exercise classes do not develop additional damage of the joints of the hands and feet in comparison with usual care. The median (IQR) Larsen score (range, 0–200) of the small joints increased 1.0 points (6.0) in the exercise group and 2.0 (9.0) in the control group after 2 years. The mean (95% CI) difference in change between the exercise and control groups amounted to −2.0 (−4.2, 0.2) in favor of the exercise group (P = 0.045). The smallest detectable difference was used as a threshold for relevant progression in damage of the small joints (11.5 points of detectable difference was used as a threshold for relevant joint damage between the groups was more pronounced in the hands and feet demonstrated that this difference in joint damage between the groups was more pronounced in the hands and feet than in the hands.

Effects of exercise on radiologic damage of the large joints
The Rheumatoid Arthritis Patients in Training trial [13**] reported a mean change of the radiographic joint damage score of the large joints (summed Larsen score of shoulder, elbows, hips, knees, and ankles; range, 0–60) of 0 after 2 years in both groups. However, the mean difference in change showed a nonsignificant trend toward a greater increase in the exercise group (mean difference in increase of the Larsen score [CI]: 0.3 [0.0, 0.7]). The smallest detectable difference threshold was used for relevant progression in damage of the large joints of 1.65 Larsen score points, and 10.8% of the control group participants and 15.3% of the exercise group participants exceeded this threshold (P = 0.284). Although the differences between the groups seem small and are not statistically significant, it was questioned whether this trend toward more damage with long-term high-intensity exercise might be detrimental for certain subgroups of patients [24]. Subgroup analysis showed that the association between long-term high-intensity weight-bearing exercise and joint damage progression in large joints was influenced by baseline damage but not by age, disease duration, baseline physical capacity, functional ability, or disease activity [25]. In addition, Larsen scores, particularly of the shoulder and subtalar joints, deteriorated more in patients participating in intensive exercise compared with conventional exercise [25].

Exercise and joint structure
Joint damage progression might be attributed in part to wearing with use and secondary osteoarthritis. Activities that demand high-intensity, acute direct joint impact carry an increased risk of causing damage to cartilage and might result in osteoarthritis of the involved joints [26,27]. Epidemiologic studies demonstrate that participation in several competitive sports increases the risk of osteoarthritis, whereas other physical activities carry a low risk, if any [26]. Furthermore, ‘individuals with abnormal joint anatomy or alignment, previous significant joint injury, osteoarthritis, joint surgery, joint instability or inadequate muscle strength have an increased risk of joint damage during participation in athletics’ [27]. Among individuals without joint disease, participation in physical activities such as those described in these studies will probably not result in joint damage. However, some rheumatoid arthritis patients, particularly those with large joint involvement, might possess several risk factors for additional joint damage as described by Buckwalter [27] and should avoid high-intensity weight-bearing activities.

Although intensive exercise might be detrimental to the large joints in subgroups of patients, it was found safe and even beneficial for the small joints characteristically involved in rheumatoid arthritis. There are several possible explanations for this phenomenon.

First, the exercises performed by the participants in the studies reviewed, although designed as dynamic, did not place heavy loads on the small joints, thereby...
minimizing the wearing forces. Second, it has been hypothesized that weight-bearing exercises mediate the downregulation of the activity of the osteoclasts and/or change the bone structure, making the bones of the small joints less susceptible to the action of the osteoclasts [23*]. On the cellular level, the osteoclast is presumed to be the final common cell in local and systemic bone destruction. The role of the osteoclast is supported by a recent investigation on a serum transfer model of arthritis, which in wild-type mice leads to severe bone erosions [28]. Recent cross-sectional studies in patients with rheumatoid arthritis demonstrate a positive relation between radiographic damage of the small joints and bone mineral density [29–31]. Given the findings from laboratory and epidemiologic studies, one might hypothesize that local and systemic bone loss in rheumatoid arthritis patients may be related to the osteoclast, a common effector cell. This hypothesis is supported by the observation that weight-bearing small joints of the feet appear to benefit more than the joints of the hands, which are not weight-bearing. In addition, long-term high-intensity weight-bearing exercises are effective in slowing down the age-related loss bone mineral density of the hip, as measured by a dual-photon X-ray absorptiometer [32*]. In a study by Häkkinen et al. [12*], patients with early arthritis were able to stop the age-related loss of bone mineral density with 5 years of sustained intensive home-based muscle strength training. It has been suggested that the relation between the positive effects of exercise and the rate of joint damage is mediated by the improvement of bone quality [23*].

**Exercise prescription**

Patients with rheumatoid arthritis can improve aerobic capacity, muscle strength, functional ability, and psychological well-being as a result of moderate or high-intensity exercise. In addition, prolonged regular exercising slows the age-related and sex-related bone loss. Exercise does not have a detrimental effect on disease activity or radiologic progression of joint damage of the hands and feet. However, the safety regarding the impact of high-intensity exercise on large joints with pre-existing joint damage is still under debate, especially for shoulder and subtalar joints.

Given these findings, it seems warranted to advise patients with rheumatoid arthritis to remain physically active and to incorporate regular physical activity into their lifestyle to enhance exercise adherence over prolonged periods [24].

Regarding the intensity of exercises, low-intensity land-based or water-based exercises can be advised safely for patients with rheumatoid arthritis in any stage of the disease.

If improvement of aerobic capacity [10,13**,33–35], muscle strength [10,11,12*,13**,35], or functional ability [11,12*,13**] is to be achieved, exercises of at least moderate intensity, for a total of 30 minutes a day on 5 days or more of the week, are necessary. This level of intensity corresponds with cardiovascular prevention programs recommended for the general population [36].

To slow down age-related bone loss, impact-generating activities seem essential [37,38], with effects specific to the sites loaded. Given the scarcity of data regarding the potential detrimental effects of moderate to high-intensity exercise in patients with pre-existent extensive damage of the large joints, specific weight-bearing impact-generating exercises can not yet be encouraged in this group of patients, and the same applies to patients with joint prostheses. However, a tailor-made program supervised by an experienced physical therapist could make it possible for these patients to participate in moderate-intensity exercises, either individually or with group programs.

An individualized approach to exercise is required because of the variable course of rheumatoid arthritis. In addition to the physical therapist’s expertise, the patient’s ability to modify the exercise program according to current health status and responses to the exercises is very important [39**]. Patients with relatively stable rheumatoid arthritis and no extensive involvement of the large joints who understand and recognize their opportunities and limitations might be able to join community-based physical activity programs with the initial or periodic supervision of an experienced physical therapist.

With respect to the clinical practice of exercise prescription, Iversen et al. [40] have conducted a study among 25 rheumatologists and 132 patients with rheumatoid arthritis to analyze the content of clinical discussions and to assess patients’ and rheumatologists’ attitudes and beliefs about exercise. It was found that rheumatologists’ beliefs about the usefulness of exercise for rheumatoid arthritis varied, with the least positive findings reported for aerobic exercise. These findings are in line with the results of a study by Munneke et al. [41] in which outcome expectations of rheumatologists, patients with rheumatoid arthritis, and physical therapists regarding high-intensity exercises as opposed to conventional exercise were investigated. It was found that rheumatologists, physical therapists, and patients had more positive expectations of conventional exercise programs than of high-intensity exercise programs.

Iversen et al. [40] also showed that patients discussed exercise with their rheumatologists in approximately half of the clinical encounters. Exercise discussions were more likely to occur if a patient was currently exercising and if the rheumatologist believed that aerobic exercises were useful in managing rheumatoid arthritis [40]. Aerobic exercise discussions contained more information about
drawbacks, side effects, pain, and bargaining than did discussions about general exercises and referral to physical therapy for exercise [42*].

Of the 132 patients included in the study by Iversen et al. [43*], 113 completed a 6-months follow-up [43*]. Predictors of exercise behavior at 6 months included the patients’ past history of exercise (odds ratio 95% CI, 6.8 [3.1–15]) and the rheumatologists’ current exercise behavior (0.26 [0.09–0.77]).

These results indicate that a broader dissemination of knowledge on the effectiveness and safety of moderate and high-intensity exercise among rheumatologists, physical therapists, and patients is needed.

Conclusion
It has been extensively documented that patients with rheumatoid arthritis can benefit from exercise. Regarding the safety of exercise, moderate or high-intensity weight-bearing exercises did not have detrimental effects on disease activity and the progression of radiologic damage of the joints of the hands and feet.

In the absence of sufficient data on exercise and radiologic progression of the large joints, rheumatoid arthritis patients with significant radiologic damage of the large joints should not be encouraged to participate unless individually curved protective measures are taken for the specific damaged joints. More research should be performed on the long-term effects of exercise on joint damage and durability of prostheses of the weight-bearing joints. For that purpose, large observational studies including patients with rheumatoid arthritis in various stages of the disease are needed.

Exercise advice concerns a joint decision between a patient, the rheumatologist, and the physical therapist. Regarding the prescription of exercise, a broader dissemination of knowledge on the effectiveness and safety of moderate and high-intensity exercise for rheumatoid arthritis patients among rheumatologists, physical therapists, and patients is needed.

References and recommended reading
Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
** of outstanding interest


This review gives a recent overview of the benefits of aerobic and muscle strengthening exercise.


An important article underlining why the maintenance of exercise routine is important.


A randomized controlled trial presenting a concise investigation on the safety of long-term high-intensity weight-bearing exercises with respect to damage of the large joints.


This article discusses the evidence for independent relationship between aerobic fitness and the rate of local damage.


42 Iversen MD, Eaton HM, Daltroy LH. How rheumatologists and patients with rheumatoid arthritis discuss exercise and the influence of discussions on exercise prescriptions. Arthritis Rheum 2004; 51:63–72. The authors demonstrate the ways by which patients’ decision making about participation in exercises is influenced by their caregivers’ opinion.

43 Iversen MD, Fossel AH, Ayers K, et al. Predictors of exercise behavior in patients with rheumatoid arthritis 6 months following a visit with their rheumatologist. Phys Ther 2004; 84:706–716. This study gives important information on the factors predicting prolonged participation in exercise and patients’ motivations to maintain exercise.
Understanding functioning, disability, and health in rheumatoid arthritis: the basis for rehabilitation care
Alarcos Ciezaa and Gerold Stucki,a,b

Purpose of review
To examine the recent literature on rheumatoid arthritis in relation to functioning and disability, highlighting it from the perspective of the biopsychosocial model of functioning, disability, and health of the World Health Organization. This review focuses on longitudinal studies because they clarify associations found in cross-sectional studies and are useful in shedding light on the mechanisms that explain functioning and disability.

Recent findings
The studies that contribute best to understanding of functioning and disability in patients with rheumatoid arthritis are studies that (1) incorporate a comprehensive model to integrate different variables of interest, (2) use a longitudinal design to examine the potential casual relationships among the variables, and (3) use hierarchical regression analyses or path analysis to study the relation among variables.

Summary
It is time to rethink and redefine what should be measured when addressing functioning and disability of patients with rheumatoid arthritis. The use of a universally agreed framework and classification, such as the International Classification of Functioning, Disability and Health, a universally agreed-on comprehensive list of variables potentially relevant to functioning and disability in rheumatoid arthritis, and a greater focus on functioning-oriented versus disability-oriented perspectives constitute a solid foundation for such a rethinking process.

Keywords
disability, functioning, ICF, outcome assessment, rheumatoid arthritis

Introduction
Functioning is recognized as an important outcome in rheumatoid arthritis. The number of clinical studies addressing functioning as a study endpoint in patients with rheumatoid arthritis has steadily increased during the last decade. These investigations have predominantly been guided by the medical perspective, from which the measurement of functioning and health is required to evaluate the patient-relevant outcomes of an intervention and from which functioning and health are seen primarily as a consequence of the disease [1].

From the perspective of rehabilitation medicine, functioning represents not only an outcome but also the starting point of the clinical assessment, the intervention management, and the evaluation and quality management. Moreover, functioning is intimately related to and influenced by the environment and the person’s characteristics [2]. Thus, the rehabilitative process targets functioning, the environment, and modifiable personal factors [3]. In accordance with this view, the basis for rehabilitation care in patients with rheumatoid arthritis begins with an in-depth understanding of the determinants of functioning and of their interactions with personal and environmental factors.

A highly useful basis for understanding these interrelationships is the biopsychosocial model of functioning, disability, and health of the World Health Organization (WHO) [4]. Based on this model, functioning, with its components body functions and structures, and activities and participation, is seen in relation to the health condition under consideration, and personal and environmental factors (Fig. 1) [4]. Functioning denotes the positive aspects, and disability, the negative aspects of the interaction between a person with a health condition and the contextual factors (environment and personal factors) of...
that person. Thus, disability is an umbrella term for impairments, limitations in activities, and restrictions in participation. This distinction can help when reading the medical literature. Disability is usually the preferred term. However, from the biopsychosocial perspective presented here, functioning is implicitly addressed when disability is studied and vice versa.

The aim of this review is to examine the recent literature on rheumatoid arthritis in relation to functioning and disability, highlighting it from the perspective of the WHO's biopsychosocial model of functioning, disability, and health. The review focuses on longitudinal studies because they clarify associations found in cross-sectional studies and can shed light on the mechanisms that explain functioning and disability.

Components of the biopsychosocial model of functioning and disability
The components and the understanding of the interactions between them can be seen in Figure 1.

Health condition is an umbrella term for disease, disorder, injury, or trauma and may also include other circumstances, such as aging, stress, congenital anomaly, or genetic predisposition. It may also include information about pathogeneses and/or cause. There are possible interactions with all components of functioning: body functions and structures, activity and participation.

Body functions are defined as the physiologic functions of body systems, including psychological functions. Body structures are the anatomic parts of the body, such as organs, limbs, and their components. Abnormalities of function and abnormalities of structure are referred to as impairments, which are defined as a significant deviation or loss (e.g., deformity) of structures (e.g., joints) or/and functions (e.g., reduced range of motion, muscle weakness, pain, and fatigue).

Activity is the execution of a task or action by a person and represents the individual perspective of functioning. Participation refers to the involvement of a person in a life situation and represents the societal perspective of functioning. Difficulties at the activity level are referred to as activity limitation (e.g., limitations in mobility such as walking, climbing steps, grasping, or carrying). Problems a person may experience in involvement in life situations are denoted as participation restriction (e.g., restrictions in community life, recreation, and leisure, but possibly in walking also, if walking is an aspect of participation in terms of life situation).

The contextual factors are the complete background of a person's life and living situation. Within the contextual factors, the environmental factors make up the physical, social, and attitudinal environment in which people live and conduct their lives. These factors are external to people and can have a positive or negative influence—i.e., they can represent a facilitator or a barrier for the person.

Personal factors are the particular background of a person's life and living situation and are composed of features that are not part of a health condition—i.e., sex, age, race, fitness, lifestyle, habits, and social background. Risk factors can thus be described in personal factors (e.g., lifestyle, genetic kit) and environmental factors (e.g., architectural barriers, living and work conditions). Risk factors not only are associated with the onset but also interact with the disabling process at each stage.

This biopsychosocial view guided the development of the International Classification of Functioning Disability and Health (ICF) [4], approved by the World Health Assembly as recently as May 2001. With the ICF, an etiologically neutral framework and a globally agreed-on language and a classification are available to describe functioning both on the individual and the population levels.

What explains disability in patients with rheumatoid arthritis?
Five recently published longitudinal studies addressing the question, 'What explains functioning and disability in patients with rheumatoid arthritis?' are included in this review and are summarized in Figure 2. In this figure, the investigated independent variables are allocated to the corresponding component in the ICF to which they belong and are marked with a square. The dependent variables are marked with a circle in Figure 2. The numbers

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**Figure 1. Biopsychosocial model of functioning, disability, and health**

The multiple possible interactions among this model's components—health condition, body junctions and structures, activities, participation, environmental and personal factors—are depicted. Reprinted with permission [4].
The Health Assessment Questionnaire Disability Index (HAQ-DI) [5,6] has been used as an instrument to address disability in four of the five studies. It is allocated in Figure 2 between the components activity and participation. This allocation is based on the results of a recent study by Stucki and Cieza [19] showing that the HAQ-DI mainly addresses limitations in activities, taking into account some aspects of the physical environment of the patients.

Two longitudinal studies investigate the predictive relation between radiologic change and disability [7,8]. In both studies, the participants were patients with rheumatoid arthritis diagnosed with rheumatoid arthritis for less than 1 year and followed prospectively for 5 years. In the study by Maillefert et al. [7], the correlation between the changes observed in the total radiologic damage and the total narrowing scores during the first year of the study period and disability after 5 years as measured by the Health Assessment Questionnaire (HAQ) was analyzed with linear regression. The correlation between those independent variables and disability after 5 years was 0.18 ($P = 0.046$) and 0.25 ($P = 0.006$), respectively. Conversely, the short-term changes in the erosion score were not significantly correlated with disability after 5 years ($r = 0.084; P = 0.36$). The authors concluded that early changes reflecting joint damage in patients with recent-onset rheumatoid arthritis are predictive of subsequent disability. However, this conclusion must be viewed with caution, because the variance explained by the regression models studied was very low ($r^2 = 0.032$ for total radiologic damage and $r^2 = 0.0625$ for the total narrowing score, respectively).

The study by Combe et al. [8] included an erosion score, a total Sharp score at baseline, and the following baseline variables in a multilinear regression model: pain, morning stiffness, the Ritchie index, tender joints, swollen joints, Disease Activity Score, erythrocyte sedimentation rate, C-reactive protein, and the HAQ. The multivariate analysis selected baseline HAQ score, Ritchie index, erythrocyte sedimentation rate, C-reactive protein, and the presence of erosion as independent, statistically significant prognostic factors of HAQ disability after 5 years. Unfortunately, the authors did not report the amount of the variance in the HAQ disability after 5 years explained by the independent variables included in the final model. Therefore, this study does not provide much information regarding the absolute importance and the relative importance of the found prognostic factors.

As mentioned, according to the WHO model of functioning and disability, the interaction between a person with...
a health condition and the contextual factors (environmental and personal factors) of that person determines the level of functioning and disability. Three of the studies reviewed in this article analyze the influence of different contextual factors in disability with different degrees of comprehensiveness.

Krishnan and Fries [9] addressed the question of whether more aggressive use of disease-modifying antirheumatic drug treatment could reduce disability and the rate of progression of disability in rheumatoid arthritis [10]. They analyzed the data collected semiannually from more than 3000 patients from 1977 to 1998 in the United States and Canada and used year of disease onset as a surrogate parameter for changes in treatment.

Semiannual data of the HAQ-DI for each patient were available. Degree of disability was then measured based on the estimated average disability for each patient and the mean disability for each calendar year, which was calculated by averaging the values from all patients in each year. The relation between successive annual cohorts and subsequent disability was examined based on regression analysis, adjusting for age, sex, race, education, clinical center, disease duration, length of follow-up, and attrition probability.

Their results indicate that functional disability in patients with rheumatoid arthritis declined substantially in the period studied, at a rate of approximately 2.7 to 2.8% per year, with an overall reduction of more than 50%. Approximately three fourths of this overall decline (40–42%) can be attributed to the year of disease onset, which was used as a surrogate for changes in treatment. This decline is consistent with a beneficial effect of the associated changes in treatment strategies.

In a more comprehensive model, Evers et al. [11] investigated the role of social support and coping with pain at the time of diagnosis in relation to the long-term course of functional disability and pain after 3 and 5 years in 78 patients with rheumatoid arthritis. A composite score of grip strength and the mobility and self-care scales of the Impact of Rheumatic Diseases on General Health and Lifestyle [12], which is an instrument derived from the Arthritis Impact Measurement Scales [13], was used to assess functional disability.

Independent linear regression analyses were performed to study the named relation between the independent variables (social support and coping with pain at the time of the diagnosis, respectively) and the dependent variables (functional disability and pain after 3 and 5 years). The regression models were adjusted for personality characteristics of neuroticism and extraversion, clinical status, and use of medication.

In line with previous results of the same authors [14], passive pain-coping strategies assessed at the time of diagnosis significantly explain 4% of the variance in functional disability at the 3-year follow-up. However, the same effect could not be confirmed in this study at the 5-year follow-up. Instead, lower levels of social support explained 12% and 11% of additional variance in functional disability at the 3-year and 5-year follow-ups, respectively.

In relation to pain after 3-year and 5-year follow-ups, perceived support significantly explained 5% of the variance in pain at both assessment points. Clinical status explained 6% of the variance in pain at the 3-year follow-up, and demographic variables 8% of the variance at the 5-year follow-up.

The authors conclude that social support predicted a milder course of functional disability and pain at the 3-year and 5-year follow-ups, and these effects occurred irrespective of the personality characteristics, clinical status, and use of medication. These results suggest that early interventions focusing on pain-related avoidance factors and social resources for patients at risk may positively influence long-term disability in rheumatoid arthritis.

Socioeconomic status is an additional personal factor investigated in relation to disability in a recent longitudinal study, Jacobi et al. [15] studied the effect of socioeconomic status on changes in health outcomes and related healthcare utilization over a 2-year period in a sample of almost 900 patients with rheumatoid arthritis. The health outcomes investigated were disease activity, disability, depression, and quality of life.

The authors studied the relation among the variables based on logistic regression models and with cross-sectional and longitudinal data. They report the effect sizes from the logistic models as odds ratios with 95% CIs. The cross-sectional data were analyzed separately for three different disease-duration groups: 0 to 5 years, 5 to 15 years, and 15 years or more.

In the cross-sectional analysis, the authors found that in the group with a disease duration of as long as 5 years, patients with low socioeconomic status had significantly worse health outcomes than patients with high socioeconomic status. Compared with patients with high socioeconomic status, those in the low socioeconomic status group more often had high disease activity (odds ratio = 2.8; 95% CI, 1.2–6.4), disabilities (odds ratio = 2.2; 95% CI, 1.0–4.6), depressive symptoms (odds ratio = 2.6; 95% CI, 1.1–6.0), and low quality of life (odds ratio = 3.1; 95% CI, 1.5–6.4).

Among patients with a disease duration of 5 to 15 years or more than 15 years, there was no statistically significant
effect of socioeconomic status on health outcomes. Trend analysis did not show statistically significant differences in health outcomes among the disease duration groups.

Regarding the use of health care, patients with a low socioeconomic status and disease duration of 0 to 5 years received significantly less allied health care (i.e., physiotherapist, occupational therapist, or chiropodist) than patients with a high socioeconomic status with comparable disease duration. For the use of other health care services (rheumatology care, additional specialist care, psychological care, and home nurse care), no statistically significant effect of socioeconomic status was found. The result of the trend analysis showed that patients with a low socioeconomic status made significantly less use of additional specialist care with increasing disease duration in comparison with patients with a high socioeconomic status.

In the longitudinal analysis, no statistically significant differences were found between different socioeconomic status groups with respect to worsening of health outcomes. With respect to improvements, the authors found that significantly more patients with a low socioeconomic status improved over a 2-year period in quality of life (odds ratio = 2.7; 95% CI, 1.2–6.3) than patients with a high socioeconomic status. The authors argued that patients with low socioeconomic status might have a different perception or interpretation of quality of life than patients with high socioeconomic status. Indications of a relation between socioeconomic status and changes in health care use also were not found. Patients with low socioeconomic status made considerably less use of allied health care than patients with high socioeconomic status during the 2 years of the study.

What explains depression in patients with rheumatoid arthritis?

Two recent longitudinal studies addressing the question, “What explains depression in patients with rheumatoid arthritis?” are included in this review and are summarized in Figure 2. As illustrated in Figure 2, depression is allocated in the component body functions because mental functions, including emotional functions, are considered a part of body functions within the WHO model of functioning and disability.

Both studies investigate the validity of a model in which depressive symptoms are the dependent variable and disability, as measured by the HAQ, is a predictive variable. Both models also include a number of different mediator variables, whose influence in the relation between disability and depression is also studied.

Neugebauer et al. [16**] studied the extent to which an increase in physical impairment as measured by the HAQ predicts an increase in depressive symptoms. Different pathways analyzing the mediator effect of valued activity disability, social comparison evaluations, and satisfaction with abilities were studied based on hierarchical linear regression analyses. Valued activity disability refers to impairment in activities that are meaningful to the individual patient, and social comparison evaluation refers to the perception of one’s own difficulties performing life activities in comparison with others.

The hierarchical analyses revealed the following associations among the variables studied. Physical impairment was associated with both greater disability in valued activities and an increased number of unfavorable comparison evaluations. Valued activity disability and comparison evaluation did not mediate the effect of physical impairment on satisfaction with functional status.

All three factors (poor functional status, valued activity disability, and unfavorable comparison evaluations) were significantly associated with low satisfaction. This finding was particularly meaningful in light of the third association found: the association between satisfaction and depressive symptoms. Low satisfaction with abilities was the only variable (except for baseline depressive symptoms) significantly associated with depressive symptoms in the full model, including all the variables. In each step of the hierarchical linear regression model, the authors report the amount of variance of the corresponding dependent variables that was explained by the corresponding independent variables.

The model investigated by Covic et al. [17**] postulates that disease activity affects both pain and depression and is mediated by passive coping and helplessness. Physical disability is treated as an indicator of disease activity and is measured with the HAQ.

To study the relation among all different variables under consideration, the authors performed path analysis, which enables the prediction of more than one dependent variable and the assessment of the relation among independent variables and dependent variables. The study presents a theoretical, directional relation (both direct and indirect) between variables and, as such, offers a causal model of relationships.

In this study, helplessness and passive coping were found to be significant mediators of the relation between physical disability and the levels of pain and depression in patients with rheumatoid arthritis after 8 and 12 months. This predictive model explained 29 to 43% of the variance in pain and 21 to 33% of the variance in depression.

The strengths of these two last studies can be summarized as follows: (1) the use of a comprehensive model.
that integrates different variables of interest, (2) the longitudinal design that enables potential causal relationships among the investigated variables to be explored, and (3) the statistical analysis performed. Hierarchical regression analyses and the path analysis reveal several ways the included variables are interconnected. In comparison with the other six studies reviewed, the statistical analysis of these two last studies provides a more interactive picture of the relation among the independent variables and between the dependent and independent variables.

The results of these two studies also have important clinical implications for rheumatoid arthritis management. For example, the study by Neugebauer et al. [16**] shows that the assessment of people’s levels of satisfaction with their physical impairments may help to distinguish among people who seek treatment with similar levels of physical impairment but have differing risks of developing depressive symptoms. These data suggest the need for interventions that focus on improving satisfaction with physical impairments. Another interpretation of the results of the study by Covic et al. [17**] is that for patients with rheumatoid arthritis, interventions should be selected that target psychological factors, such as helplessness and coping strategies.

**Conclusion**

Recently published longitudinal studies concerning functioning and disability in patients with rheumatoid arthritis are scarce, and the models investigated in them vary considerably with regard to their comprehensiveness and use of statistical analysis to clarify the relation between dependent and independent variables. This variability reflects the fact that the true nature of functioning and disability in patients with rheumatoid arthritis is only beginning to be understood, and more work in this area needs to be performed to improve knowledge and understanding of disability in rheumatoid arthritis.

This review demonstrates that the WHO model of functioning and disability is a useful framework for understanding the interactions among variables studied in the different models. The depiction of the independent and dependent variables in the WHO model helped to address the complexity of the different possible interactions among variables. It could also be shown that important aspects of functioning, such as participation, have not been reported in recently published longitudinal studies.

In addition, the depiction of the investigated variables in the WHO model suggests the usefulness of this model when planning studies focusing on examining functioning and disability of patients with rheumatoid arthritis. A theoretical model rather than practical considerations should be the basis for future investigations. A theoretical framework may lead to the study of comprehensive models integrating the highest possible number of relevant variables.

Within this context, it is important to mention that internationally agreed ICF Core Sets for rheumatoid arthritis have been developed [18**]. The ICF Core Sets for rheumatoid arthritis are lists of ICF domains that include as few domains as possible to be practical but as many as necessary to be sufficiently comprehensive to describe the typical spectrum of problems in functioning among patients with rheumatoid arthritis in comprehensive, multidisciplinary assessments or in clinical studies. These generally agreed-on lists of ICF domains provide an ideal basis from which to define theoretically sound models of functioning and disability in patients with rheumatoid arthritis.

The ubiquity of the HAQ in relation to disability and rheumatoid arthritis is also reflected in this review. In all but one of the studies reviewed, the HAQ was the instrument selected to measure disability. The question raised by this observation is this: to what extent does the HAQ address all relevant aspects of disability in patients with rheumatoid arthritis? As mentioned, the HAQ-DI mainly addresses limitations in activities, taking into account some aspects of the physical environment of the patients [19].

Moreover, the HAQ has been defined by its developers as a ‘disability index.’ Although this label is not consequently used in the literature, it automatically has a negative connotation that may have influenced the hitherto performed investigations.

Equally important to the understanding of the determinants of disability is the understanding of the determinants of functioning. Questions referring to why functioning can be maintained in some patients but not in others have not been addressed. Insight into the determinants of functioning could lead physicians and health professionals to target relevant and modifiable factors to regain and maintain functioning and to prevent disability. In other words, based on models to explain functioning, physicians and health professionals could tailor rehabilitation care and prevention most efficiently [1].

It is time to rethink and redefine what should be measured when addressing functioning and disability of patients with rheumatoid arthritis. The use of a universally agreed-on framework and classification, such as the ICF, and a universally agreed-on, comprehensive list of variables potentially relevant to functioning and disability in rheumatoid arthritis and a greater focus on functioning-oriented versus disability-oriented perspectives constitutes a solid foundation for such a rethinking process.
References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest


In this article, data collected semiannually from more than 3000 patients from 1977 to 1998 in the United States and Canada were analyzed. The year of disease onset was used as a surrogate parameter for changes in treatment, and the HAQ-DI was used to quantify the degree of disability. The relationship between successive annual cohorts and subsequent disability was examined based on regression analysis adjusting for age, sex, race, education, clinical center, disease duration, length of follow-up, and attrition probability. The results indicate that functional disability in patients with rheumatoid arthritis declined substantially in the period studied at a rate of approximately 2.7 to 2.8% per year, with an overall reduction of more than 50%. Approximately three-fourths of this overall decline (40–42%) can be attributed year of disease onset, which was used as a surrogate for changes in treatment.


In this study, the extent to which an increase in physical impairment as measured by the HAQ predicts an increase in depressive symptoms was studied. Different pathways analyzing the mediator effect of valued activity disability, social comparison evaluations, and satisfaction with abilities were studied based on hierarchical linear regression analyses. The hierarchical analyses reveal the following associations among the variables studied: (1) physical impairment was associated with both greater disability in valued activities and an increased number of unfavorable comparison evaluations, (2) valued activity disability and comparison evaluation did not mediate the effect of physical impairment on satisfaction with functional status, and (3) all three factors (poor functional status, valued activity disability, and unfavorable comparison evaluations) were significantly associated with low satisfaction. This finding is particularly meaningful in light of the third association found: the association between satisfaction and depressive symptoms. Low satisfaction with abilities was the only variable significantly associated with depressive symptoms in the full model, including all the variables.


The model studied in this article postulates that disease activity affects both pain and depression and is mediated by passive coping and helplessness. Physical disability is treated as an indicator of disease activity and is measured with the HAQ. Path analyses are performed, and the results reveal that helplessness and passive coping are significant mediators of the relationship between physical disability and the levels of pain and depression in patients with rheumatoid arthritis.


Exercise in fibromyalgia
Kaisa Mannerkorpi

Purpose of review
Several studies have indicated that physical exercise is beneficial for patients with fibromyalgia. The aim of this article is to review the recent literature relating to exercise in fibromyalgia, specifically articles published between September 2003 and September 2004, to highlight developments in the field.

Recent findings
Previous studies indicate that aerobic exercise performed at adequate intensity for an individual can improve function, symptoms, and well-being. A recent study of aerobic exercise showed that training in sedentary women with fibromyalgia using short bouts of exercise produces improvements in health outcomes. A study of aerobic walking resulted in improvements in physical function, symptoms, and distress. Two studies of low-intensity pool exercise reported a positive impact on fibromyalgia symptoms and distress. Two studies of qigong movement therapy were reported, one indicating improvements in symptoms and the other in movement harmony, indicating that this mode of exercise needs to be evaluated further.

Summary
The recent studies support existing literature on the benefits of exercise for patients with fibromyalgia. The outcomes appear to be related to the program design and the characteristics of the populations studied. As the patients with fibromyalgia form a heterogeneous population, more research is required to identify the characteristics of patients who benefit from specific modes of exercise. Moreover, long-term planning is needed to motivate the patients to continue regular exercise. Informing patients about the benefits of exercise and adjusting the exercise intensity to individual limitations enhances adherence. The social support gained by exercising in groups also enhances adherence to exercise.

Keywords
aerobic, exercise, fibromyalgia, pain, physical

Abbreviation
RCT randomized controlled trial

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Introduction
Fibromyalgia is characterized by long-lasting, widespread pain and generalized tenderness, often accompanied by fatigue [1]. The prevalence of fibromyalgia ranges from 1–3% in the general population [2], and the condition is more common among females than males. Aberrant physiologic pain-processing mechanisms, together with multiple psychological and environmental factors, are thought to interact in the development and maintenance of fibromyalgia.

Many individuals with fibromyalgia report limitations in daily activities such as carrying objects, walking, and working with their arms. Patients with fibromyalgia demonstrate reduced physical performance capacity of the upper and lower extremities [3,4] and aerobic capacity at levels similar to [3,5] or below [6] that of sedentary women. Perceived disability can affect every dimension of life, including social roles, employment, and leisure time, which in turn can impact one’s perception of the self and one’s abilities and disabilities. The severity and consequences of fibromyalgia are associated with pain, fatigue, helplessness, psychological distress, coping, and level of education [7].

Several recent reviews indicate that physical exercise is beneficial for patients with fibromyalgia [8,9], and two recent surveys conducted in the United Kingdom [10] and Ireland [11] indicate that exercise is now an integral part of physical therapy in fibromyalgia.

This review updates our present knowledge of the role of physical exercise in the rehabilitation of patients with fibromyalgia by summarizing the literature from September 2003 to September 2004. The randomized controlled trials (RCTs) included in this review are divided according to the main component of the treatment program into (1) aerobic exercise by means of cycling, dance, or whole-body exercise; (2) walking, (3) pool exercise, (4) strength training, and (5) qigong.

Aerobic exercise by means of cycling, dance, or whole-body exercise
Several studies of moderate-intensity to high-intensity aerobic exercise by means of cycling, dance, or whole-body
exercise for patients with fibromyalgia have been published since 1988. McCain et al. [12], who studied the effects of moderate-intensity to high-intensity ergometer cycling, found improvements in aerobic capacity, tender point pain threshold, and global well-being in the group that exercised three times a week for 20 weeks. Improvements in aerobic capacity [13,14] and pain threshold [14,15] have since been reported in other studies. A meta-analysis of four studies examining the efficacy of physical exercise [16] found a 17% improvement in aerobic performance, a 28% improvement in tender point pain threshold, and an 11% reduction in pain rating in the exercise programs performed at 55–90% of predicted maximum heart rate at least twice a week for a minimum of 20 min.

Not all studies of aerobic exercise have reported improvements in aerobic capacity, however [17–19]. The reasons for the inconsistency in results may be differences in the training programs or the patients’ baseline physical capacity. For example, a study aiming to evaluate the effects of high-intensity aerobic exercise found that patients were not able to manage high-intensity exercise [19]. Only a few studies include formal testing of patients’ baseline function and use baseline function as a criterion for inclusion [12,20]. From a clinical point of view, exercise in fibromyalgia appears to produce the best benefits when the program is individually tailored to the patient’s baseline function, symptom severity, and tolerance of exercise-induced pain.

A recent study indicates that aerobic exercise divided into short bouts in sedentary women with fibromyalgia can produce positive results [20]. The effects of short compared with long bouts of aerobic exercise were compared in a study that recruited 143 sedentary women with fibromyalgia [20]. Participants performing the long bouts of exercise were instructed to gradually increase their exercise session to 30 min, while those exercising in short bouts were instructed to exercise for two sessions a day for a total of 30 min. All major muscle groups of the lower extremities were used in the rhythmic dynamic exercise program that was performed at home and guided by means of videotapes. The intensity started with 40–50% of the heart rate reserve and progressed to 65–75% by week 12, and was then held constant to week 16. Both exercise groups improved in terms of self-efficacy and disease severity compared with the control group. No differences were found between the two exercise groups, however [20].

Walking
Walking can be performed at varying intensities, and therefore, walking may be an alternative exercise option for patients with fibromyalgia who are unable to participate in aerobic exercise programs of higher intensities. Exercise programs consisting primarily of walking have shown improvements in physical function [21], self-efficacy [21,22], tender point status [21,23], well-being [23], and quality of life [22]. Several of these improvements persisted up to 7–11 months [22] or 1 year [21,23].

A recently published study reported positive effects of walking [24***]. Seventy-six sedentary women were recruited to compare the effects of supervised walking and stretching three times per week for 45 min over a 20-week period. Exercise intensity in the walking group was individually tailored to the patient’s baseline physical function. Sixty-six percent of the patients in the walking group and 33% of those in the stretching group gained at least 15% improvement of their oxygen uptake. The between-group analysis showed that the walking group improved in terms of maximum oxygen uptake, vital capacity, the Fibromyalgia Impact Questionnaire (FIQ) total score, depression, and mental health compared with the control group who had practiced stretching [24***].

Pool exercise
Pool exercise is a common therapeutic modality for patients with rheumatic diseases, especially in Scandinavian countries. Temperate pool water reduces stiffness and alleviates pain, while the viscosity of water provides the resistance required in aerobic and strengthening exercises.

Previous studies of pool exercise programs have varied in length, ranging from 6 weeks [25] to 6 months [26], and intensity has ranged from low [26] to moderate-to-high [27]. Two of the pool programs evaluated were combined with an educational program [25,26]. Significant improvements in aerobic performance capacity were found as measured by the 6-min walk test [25,26,28] and the bicycle ergometer test [27]. Improvements were also seen in fibromyalgia symptoms and distress [25,26,28]. Follow-ups ranging from 12 weeks to 6 months demonstrated lasting benefits in aerobic performance capacity [25–27] and symptoms [25,26]. A long-term follow-up found that improvements in physical performance, pain, and fatigue lasted for more than 2 years [29], probably because the patients had continued to exercise after completing the trial.

Two recent studies of pool exercise report improvements in symptom severity and distress. These exercise programs were described as low-intensity exercise programs. Cedraschi et al. [30***] allocated 164 patients with fibromyalgia to either a 6-week program of pool exercise and education or to a waiting list control group. The intervention program consisted of 12 sessions of swimming and relaxation exercises performed twice a week for 6 weeks. Each session comprised 45 min exercise and 45 min education. After 6 months, the patients in the exercise group showed improvements in fibromyalgia symptoms and
Rehabilitation medicine in rheumatic diseases

One hundred twenty-eight patients with fibromyalgia to a 12-week pool exercise program or balneotherapy. The treatment programs were conducted three times a week for 12 weeks, and each session lasted for 35 min. The exercise group performed aerobic, flexibility, and stretching exercises and relaxation, while the balneotherapy group did not exercise. The between-group analysis showed that the exercise group had significantly improved in terms of depression compared with the balneotherapy group. Significant within-group improvements were found in both treatment groups for several symptoms, including scores for the severity of pain, fatigue, and stiffness.

**Strength training**

Two previous studies have independently evaluated the effects of strength training, finding positive results in improved muscle strength [32,33]. Both programs started at a low exercise load and progressed toward higher loads. No new studies of strength training in fibromyalgia have been published during the last year.

**Qigong movement therapy**

Two recent studies have evaluated the effects of qigong, an ancient movement therapy developed in China. Slow qigong movements are performed either in a standing position or while changing position. They are aimed to improve not aerobic capacity but the quality of movement, concentration, and peacefulness.

One hundred twenty-eight patients with fibromyalgia with ages ranging from 18 to 60 years and an average duration of fibromyalgia symptoms of 5 years were enrolled in a study designed to evaluate the effects of an 8-week program of qigong focusing on posture, breathing, and concentration, and mindfulness meditation focusing on mental awareness. Patients were allocated to either the intervention program or an education support program. The weekly lectures lasted for 2.5 hr in both programs [34]. Significant within-group improvements were found for fibromyalgia symptoms and depression both in the qigong and education groups. No between-group differences were found, however, indicating that qigong combined with meditation was not superior to the educational program.

Another recent study investigated the effects of a 3-month program of qigong and body awareness therapy [35]. Thirty-six patients with fibromyalgia with the mean age of 45 years and a mean symptom duration of 10 years were recruited to the study and randomized either to an intervention group or to an untreated control group. The weekly lectures were 1.5 hr long, and the program comprised a total of 14 sessions including various body awareness movements focusing on breathing and posture and qigong movements focusing on relaxation, grounding, and concentration. Significant improvements were found in movement harmony in the treatment group compared with the control group, while no improvement was found for the symptoms. Further research is needed to determine which patients with fibromyalgia can obtain benefits from qigong and other movement therapies focusing on the enhancement of mental awareness and movement harmony.

**Exercise combined with education**

Patient education in rheumatology aims to enhance the individual’s ability to manage disease and the difficulties encountered in daily life by learning more about the body, the disease, and the individual’s own responsibility for treatment and healthy behavior. Education or collaborative reasoning designed to enhance the patient’s understanding and management of the disease or disorder commonly occurs simultaneously with clinical treatments or during standardized educational programs.

One recent study [30] and a few previous studies [22,25,26] have combined exercise with an educational self-management program, finding improvements in self-efficacy [22,25] and symptom severity [22,25,26,30]. It is likely that the improvements in self-efficacy and symptom severity were probably obtained by the combination of education and exercise. Two of these studies explicitly describe using the exercise program as a mode of education to teach the participants to handle their symptoms during exercise [26,30].

A recently published qualitative study found that patients who are well informed about the risks and benefits of exercise are more likely to adhere to an exercise regimen [36]. Another qualitative study showed that education and exercise in a group provides an opportunity for social interactions during which the patients learn how to manage their symptoms and disabilities better [37].

**Exercise and symptoms**

Previous studies yield inconsistent results about the effects of exercise on pain and other symptoms. Some studies report improvements in tender point status. Other studies found improvements in variables reflecting perception of overall health status and distress. Still other studies did not find improvements in these variables [8]. Four of the six recent studies indicate some improvements in symptoms and distress [20,30,31,34]. These improvements were found in a walking exercise program [20], pool exercise combined with education [30], pool exercise alone [31], and qigong movement therapy [34]. Between-group differences were not found in the two studies comparing one treatment with another.
treatment, however [31,34], indicating that balneo-
therapy [31] and education [34] also had a positive im-
 pact on fibromyalgia symptoms. It appears that the
majority of patients with fibromyalgia can take part in
low-intensity exercise or in exercise performed at self-
selected intensities by adjusting the load and passing
during the program, while only a minority exercise at higher
intensity levels [8,19]. Also, a recent study conducted at
our clinic showed that most patients engage in low-inten-
sity physical activity or exercise during their leisure time,
such as walking and cycling [38], while only a few patients
exercise at a high intensity level. The total amount of ex-
ercise was fairly high, however, around 5 hr/week.

The aerobic exercise programs evaluated during the past
year either were of low intensity/impact [20,30,31] or
the exercise intensity level was adjusted to match the
patients’ baseline functional level [24]. From a clinical
point of view, this approach works best. A need also exists
for studies evaluating the effects of exercise at higher
intensities in patients who are able to engage in high-
intensity exercise, however, as previous studies have found
improvements in aerobic capacity and the tender point
status after exercise of moderate to high intensity [16].

Long-term adherence
Motivating patients to continue regular exercise after
completing a supervised program is crucial to maintain
long-term gains. Adherence to exercise has been found to
improve if the patients are informed about the risks and
benefits of exercise [36] and if they are taught how to adjust the exercise match their individual limita-
tions [29]. Moreover, an exercise program that conveys
positive experiences of the body may be important for
patients who commonly perceive their body negatively
in terms of pain, fatigue, and disabilities [37].

Conclusion
Aerobic exercise performed at adequate intensity for an
individual patient can improve function, symptoms, and
well-being. The results of a recent study suggest that
a walking program performed at adequate intensity may
produce similar results in sedentary patients. Another re-
cent study indicates that an exercise program for seden-
tary women with fibromyalgia can be divided into short
bouts and produce positive results. Two studies of pool ex-
ercise of low intensity demonstrated positive effects on
fibromyalgia symptoms and distress. One study of qigong
and meditation indicated positive effects on symptoms,
while another study of qigong and body awareness therapy
indicated benefits in terms of movement harmony, imply-
 ing that movement therapies need to be evaluated further
in fibromyalgia. The benefits of the exercise programs
appear to be related to the design of the program and the
characteristics of the population studied. As patients with
fibromyalgia form a heterogeneous population, more re-
search is needed on what characterizes the subgroups that
benefit from a specific mode of exercise.

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Joint injury causes knee osteoarthritis in young adults
Ewa M. Roos

Purpose of review
This review presents recent data on joint injury as the cause of osteoarthritis development in young adults and proposes and discusses a model that highlights how joint injury and other risk factors may contribute to osteoarthritis development through two different pathways: joint-related mechanisms and deconditioning of the musculoskeletal system.

Recent findings
Knee osteoarthritis in young adults is common after knee injury. In women who sustained an anterior cruciate ligament injury in soccer, 51% (mean age 31) had radiographic changes after 12 years. Men, 41% (mean age 36) had osteoarthritis after 14 years. An injury to the menisci during middle age resulting in a horizontal tear is more probably the first signal of an already ongoing osteoarthritis process of the knee. Known risk factors seem to contribute to osteoarthritis through pathways related to (1) mechanical aspects of the joint and (2) the musculoskeletal system.

Summary
Osteoarthritis in young adults is most commonly a result of a previous injury to the knee. Deconditioning of the musculoskeletal system is seen with joint injury, obesity, and aging, all known risk factors for osteoarthritis. Muscular deconditioning contributes to increased joint loads and knee osteoarthritis development and progression. So far, it is unclear whether surgery reduces the development or progression of osteoarthritis. The risk for osteoarthritis development seems to increase as the amount of meniscal tissue removed increases. Knee injury prevention, rehabilitation after knee injuries, regular exercise, maintaining body weight, and a changed locomotion pattern may prevent osteoarthritis initiation and progression in young adults.

Keywords
injury, knee, muscle function, osteoarthritis

Introduction
Osteoarthritis is often thought of as a disease of the elderly; however, knee osteoarthritis is evident at younger ages. Approximately 5% of the population age 35 to 54 years has radiographic signs of knee osteoarthritis [1–5]. Of these, the majority has a previous knee injury. Joint injury is the most common risk factor for osteoarthritis development in young adults. Data on osteoarthritis progression in young adults are scarce. In a population-based cohort (N = 148; mean age, 45 years) with chronic knee pain, 54 subjects had radiographic osteoarthritis at entry. Of these, 29 (54%) progressed over a period of 5 years [6**]. When a subgroup (n = 47; median age, 50 years) from this sample was evaluated with MRI, cartilage defects were found to increase, decrease, or disappear over a period of 2 years [7].

Joint injury as a risk factor of knee osteoarthritis
A knee injury in young adulthood increases the risk of developing radiographic and symptomatic osteoarthritis. In a long-term follow-up (36 years) from the Johns Hopkins Precursor Study, self-report of a knee injury at study entry (mean age, 22 years) or during follow-up substantially increased the risk for subsequent knee osteoarthritis with a relative risk of 5.17 [8]. To help understand these results in clinical terms, for a man of 180 cm in the same study population, each 8 kg greater weight at ages 20 to 29 years was associated with an increased relative risk of 1.7 of subsequent knee osteoarthritis after adjustment for year of birth, physical activity, and knee injury [9].

Joint injury leads to osteoarthritis in people who are in their 30s or 40s (Fig. 1) [10**,11,12**,13**]. As seen in figure 1, OA is evident in approximately every other subject with a previous knee injury, at ages where OA is uncommon in the population. According to Lohmander [14], ‘A best interpretation of the available data suggest that at 10 years after sustaining an injury to the meniscus alone or in combination with cruciate ligament rupture, an average of 1/3 knees show joint space narrowing on radiographs. At 20 years after the injury about half the injured population shows corresponding changes. Ten or twenty years may seem like a very long time, but it means that the formerly injured individuals likely are in their thirties or forties, and still have high demands and
Figure 1. Prevalence of radiographic knee osteoarthritis in population and after injury

Kindly provided by Stefan Lohmander, Department of Orthopedics, Lund, Sweden. From [10**,11,12**,13**].

expectations on their level of work and physical activity. Their rate of radiological knee OA is on par with that of uninjured individuals at about 70 years of age; loss of a meniscus or cruciate ligament ‘ages’ the knee by 30 years.’

Osteoarthritis after an injury of the anterior cruciate ligament

More specifically, 12 years after an anterior cruciate ligament (ACL) tear sustained in soccer, 51% of women with a mean age of 31 years (range, 26–40) had radiographic changes comparable with Kellgren and Lawrence grade 2 or more in their previously injured knee [13**]. In a corresponding study on men (mean age, 38 years; range, 30–56), 41% had radiographic osteoarthritis 14 years after the injury [12**]. Both women and men reported a high prevalence of knee pain and functional limitations resulting in lifestyle modifications for 50% of the women and for 30% of the men.

Concomitant injuries may contribute to a worse outcome. Women who ruptured their ACL and also underwent meniscus surgery had a higher prevalence of radiographic knee osteoarthritis, indicating that the loss of meniscal function in an ACL-injured knee may contribute to increased cartilage contact stress through decreased load distribution, shock absorption, and joint stability [13**].

Reconstruction of the knee, aiming at mechanically stabilizing the knee, has not been shown to be associated with a better outcome [12**,13**,15]. On the contrary, in reconstructed knees of women, an increased rate of patellofemoral osteoarthritis was seen [13**]. Randomized studies in this area are scarce. A recent such randomized study compared patellar tendon graft with semitendinosus graft and showed no medium-term (2-year) differences in clinical outcomes. However, patients randomized to patellar tendon graft had lower quadriceps strength at follow-up, possibly indicating an increased risk of future patellofemoral osteoarthritis. All women in the study by Lohmander et al. [13**] who demonstrated an increased rate of patellofemoral osteoarthritis had reconstructive surgery using a patellar tendon graft. No randomized controlled studies on reconstructive surgery and rehabilitation versus rehabilitation only after an acute ACL injury are available. Such a study is underway [16].

Osteoarthritis and meniscectomy

Osteoarthritis is common after meniscectomy. In a 16-year follow-up of 155 patients with intact ACLs (mean age, 54 years) who had undergone isolated limited meniscectomy, 66 (43%) had radiographic features of osteoarthritis corresponding to Kellgren and Lawrence grade 2 or more [10**]. Of these, 39 (59%) were symptomatic.

A degenerative type of meniscus tear is associated with worse clinical outcome and more radiographic osteoarthritis. Degenerative tears occur in the middle-aged and commonly have an insidious onset. It has been suggested that a degenerative meniscal tear (defined as horizontal tears) is the first feature of osteoarthritis of the knee joint, as opposed to traumatic meniscal tears (defined as longitudinal tears), which are thought to cause osteoarthritis as a result of increased joint instability and contact forces [17**].

Partial meniscal resection may be associated with less radiographic osteoarthritis over time compared with total meniscectomy. In a follow-up of 317 patients (mean age, 54 years) with no cruciate ligament injury, meniscectomized 15 to 22 years earlier, subjects who had undergone a total meniscectomy had a higher likelihood of developing radiographic osteoarthritis compared with subjects who had undergone partial meniscectomy [18*]. These data contrast with the 8-year follow-up of 200 patients included in a randomized study on partial versus total meniscectomy by Hede et al. [19], in which no difference with regard to radiographic outcome was found between groups. Possibly the time to follow-up, 8 years, was not long enough to detect any differences between the groups.

No controlled studies comparing operative versus nonoperative treatment of meniscal tears in subjects with intact cartilage are available. In a controlled study of middle-aged subjects (mean age, 52 years) with osteoarthritis of the knee, arthroscopic surgery of the knee was not associated with better clinical outcome than sham surgery treatment [20].

Uncommon risk factors for osteoarthritis in young adults

Other risk factors for osteoarthritis development in young adults include specific gene defects, joint dysplasia, and metabolic disorders [21]. Mild degrees of joint hypermobility are not associated with evidence of premature-osteoarthritis [22].
Mechanisms promoting/preventing osteoarthritis of the knee

Osteoarthritis is a mechanically driven disease. Increased or altered joint loads are a prerequisite for osteoarthritis development. It has been suggested that osteoarthritis differs from other forms of joint disease because mechanical factors are involved in the development and progression of osteoarthritis [23].

As shown in Figure 2, the known risk factors of osteoarthritis may contribute to the development and progression of osteoarthritis through different pathways: joint-related mechanisms and deconditioning of the musculoskeletal system. Increased or altered joint loads contribute to the development of osteoarthritis. The scientific evidence for this model is discussed.

Increased joint loads contribute to osteoarthritis development and progression

Andriacchi et al. [24**] have proposed a framework for the in vivo pathomechanics of osteoarthritis at the knee. The framework is divided into two phases: the initiation phase, defined as the phase in which kinematic changes take place that shift load bearing to infrequently loaded regions of the cartilage that cannot accommodate the loads, and the progression phase, defined as the phase after cartilage breakdown when the disease progresses more rapidly with increased loads.

Cartilage response to load is dependent on the health of the cartilage. Andriacchi et al. [24**] discuss the apparent paradox between laboratory and clinical studies on the relative influence of mechanical factors on the progression of degenerative changes to the articular cartilage of the knee. Laboratory studies suggest that load can produce an adaptive response (thickening, enhanced mechanical properties, and so forth) of the cartilage. In contrast, a recent clinical study reported that patients with knee osteoarthritis and higher loads at the knee during walking have a more rapid rate of cartilage breakdown than patients with lower loads [25]. However, this clinical study enrolled patients with osteoarthritis and thus relates to the progression of osteoarthritis.

In summary, additional data are needed on the influence of load on the knees of subjects at risk of knee osteoarthritis.

Joint-related pathway

Instability, malalignment, and decreased proprioception are joint-related factors shown to contribute to increased joint loads and, eventually, joint failure. Sagittal instability is often a result of a previous ACL injury [26,27]. Surgery to reconstruct the ACL is undertaken to decrease the sagittal instability, which may not always be achieved [27] and is not always related to the functional outcome of the procedure [28]. Mediolateral instability increases after meniscal resection. This increase is related both to the amount of meniscal tissue removed and the time after meniscectomy [19].

Knee alignment as a risk factor for knee osteoarthritis development in young adults is not well studied. However,
Joint proprioception is reduced in patients with ACL deficiency, and a generalized proprioceptive deficit appears to be associated with osteoarthritis. This deficit could result from loss of receptors, altered muscle function, or the consequent joint instability [32].

**Pathway related to musculoskeletal deconditioning**

Deconditioning of the musculoskeletal system, expressed as loss of muscle function, increases knee joint load during weight bearing and may predict osteoarthritis development. Mikesky et al. [33] showed that women who were strength-trained and on average had a stronger quadriceps muscle had lower rates of loading over the knee joint compared with sedentary women, who on average had weaker quadriceps muscles. In a prospective study of 148 subjects (mean age, 45 years) from a community-based cohort with chronic knee pain at inclusion, reduced muscle function, measured as the maximum number of one-leg rises from sitting, predicted osteoarthritis development 5 years later [6**].

Another aspect of musculoskeletal deconditioning is inappropriate neuromuscular control, possibly resulting from reduced muscle function. In a recent article, Radin [23] reviewed his hypothesis that microklutziness may contribute to osteoarthritis. Microklutziness, defined as hitting the floor with a stronger impact, is found in one of three adults, is detected with gait analysis, and is not visible to an observer [34]. Neuromuscular quadriceps dysfunction has been found in a group of previously meniscectomized men (N = 32; mean age, 43 years) with no radiographic or clinical features of osteoarthritis compared with matched controls [35*]. The authors suggest that muscle function may be an etiologic factor underlying the pathologic changes of osteoarthritis.

Deconditioning of the musculoskeletal system may also be related to lifestyle. Physical inactivity is common today, and most US adults do not meet the recommendations for physical activity to promote good general health [36].

**Risk factors of osteoarthritis may contribute through both pathways**

Most risk factors of osteoarthritis, both in young adults and the elderly, may contribute to increased joint loads by affecting both the joint and the musculoskeletal system. Joint injuries result in increased sagittal and mediolateral instability, resulting in altered mechanics and increased joint loads. It is also well known that few patients with a knee injury regain their previous muscle strength and neuromuscular function. Obesity may contribute to increased joint loads by (1) the increase in mass, (2) the frequently associated physical inactivity, and possibly (3) the increase in thigh girth and the resultant wider-based stance, which alter the physiologic axis of the knee joint [37]. Aging is associated with increased malalignment [38], increased joint laxity, reduced muscular strength, and loss of proprioception and balance [39*].

**Can development and progression of osteoarthritis be delayed or prevented?**

This discussion is primarily based on the identification of modifiable risk factors of osteoarthritis initiation and progression.

No studies aiming at restoring joint mechanics after an ACL injury have altered the outcome with regard to knee osteoarthritis development [12**,13**,15]. In meniscectomized subjects, the risk for osteoarthritis development seems to increase with a larger amount of meniscal tissue removed [18*]. In subjects with unicompartmental osteoarthritis, tibial osteotomy decreases joint loads and slows the progression of cartilage breakdown in the affected compartment [40,41].

General physical activity and specific exercises may prevent or delay osteoarthritis. Results from animal studies and preliminary data from humans support the hypothesis that moderate exercise is beneficial for the cartilage in subjects at risk of osteoarthritis [42–44]. Reduced muscular performance is a risk factor for osteoarthritis development in the middle-aged, and quadriceps dysfunction is present in subjects at risk before developing osteoarthritis [35*]. Also, epidemiologic data support moderate exercise being preventive of severe osteoarthritis requiring total knee replacement [45].

**Conclusion**

The available scientific evidence supports the prevention of development and progression of osteoarthritis by focusing on aspects related to deconditioning of the musculoskeletal system. Future intervention studies in patients at high risk of osteoarthritis should apply a rigorous study...
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- Papers considered by the reviewers to be of outstanding interest.
- Papers considered by the reviewers to be of special interest.

The number in square brackets following a selected paper, for example [7], refers to its number in the annotated references of the corresponding review.

**Current Opinion in Rheumatology**

2005, 17:201–230

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**Contents**

**Epidemiology and health-related services**

201 Evidence-based practice and health care research

206 Computer applications in practice and instruments of measurement

208 Outcomes of orthopedic surgery in patients with arthritis

209 Epidemiology of back disorders: prevalence, risk factors, and prognosis

210 Nutritional epidemiology: dietary risk factors for rheumatic diseases and exercise

211 Health disparities

211 COPCORD (community oriented program for control of rheumatic diseases): studies of rheumatic diseases in the developing world

211 Genetics of rheumatic diseases

213 Epidemiology of RA and arthropathies

215 Epidemiology of TNF and other therapies

219 Cost-effectiveness and effects of arthritis on work

219 Miscellaneous

**Rehabilitation medicine in rheumatic diseases**

220 Evolution of team care and evaluation of effectiveness

221 Exercise and myositis

222 Cost benefit analysis and outcomes for patients with RA receiving rehabilitation

223 Safety of exercise in patients with rheumatoid arthritis

223 Assessment of disability

225 Fibromyalgia and related conditions

226 Joint injury causes knee osteoarthritis in young adults

226 Nutrition and osteoarthritis

227 Epidemiology

227 Therapeutic modalities in rehab

229 Miscellaneous

---

### Epidemiology and health-related services

#### Evidence-based practice and health care research

Review (pp. 117–123)


Epidemiology and health-related services: Evidence-based practice and health care research


Epidemiology and health-related services: Evidence-based practice and health care research


Epidemiology and health-related services: Evidence-based practice and health care research


Computer applications in practice and instruments of measurement

Review (pp. 124–128)


Epidemiology and health-related services: Computer applications in practice and instruments of measurement


Sterg AG, Mosley G, Rao TPS, et al.: Utility of digital photographs of the hand for assessing...


Outcomes of orthopedic surgery in patients with arthritis

Related review: Advancements in the surgical and alternative treatment of arthritis (pp. 129–133).


Epidemiology and health-related services: Health disparities 211


Genetics of rheumatic diseases


Epidemiology and health-related services: Genetics of rheumatic diseases


Epidemiology and health-related services: Epidemiology of RA and arthropathies


Epidemiology and health-related services: TNF and other therapies


Rehabilitation medicine in rheumatic diseases: Evolution of team care and evaluation of effectiveness

Review (pp. 160–163)

Rehabilitation medicine in rheumatic diseases

Evolution of team care and evaluation of effectiveness


Associate editor.


Rehabilitation medicine in rheumatic diseases: Exercise and myositis


de Buck PDM, Schoonjes JW, Allaire SH, et al.: Exercise and myositis 221
Rehabilitation medicine in rheumatic diseases: Safety of exercise in patients with rheumatoid arthritis

223


Aaron LA, Mancl L, Turner JA, et al.: Reasons for missing interviews in the daily electronic


Forderreuther S, Uailer S, Austra A: Impaired self-perception of the hand in
Rehabilitation medicine in rheumatic diseases: Fibromyalgia and related conditions 225


Rehabilitation medicine in rheumatic diseases: Joint injury causes knee osteoarthritis in young adults

Iversen MD, Eaton HM, Daltroy LH: How ••
Raphael KG, Janal MN, Nayak S, et al.: Familial aggregation of depression in fibromyalgia: a community-based test of alternate hypoth-
Ross SD, Estok RP, Frame D, et al.: Disability and chronic fatigue syndrome - A focus on func-
Sewitch MJ, Dobkin PL, Bernatsky S, et al.: Medi-
cation non-adherence in women with fibro-
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Joint injury causes knee osteoarthritis in young adults
Review (pp. 195–200)
Becker R, Berth A, Nehring M, et al.: Neurounus-
cular quadrecipis dysfunction prior to osteo-
Englund M, Roos EM, Lohmander LS: Impact of ••
type of meniscal tear on radiographic and symptomatic knee osteoarthritis - A sixteen-
Englund M: Meniscal tear - A feature of osteo-
Englund M, Lohmander LS: Risk factors for symp-
tomatic knee osteoarthritis fifteen to twenty-
Loeser RF, Shakoor N: Aging or osteoarthritis - ••
Thorstensson CA, Petersson IF, Jacobsson LTH, ••
von Porat A, Roos EM, Roos H: High prevalence of ••
osteoarthritis 14 years after an anterior cru-

Nutrition and osteoarthritis

Petchkrua W, Burns SA, Stiens SA, et al.: Preva-
Stokstad E: Nutrition - The vitamin D deficit. Sci-
Rehabilitation medicine in rheumatic diseases: Epidemiology


Therapeutic modalities in rehab


Nyland J, Nolan MF: Therapeutic modality: reha-


