OSTEOARTHRITIS PUBLIC HEALTH AGENDA:

INTERVENTION WHITE PAPER

PREPARED BY THE OSTEOARTHRITIS INTERVENTION WORKING GROUP

TABLE OF CONTENTS

SUMMARY OF RECOMMENDATIONS

The Osteoarthritis Intervention Working Group recommends widespread public health dissemination of the following effective interventions:

1. Low impact, moderate intensity aerobic **physical activity** and **muscle strengthening exercise** should be promoted widely as a public health intervention for adults with osteoarthritis of the hip and/or knee.
    - Adults with osteoarthritis should avoid physical inactivity and be encouraged to participate in any amount of low impact, moderate intensity aerobic and muscle strengthening activities as their abilities and condition allow.
    - Aerobic and muscle strengthening activity should be done in addition to daily activities.
2. Implementation of **self management education** (SME) should be expanded as a community-based intervention with supportive policies, tools, and evaluation and sustainability strategies that clarify relevant outcomes, define the effects, develop alternative modes of program delivery, and explore new venues and partnerships.
3. **Weight management** should be promoted for the prevention and treatment of OA, and **national nutrition and dietary guidelines** for the general population should be followed by adults with OA.
4. Policies and interventions that have been shown to reduce OA-related **joint injuries** should be implemented and enforced (e.g., breakaway bases at all levels of baseball and softball to prevent ankle injuries and motor vehicle safety laws).

We further recommend cautious implementation of several interventions that appear promising, accompanied by rigorous evaluation:

5. Evidence-based injury prevention strategies should be adopted in sports and recreation settings and motor vehicle occupant and pedestrian crashes, specifically:
    - **Neuromuscular conditioning programs for the prevention of ACL injuries**; and
    - **Environmental changes** such as pedestrian-traffic separation and bike lanes.

Lastly, we recommend an agenda for further prevention research:

Expanded research related to several intervention areas should be pursued to determine their effectiveness for widespread public health practice:

6. Describe the epidemiology of post-traumatic OA and evaluate potential **injury prevention** interventions to limit OA-related consequences.
7. Better understand the relationship between **body weight status** and the development and progression of knee OA.

8. Test the appropriate use of **biomechanical interventions** (e.g., patella taping, medial wedge orthotics for lateral tibiofemoral OA, and shock absorbing insoles)for individuals diagnosed with knee OA in public health settings to ascertain the feasibility of these interventions and their impact on disease outcomes and structural disease progression.

9. Determine the effect of selected **mind/body** interventions (e.g., tai chi and yoga) on relevant OA outcomes.

10. Describe the epidemiology of OA in the **workplace** and evaluate potential prevention and management interventions for OA among the workforce.

11. Examine the role of **dietary choices, nutrient and dietary supplementation**, as well as therapeutic use of supplements in the development and progression of OA symptoms and structural change.

In addition, given the modest effect of any single intervention to prevent OA and its consequences, an overarching study is recommended to:

12. Develop and perform **research on a combination of evidence-based interventions** to maximize the prevention of OA-associated structural damage, symptoms, activity limitation, reduced quality of life, and participation restriction for persons with knee OA and those at risk for knee OA.

OSTEOARTHRITIS PUBLIC HEALTH AGENDA

Intervention White Paper

INTRODUCTION

The Osteoarthritis Intervention Working Group was charged with developing and presenting a concise white paper on public health interventions for osteoarthritis that could serve as the basis for broad recommendations for public health action in the next 3-5 years. Members were chosen carefully to reflect relevant background, expertise, and experience in the application and use of available osteoarthritis prevention and treatment approaches – in both clinical and public health settings. Collectively, the Working Group represents such disciplines as: rheumatology, epidemiology, psychology, nursing, physical therapy, exercise physiology, nutrition, biomechanical engineering, occupational health, healthy aging, behavior change, and public health. A complete listing of Working Group members can be found in Attachment A.

The Working Group's first task was to identify and define key terms to establish a common vocabulary. Attachment B provides a full Glossary of terms; two fundamental to the Group's deliberations are:

> ***Osteoarthritis***: A joint disease caused by genetic, local mechanical stresses and systemic factors, and other unknown factors that lead to articular cartilage loss, boney overgrowth and other bone changes, and potential alterations in the ligaments, menisci, and muscles. Symptoms include joint pain, stiffness and weakness and poor function, which can be disabling and result in surgical joint replacement. Physical examination findings include boney swelling, crepitus, and loss of joint range of motion. Articular cartilage loss and bone changes can be detected by x-ray. MRI can assess the ligaments, menisci, and muscles as well. In clinical and epidemiologic studies, osteoarthritis is often defined by:
>
> 1) self-report of joint symptoms,
>
> 2) self-report of healthcare provider diagnosis,
>
> 3) radiographic findings, and/or
>
> 4) a combination of 2 or more of the above.
>
> For instance, in large epidemiologic surveys, self-report of joint symptoms can be used to identify those with "possible arthritis." However, to identify those with "osteoarthritis," a self-report of a healthcare provider's diagnosis of "osteoarthritis" might be required. Similarly, in clinical and epidemiologic studies that include x-ray assessments, "osteoarthritis" might be defined radiographically, but a definition of "symptomatic osteoarthritis" would also require the presence of self-reported symptoms.

> ***Public Health Intervention:*** An intervention (activity) that prevents disease, injury, or disability or promotes health in a group of persons. These interventions are distinguished from individual clinical interventions.

Drawing upon their wide range of expertise, members then generated a list of eleven intervention areas felt to hold promise for preventing osteoarthritis or reducing its public health burden.

INTERVENTION AREAS

Physical Activity	Biomechanics
Self Management Education	Mind/Body
Weight Management	Acupuncture
Nutrition	Early Diagnosis and Treatment
Injury Prevention	Environmental Modifications
Workplace	

METHODOLOGY

For each of the intervention areas, the Working Group evaluated the literature to describe available evidence and assess effectiveness as a public health intervention. Search terms for each of the intervention areas were developed by the Working Group and combined with a standardized search for osteoarthritis (see Attachment C). The literature searches were conducted by Centers for Disease Control and Prevention (CDC) librarians experienced in systematic literature searches and data retrieval; and were limited to English publications, from 1980 – 2008, and for adults aged 19 and older. They focused primarily on published systematic reviews and/or meta-analyses from the Cochrane database, Medline, and other comparable sources. For intervention areas where no systematic reviews or meta-analyses were identified through the literature search, "key" studies were selected for review by a sub-group of the full Working Group.

Each intervention area 'sub-group committee' examined the search results, applied inclusion/exclusion criteria, and selected final papers for review. The evaluation of this literature was considered a 'first pass' with the understanding that additional literature reviews and/or expert consultation might be needed. Several sub-groups used modified search strategies (e.g., injury prevention and occupational); details are provided in Attachment D for each relevant section. Studies were considered in aggregate and consensus judgments made as to the strength of the evidence, using an algorithm adapted from the *Physical Activity Guidelines Advisory Committee Report.* The adopted methodology was systematic but not intended to be comprehensive; rather, it emphasized utilization of systematic reviews and/or meta-analyses to be feasible within tight time constraints and available resources. The search results were then organized into data tables.

Working group members used the literature search results to address five questions:

1. What is the evidence regarding the effectiveness of this practice?
2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?
3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?
4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?
5. What more research is needed on this practice to address gaps in evidence?

FINDINGS

The results of the literature review evaluations for 10 of the intervention areas are summarized below. The literature for the remaining intervention, environmental modifications, was not considered sufficient to warrant analysis and is thus not included. More detailed analyses for each intervention, including citations for relevant references, can be found in Attachment D. Corresponding data tables are available upon request.

Physical Activity

There is overwhelming evidence to endorse low impact moderate intensity aerobic physical activity and muscle strengthening exercise as a public health intervention for adults with osteoarthritis of the hip and/or knee. Few studies have tested physical activity programs for OA in other joints. While the optimum dose has yet to be determined, improved pain, function and muscle strength have been noted with as little as 60 minutes per week of aerobic or muscle strengthening activity. In general, adults with osteoarthritis should avoid physical inactivity and be encouraged to participate in any amount of low impact moderate intensity aerobics that their abilities and condition allow. Aerobic and muscle strengthening activities should be in addition to their usual daily activities.

Different types of low impact aerobic activity (walking, water exercise, cycling, etc.) and muscle strengthening activity (isometric, isotonic and isokinetic) have been shown to benefit pain, function and muscle strength, and have been delivered in a variety of formats (home, group, individualized). No single type of activity or delivery format has been determined to be more effective than another. Exercise programs that have 12 or more supervised contact sessions with participants, regardless of delivery format, are likely more effective.

For most adults with mild to moderate OA, moderate intensity aerobic and muscle strengthening activities are safe and produce substantial health benefits. As such, most persons can self-initiate and monitor their activity without professional advice. However, persons with special issues (e.g., severe lower extremity malalignment, multiple co-existing chronic conditions) should consult with a health care professional before initiating physical activity.

AVERAGE EXERCISE PROGRAM COMPONENTS IN 24 RCTS OF ADULTS WITH ARTHRITIS

Aerobic Exercise Program Components

- Frequency: 3-5 days per week
- Duration: 20-60 minutes per session (total 120-180 minutes/week)
- Intensity: Moderate to vigorous (60-80% maximum heart rate)
- Type: Low impact

Muscle Strengthening Exercise Program Components

- Frequency: 2-3 days per week
- Duration: 8-12 repetitions; all major muscle groups
- Intensity: Moderate to vigorous (60-75% of 1 repetition maximum)
- Type: Isotonic/iometric/isokinetic

Source: The Physical Activity Guidelines Advisory Committee Scientific Report available at: http://www.health.gov/PAGuidelines/Report/pdf/CommitteeReport.pdf

Since some people may not have access or desire to participate in group exercise programs, expanding the delivery format options for effective physical activity programs for adults with OA may have the most public health impact. To achieve this, efficacious research intervention protocols need to be translated into effective 'packaged' programs that can be delivered in a variety of community-accessible formats (group classes, home-based, self-directed, etc.).

Self Management Education

There is sufficient evidence to support self management education (SME) as an effective public health intervention. While the effects of SME on pain and disability, as determined by meta-analyses, are small, these effects can be collectively large when evaluated on a population basis. Further, evidence suggests that these types of programs can produce mental health/psychological benefits such as reductions in anxiety, depression, and health distress. These benefits, along with the absence of side effects, make SME a valuable public health intervention and a useful adjunct to care delivered in a clinical setting.

To implement and sustain SME as a community-based intervention, certain tools, policies and evaluation strategies are recommended:

- Clarify which outcomes are most relevant for this intervention; a focus on traditional clinical outcomes (i.e., pain and disability) may overlook benefits in maintaining valued life roles and managing the emotional stress living with a chronic disease.
- Examine the effect of these programs, particularly as they are delivered in new populations, by collecting pre and post intervention data as programs establish widespread use.
- Develop alternative modes of program delivery, new venues of delivery, and new kinds of partnerships to support program delivery.
- Provide tools to support efficient and effective program implementation including, but not limited to, tools to guide an organization's decision to adopt a specific intervention program, foster quality improvement, engage participants in the organizational structure, calculate cost of program delivery, recruit participants, and support program implementers.

Weight Management

Many of the available studies have focused upon the impact of weight management on knee OA. Collectively, the findings of these studies suggest that modest weight loss results in meaningful improvements in clinically-relevant OA outcomes such as physical function, self-reported disability, pain symptoms, and quality of life. Indeed, findings in the literature consistently demonstrate that higher body mass index (BMI) is strongly associated with increased risk of developing knee OA. Conversely, however, evidence supporting the relationship between higher BMI and the *progression* of OA in the lower extremity joints presently remains equivocal. Thus, whereas there is strong evidence that higher BMI is linked with increased risk of incident knee OA, much less is known about the extent to which higher BMI may exacerbate the progression of OA in persons diagnosed with the disease. These findings underscore the potential public health importance of implementing appropriate weight management approaches in the prevention and treatment of OA.

Nutrition

Nutrition interventions include those related to day-to-day food choices and the resulting nutrient intake, as well as the use of dietary supplements, nutraceuticals and functional foods. There is growing recognition that factors related to nutrient intake and nutritional status may play a role in the development, progression, and management of OA. In addition, a wide range of supplements of food components, other botanicals and animal products are proposed to affect the OA disease process and outcome. Researchers are beginning to examine the role of dietary choices, nutrient and dietary supplementation, but current knowledge of the effects of every-day nutritient intake as well as therapeutic use of supplements on the pathogenesis and pathophysiology of OA is insufficient. Research to date has also not substantiated special dietary needs for people with OA. Many people with OA are also affected by or at risk of other chronic conditions through the effects of their condition or through lifestyle choices. Therefore, dietary recommendations for the general population should be followed by adults with OA, taking into account the broader relationships between diet and chronic disease prevention and management.

Current recognition that population recommendations for daily needs of Vitamin D are too low apply to people with OA as well. The role of Vitamin D in health and disease is currently an area of intense study and research is underway to better understand its role in bone and joint health beyond bone mineralization as well as its broader relationship to chronic disease risk. Recent studies suggesting that our recommendations for intake for Vitamin D are too low, issues with appropriate standards for measurement of Vitamin D, and the need to re-evaluate the kinetics of Vitamin D metabolism and assessment of toxicity levels make it difficult to make any recommendations beyond those recommending higher intakes for general health. Similarly, while there is evidence that omega-3 polyunsaturated fatty acids alleviate the progression of OA, there is insufficient information make recommendations specific to people with OA so the population recommendation to shift to foods rich in omega-3 polyunsaturated fatty acids to prevent other chronic conditions is also appropriate for people with OA. As the relationships between OA and other co-morbid chronic diseases with respect to overall management of health evolve, the relationships with regard to dietary recommendations and management with a holistic view of health promotion will become clearer.

Among dietary supplements, glucosamine and chondroitin are the most studied. The research has shown conflicting results and the quality of the studies with regard to design and duration make clear recommendations difficult. The most recently published results of the GAIT and STOPP trials, showing no clinically important effects of glucosamine compared to placebo and potential but not clear disease-modifying effects of chondroitin, provide the clearest results and suggest key research and methodological questions for further evaluation. Other supplements that have shown potential benefit but require additional investigation in order to make specific recommentations include avocado/soybean unsaponifiables and S-adenosylmethionine.

Injury Prevention

Prevention of incident OA through injury prevention is extremely complex because injuries happen during a variety of activities (sports and recreation, home and leisure, motor vehicle accidents, etc.), have different mechanisms (contact/noncontact, falls, etc.), and require interventions targeted to different entities (individual, communities, industry, etc.). Even within the sports and recreation domain, the same sport can be played with different rules and equipment at different levels of intensity (professional, collegiate, high school, community, sandlot, etc.), be governed by different organizations, and have different injury patterns. In addition, interventions deemed 'effective' may be difficult to disseminate in traditional public health settings due to lack of standardization of intervention components and underdeveloped infrastructure systems. Despite these challenges, several examples

of effective interventions for preventing OA-related injuries that occur primarily in sports and recreation settings show potential for public health adoption.

Neuromuscular Conditioning Programs

Given the impact of the acute anterior cruciate ligament (ACL) injury and the likelihood of OA development following ACL injury, primary prevention is the ideal goal. Neuromuscular conditioning programs have demonstrated effectiveness in reducing the risk of ACL injury in select settings. At present there are no published evaluations of these programs in a true public health setting. Nevertheless, given the impact of the injury and the effectiveness of these programs, their dissemination and implementation should be advocated.

A number of hurdles to implementation will need to be overcome: 1) no standardized program has been identified as "best practice"; 2) instructor training and dissemination infrastructures are highly variable; 3) one evaluated program is proprietary and has substantial training and licensing fees, while another is free but has no system to monitor fidelity; 4) national sport governing bodies and health/safety organizations have yet to endorse these programs; and 5) expected benefits depend upon an individual athlete's compliance to the prescribed program and compliance in some programs is low.

The importance of safe participation in physical activity for health promotion has been proactively addressed by the U.S. Department of Health and Human Services in the *2008 Physical Activity Guidelines for Americans*. Endorsement of neuromuscular conditioning programs for the prevention of ACL injury by health and safety organizations and sports governing bodies would help communities and schools recognize the need for broad implementation of these programs. In addition, a coordinated effort across multiple organizations, government, and individuals is essential for progress in this area to be realized.

Breakaway Bases

Ankle injuries are common and severe injuries can lead to OA. Because ankle OA is difficult to treat, primary prevention of OA-related ankle injuries should be a priority. An example of an intervention to reduce ankle injuries targeted to facilities andorganizations - not individuals - are breakaway bases. There is sufficient scientific evidence to support the use of breakaway bases in baseball and softball that release upon impact (e.g., breakaway, quick release, or impact bases) as a public health intervention. This intervention strategy has been evaluated across various levels of play (recreational, scholastic, intercollegiate, and professional), among different age groups, and among both males and females. Installation of breakaway bases may be slightly more expensive than stationary bases, but are still highly cost effective when compared to the cost of ankle injuries. In addition, use of these bases during game situations does not cause excessive delays in the length of game or complicate judgment calls by umpires.

Despite the availability of scientific evidence demonstrating the effectiveness of breakaway bases for almost 20 years, adoption of this intervention at the population level has been slow. In 2006, Little League Baseball instituted a policy requiring the use of breakaway bases on all fields to be effective January 1, 2008, but no other baseball or softball governing body has implemented similar mandatory policies. In addition, a Position Statement from the American Academy of Orthopedic Surgeons recommends use of breakaway bases at all levels of baseball and softball. Implementation and enforcement of policies mandating use of breakaway bases across all levels of baseball and softball could significantly expand reach of this effective intervention.

Motor Vehicle/Pedestrian Accidents

Motor vehicle-related injuries that can lead to OA are a result of frontal crashes, side impacts, and pedestrian/motor vehicle collisions. There is sufficient scientific evidence to support Interventions that prevent motor vehicle crashes in general (reducing alcohol-impaired driving, road design, traffic calming, etc.), as well as new automobile design and restraint systems (safety belt laws, airbags, etc.) that result in reduced rates and severity of injuries.

Workplace

Despite the heavy burden of OA on workers of every sector, no published studies could be found that describe or evaluate occupational interventions for OA. This gap presents considerable opportunity for investigators in occupational health to address underlying mechanisms and potential interventions for OA prevention and management. The implementation of effective interventions in the workplace could reduce pain and psychological anguish, improve productivity rates and morale, and decrease economic costs for employers.

Biomechanics

Several biomechanical interventions have been studied to determine their impact on reducing chronic knee pain and function among persons with symptomatic OA of the knee. They include: patella taping, osteotomy, knee bracing, lateral heel wedges, and canes. Of these interventions, only one – patella taping (when tape is applied to exert a medially-directed force on the patella) – has been shown to produce a clinically meaningful change in chronic knee pain and function with little risk. There is also some clinical evidence for the efficacy of other interventions:

- The use of medial heel wedges may be an appropriate low risk intervention in persons with symptomatic lateral tibiofemoral OA, as it provides salutary improvements in pain and function with little risk.
- The use of shock absorbing insoles and Masai Barefoot technology appears to be associated with small effects with little adverse impact.

At present, patella taping requires access to the health care system . Individuals would first need to be appropriately diagnosed with symptomatic knee OA. Once diagnosed, patella taping can be administered by a trained allied health practitioner. This practice is already widespread; however, further promotion of the taping technique and dissemination of the evidence supporting this intervention would be beneficial. Similarly, administration of the other interventions (wedges, insoles, and Masia Barefoot technology) requires involvement of a health professional to make an accurate diagnosis and recommend the appropriate intervention.

As of yet, none of these interventions has been tested in a public health setting nor is there any evidence that any of them have an effect on disease incidence or structural progression. Thus, before any of the interventions could be implemented and sustained on a community-based level, their efficacy in public health settings should be replicated and confirmed.

Mind/Body

Mind/body interventions focus on the interactions among the brain, mind, body, and behavior, and on the powerful ways in which emotional, mental, social, spiritual, and behavioral factors can directly affect health. Initial findings suggest selected mind/body interventions may result in favorable changes in some relevant clinical OA

outcomes for individuals burdened with OA. The efficacy of Tai Chi, the mind/body approach most studied, . Findings of trials on the efficacy of Tai Chi, the mind/body approach most studied, have been mixed but those studies yielding favorable results demonstrated that Tai Chi was associated with meaningful improvements in pain and physical function comparable to effect sizes accompanying other common self-management approaches such as NSAID use and exercise. These studies point to the potential benefit of this specific mind/body approach for OA patients. Nonetheless, evidence supporting this intervention remains too sparse to draw definitive conclusions regarding public health recommendations. In addition, appropriate conclusions regarding what outcomes should be targeted or individual differences that may determine which patients may benefit most from these approaches have yet to be adequately delineated.

Acupuncture

Evidence exists to support the use of acupuncture as a clinical intervention to reduce pain in knee osteoarthritis. No trials, however, have yet been published that study acupuncture as a public health intervention. As a result, no specific recommendations for its widespread use can be made at this time. Furthermore, public health related research does not seem warranted to address this evidence gap for a variety of important reasons: 1) the impact of acupuncture's effect on knee pain and function has not been reproducibly quantified; 2) no standard acupuncture regimen has been developed that could serve as a basis for dissemination; 3) the need for acupuncture to be given individually by healthcare providers or trained allied health practitioners may preclude population-based dissemination; and 4) the available supply of acupuncture practitioners cannot service the needs of the nation's population with OA.

Early Diagnosis and Treatment

At this time, there is no evidence supporting early diagnosis and treatment of osteoarthritis. While several risk factors have been identified that are associated with the onset and progression of knee OA (and to a lesser extent other joints affected by OA), no prevention research to date has proven that early diagnosis via screening coupled with alteration of these risk factors leads to better OA radiologic or clinical outcomes.

Screening and early treatment efforts would be greatly enhanced if valid and responsive markers of structural disease could be identified. Research on the efficacy of early treatment is hampered by the insensitivity to change of the standard x-ray which is currently the gold-standard for OA-related structural damage. Such markers would obviate this problem and could also be useful screening tools to detect early disease in those at risk for OA.

Overall

Individuals have various sets of determinants for the onset and/or progression of OA and will have varying responses to specific interventions noted above. In order to maximize the prevention of OA and its associated structural loss, symptoms, activity limitations, and participation restrictions, a combination of evidence-based interventions (e.g., physical activity, weight reduction, self-management education, and biomechanical interventions) should be considered and tested in population settings. This approach would be analgous to the Multiple Risk Factor Intervention Trial (MRFIT) undertaken to prevent coronary artery disease.

CONCLUSIONS

On the basis of these findings, the OA Intervention Working Group offers the following recommendations for a national public health agenda to reduce the burden of OA.

Interventions that have been proven effective and are ready for widespread public health dissemination

1. We recommend low impact, moderate intensity aerobic **physical activity** and **muscle strengthening exercise** as a public health intervention for adults with osteoarthritis of the hip and/or knee.
    - Adults with osteoarthritis should avoid physical inactivity and be encouraged to participate in any amount of low impact, moderate intensity aerobic and muscle strengthening activities as their abilities and condition allow.
    - Aerobic and muscle strengthening activity should be done in addition to daily activities.
2. We recommend expanded implementation of **self management education** (SME) as a community-based intervention with supportive policies, tools, and evaluation and sustainability strategies that clarify relevant outcomes, define the effects, develop alternative modes of program delivery, and explore new venues and partnerships.
3. We recommend **weight management** for the prevention and treatment of OA, and adherence by adults with OA to **national nutrition and dietary guidelines** for the general population.
4. We recommend Implementation and enforcement of policies and widespread dissemination of interventions that have been shown to reduce OA-related **joint injuries** (e.g., breakaway bases at all levels of baseball and softball to prevent ankle injuries and motor vehicle safety laws).

Interventions that appear promising and should be implemented with caution, accompanied by rigorous evaluation

5. We recommend the dissemination and implementation of evidence-based injury prevention strategies in sports and recreation settings and motor vehicle occupant and pedestrian crashes, specifically:
    - **Neuromuscular conditioning programs for the prevention of ACL injuries**
    - **Environmental changes such as pedestrian-traffic separation and bike lanes**

An agenda for further prevention research

Further clinical research to identify valid and responsive markers of OA structural damage would greatly facilitate many OA public health research initiatives. Both clinical and public health intervention research would be aided by a more efficient means of judging structural damage than the current gold standard, conventional x-rays. For instance, such markers would enhance research on **early diagnosis (screening) and treatment** as a public health intervention for OA, since a prerequisite for success of such research is the determination that early treatment can influence long-term outcomes such as a reduction of structural damage.

With regard to public health interventions, we call for expanded research related to several intervention areas to determine their effectiveness for widespread public health practice:

6. Describe the epidemiology of post-traumatic OA and evaluate potential **injury prevention** interventions to limit OA-related consequences.

7. Better understand the relationship between **body weight status** and the development and progression of knee OA.

8. Test the appropriate use of **biomechanical interventions** (e.g., patella taping, medial wedge orthotics for lateral tibiofemoral OA, and shock absorbing insoles)for individuals diagnosed with knee OA in public health settings to ascertain the feasibility of these interventions and their impact on disease outcomes and structural disease progression.

9. Determine the effect of selected **mind/body** interventions (e.g., tai chi and yoga) on relevant OA outcomes.

10. Describe the epidemiology of OA in the **workplace** and evaluate potential prevention and management interventions for OA among the workforce.

11. Examine the role of **dietary choices, nutrient and dietary supplementation**, as well as therapeutic use of supplements in the development and progression of OA symptoms and structural change.

In addition, we recommend an overarching study to:

12. Develop and perform **research on a combination of evidence-based interventions** to maximize the prevention of OA-associated structural damage, symptoms, activity limitation, reduced quality of life, and participation restriction for persons with knee OA and those at risk for knee OA.

While additional research to better define the role of **acupuncture** as a clinical intervention for OA appears justified, further research on the implementation of acupuncture as a *public health* intervention for OA is not warranted at present, given its reliance on a small number of qualified practitioners among other challenges to wider dissemination. A full public health research agenda can be found in Attachment E.

ATTACHMENT A

Working Group Members

Co-Chairs

Leigh F. Callahan, PhD
Associate Professor, Medicine,
Orthopaedics, and Social Medicine
Thurston Arthritis Research Center
3300 Thurston Building, CB 7280
University of North Carolina
Chapel Hill, NC 27599
Ph: 919-966-0564
Fax: 919-966-1739
Leigh_Callahan@med.unc.edu

Rowland W. Chang, MD, MPH
Professor of Preventive Medicine,
Medicine, and Physical Medicine and
Rehabilitation
Northwestern University
Feinberg School of Medicine
680 N. Lake Shore Drive, Suite 1102
Chicago, IL 60611
Voice phone: 312-503-2952
Voice mail: 312-908-5300
Fax: 312-908-9588
rwchang@northwestern.edu

Members

Lynda A. Anderson, PhD
Director, Healthy Aging Program
Division of Adult and Community Health
(MS K45)
National Center for Chronic Disease
Prevention and Health Promotion
Coordinating Center for Health Promotion
Centers for Disease Control and Prevention
770-488-5360 (Healthy Aging Program)
770-488-5998 (Direct line)
LAA0@cdc.gov

Basia Belza, PhD, RN
The Aljoya Endowed Professor in Aging
Professor, School of Nursing
Adjunct Professor, Health Services
Box 357266
University of Washington, Seattle, WA
98195-7266
Ph: 206-685-2266
basiab@u.washington.edu

Teresa J. Brady, PhD
Senior Behavioral Scientist, Arthritis
Program
Centers for Disease Control and Prevention
4770 Buford Hwy NE MS K-51
Atlanta GA 30341
Ph: 770-488-5856
Fax: 770-488-5486
tob9@cdc.gov

Brian C. Focht, PhD, CSCS, FACSM
Department of Health, Nutrition, and
Exercise Science
University of Delaware
13 Carpenter Sports Building
Newark, DE 19716
Ph: 302-831-1014
bfocht@udel.edu

Jennifer M. Hootman PhD, ATC, FACSM
Epidemiologist - Arthritis Program
Division of Adult and Community Health
National Center for Chronic Disease
Prevention and Health Promotion
Centers for Disease Control and Prevention
Atlanta, GA 30341
Ph: 770-488-6038
Fax: 770-488-5486
jhootman@cdc.gov

David J. Hunter
Chief, Division of Research
New England Baptist Hospital
125 Parker Hill Ave
Boston MA 02120.
Ph: 617-754-6655
Fax: 617-754-5728
djhunter@caregroup.harvard.edu

Lore Jackson Lee, MPH
Healthy Workplaces Goal Team Leader
Centers for Disease Control and Prevention
1600 Clifton Rd, NE
Mailstop E-20
Atlanta, GA 30333
Ph: 404-498-2589
Fax: 404-498-2510
laj2@cdc.gov

John Hayes Mason, PhD
Senior Director: Performance Measurement Evaluation
Blue Cross Blue Shield of Massachusetts
Landmark Center
401 Park Drive
Boston, MA 02215-3326
Ph: 617-246-4909
Fax: 617-246-4915
John.Mason@bcbsma.com

Marian A. Minor, PT, MSPH, PhD
Professor and Chair
Department of Physical Therapy
School of Health Professions
106 Lewis Hall
University of Missouri
Columbia, MO 65211
Ph: 573-882-7103
Fax: 573-884-8369
minorm@health.missouri.edu

Albert E. Munson, PhD
Director, Health Effects Laboratory Division
National Institute for Occupational Safety and Health
1095 Willowdale Road
MS 4020
Morgantown, WV 26505
Ph: 304-285-6121
Fax: 304-285-6126
AMunson@cdc.gov

W. Jack Rejeski
Wake Forest University
Dept of HES, Box 7868
Winston-Salem, NC 27109
Ph: 336-758-5837
Fax: 336-758-3390
rejeski@wfu.edu

Laura Robbins, DSW
Vice President, Education & Academic Affairs
Associate Scientist, Research Division
Associate Professor, Weill Medical College
Hospital for Special Surgery
535 East 70th Street
New York, New York 11215
Ph: 212-606-1057
robbinsl@hss.edu

Nancy Whitelaw, PhD
Director, Center for Healthy Aging
Senior Vice President
National Council on Aging
1901 L St NW, 4th Floor
Washington, DC 20036
www.healthyagingprograms.org

Pamela Van Zyl York, MPH, PhD, RD, LN
Division of Health Promotion and Chronic Disease
Street address (use for courier or fed ex delivery)
85 East Seventh Place Suite 220
St. Paul, Minnesota 55101
Mailing address:
P.O. Box 64882
St. Paul, Minnesota 55164-0882
Ph: 651-201-3616
Fax: 651-201-5800
pam.york@state.mn.us

ATTACHMENT B

Glossary

Acupuncture: A family of procedures involving the stimulation of anatomical points on the body using a variety of techniques. The acupuncture technique that has been most often studied scientifically involves penetrating the skin with thin, solid, metallic needles that are manipulated by the hands or by electrical stimulation.

Source: Adapted from the National Center for Complementary and Alternative Medicine website http://nccam.nih.gov/

Depressed Affect: A syndrome or cluster of symptoms that reflect a sad mood. Common symptoms include feeling worthless, irritability, sadness, crying, and fatigue.

Source: Beck AT, Steer RA, Brown GK. Beck Depression Inventory-II Manual. New York: The Psychological Corporation, 1996.

Depression: A common mental disorder that presents with depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy, and poor concentration. These problems can become chronic or recurrent and lead to substantial impairments in an individual's ability to take care of his or her everyday responsibilities.

Source: http://www.who.int/mental_health/management/depression/definition/en/

***Dietary Supplement*:** Defined by Congress in the Dietary Supplement Health and Education Act (DSHEA) of 1994, a dietary supplement is a product taken by mouth that contains a "dietary ingredient" intended to supplement the diet. The "dietary ingredients" in these products may include: vitamins, minerals, herbs or other botanicals, amino acids, and substances such as enzymes, organ tissues, glandular, and metabolites. Dietary supplements can also be extracts or concentrates, and may be found in many forms such as tablets, capsules, softgels, gelcaps, liquids and powders.

Source: US Food and Drug Administration, Center for Food Safety and Applied Nutrition, January 3, 2001. http://www.cfsan.fda.gov/~dms/ds-overview.html#what.

Disability: A medical condition that captures impairments, activity limitations, and participation restrictions in an individual's daily life. Traditionally, disability measures have been limited to activity and participation restrictions under the following 3 categories: a) *basic activities of daily living* including tasks such as toileting, getting in and out of bed and dressing oneself; b) *mobility* or the ability to transport oneself from one location to another using lower extremity function; and c) *instrumental activities of daily living* that involve more complex abilities related to participation in social roles such as doing light house work, visiting relatives, or being able to care for a family member. Disability can be assessed using both self-report and performance based measures.

Source: The ICF web site http://www.who.int/classifications/icf/en/ and Katz, S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. JAGS 1983;31:721-727.

Disability Concepts in International Classification of Functioning, Disability and Health (ICF) Model:

Impairment*:* Problems in body function or structure, such as a significant deviation or loss

Activity limitations: Difficulties that an individual may have in executing activities

Participation restriction*:* Problems that an individual may experience in involvement in life situations

Source: The Future of Disability in America, Committee on Disability in America Board on Health Sciences Policy Marilyn J. Field and Alan M. Jette, Editors, Institute of Medicine of the National Academies, The National Academies Press, Washington, DC, 2007. http://www.nap.edu/catalog.php?record_id=11898

Effectiveness: Improvement in health or behavioral outcome produced by an intervention in a community setting.

Source: The Community Guide to Preventive Health Services http://www.thecommunityguide.org/

Enrichment: Synonymous with fortification and refers to the addition of nutrients to a food irrespective of whether the nutrients were originally in the food before processing or not.

Source: Allen, L, de Benoist, B, Dary, O, and Hurrell, R, editors. Guidelines on food fortification with micronutritients. World Health Organization, Food and Agricultural Organization of the United Nations. 2006.

Environmental Modifications: Adaptations to homes, schools, worksites, communities, and neighborhoods to accommodate physical limitations and disability due to arthritis. These modifications include things such as ramps, grab bars, smooth walkways, and wheelchair assessable doors.

Essential Nutrient: Any nutrient which is needed for growth and development and the maintenance of healthy life that is normally consumed as a constituent of food and cannot be synthesized in adequate amounts by the body.

Source: Allen, L, de Benoist, B, Dary, O, and Hurrell, R, editors. Guidelines on food fortification with micronutritients. World Health Organization, Food and Agricultural Organization of the United Nations. 2006.

Evidence-based Method: A strategy for explicitly linking public health or clinical practice recommendations to the underlying scientific evidence that demonstrates effectiveness.

Source: The Community Guide to Preventive Health Services http://www.thecommunityguide.org/

Exercise: *A* subcategory of physical activity that is "planned, structured, and repetitive and purposive in the sense that the improvement or maintenance of one or more components of physical fitness is the objective."

Source: 2008 Physical Activity Guidelines for Americans. Washington, DC: U.S. Department of Health and Human Services, 2008. Available at http://www.health.gov/paguidelines/guidelines/glossary.aspx

Fortification: The practice of deliberately increasing the content of an essential nutrient in a food so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.

Mandatory fortification occurs when governments legally oblige food producers to fortify particular foods with specified nutrients. **Voluntary fortification** occurs when a food manufacturer freely chooses to fortify a particular food in response to permission given in food law, or under special circumstances, is encouraged by government to do so.

Source: Allen, L, de Benoist, B, Dary, O, and Hurrell, R, editors. Guidelines on food fortification with micronutritients. World Health Organization, Food and Agricultural Organization of the United Nations. 2006.

***Functional Foods*: C**omponents of the usual diet that may have special disease prevention attributes. They include any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains.

Source: Halsted, CH, Dietary supplements and functional foods: 2 sides of a coin. Am J Clin Nutr 2003;77(suppl):1001S-7S.

Health-related Quality of Life: Quality of life (QOL) is a term that conveys an overall sense of well-being, including aspects of happiness and satisfaction with life as a whole. Health is an important domain of overall quality of life. Other domains that contribute to QOL include jobs, housing, schools, and the neighborhood as well as aspects of culture, values, and spirituality. Health-related QOL (HRQOL) encompasses aspects of overall QOL that have been shown to affect physical or mental health.

Source: Adapted from Centers for Disease Control and Prevention. Measuring Healthy Days. Atlanta, Georgia: CDC, November 2000.

Mind-Body Interventions: Interventions focused on the interactions among the brain, mind, body, and behavior, and on the powerful ways in which emotional, mental, social, spiritual, and behavioral factors can directly affect health. Examples of mind-body interventions include relaxation, hypnosis, visual imagery, meditation, yoga, biofeedback, tai chi, qigong, cognitive-behavioral therapies, group support, autogenic training, and spirituality.

Source: Adapted from the National Center for Complementary and Alternative Medicine website http://nccam.nih.gov/

Neuromuscular Conditioning Program: A specific-exercise program that "teaches" proper body mechanics to aid in lower extremity stability designed to reduce the risk of some musculoskeletal injuries (e.g., ACL injuries). No standardized program exists, but the following 4 components are considered essential: 1) muscle strengthening; 2) plyometrics (jump training); 3) balance exercises; and 4) proper technique coaching.

Source: Hewett,Te, Ford KR, Myer GD. Anterior cruciate ligament injuries in female athletes, Part 2: A meta-analysis of neuromuscular interventions aimed at injury prevention. Am J Sports Med, 2006;34(3):490-8.

***Nutraceuticals*:** Substances produced in a purified or extracted form that are administered orally to provide or stimulate production of raw materials required for normal bodily functions. A nutraceutical is effectively, any substance that is a food, or part of a food, that provides medical or health benefits, including prevention and treatment of disease. They may be distinguished from functional foods in that they are the natural bioactive chemical compounds derived from whole foods and available in a non-food matrix.

Sources: Goggs, R, Vaughan-Thomas, A, Clegg, PD, et. al. Nutraceutical Therapies for Degenerative Joint Diseases: A Critical Review. Critical Reviews in Food Science and Nutrition, 45:145-164, 2005.

Ameye, LG, and Chee, WSS. Osteoarthritis and nutrition. From nutraceuticals to functional foods: a systematic review of the scientific evidence. Arthritis Research and Therapy, 2006, 8:R127.

Obesity: A chronic medical condition that is characterized by excessive body weight. As defined by body mass index (BMI), Class I obesity is a BMI of 30.0 – 34.9; Class II obesity is a BMI of 35.0 – 39.9, whereas Class III obesity is a BMI of 40+.

Source: National Heart, Lung, and Blood Institute (NHLBI). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report. Obesity Research 1998: 6:51S209S.

Osteoarthritis: A joint disease caused by genetic, local mechanical stresses and systemic factors, and other unknown factors that leads to articular cartilage loss, boney overgrowth and other bone changes, and potential alterations in the ligaments, menisci, and muscles. Symptoms include joint pain, stiffness and weakness which can be disabling and result in surgical joint replacement. Physical examination findings include boney swelling and loss of joint range of motion. Articular cartilage loss and bone changes can be detected by x-ray. MRI can assess the ligaments, menisci, and muscles as well. In clinical and epidemiologic studies, osteoarthritis is often defined by:

1) self-report of joint symptoms,

2) self-report of healthcare provider diagnosis,

3) radiographic findings, and/or

4) a combination of 2 or more of the above.

For instance, in large epidemiologic surveys, self-report of joint symptoms can be used to identify those with "possible arthritis." However, to identify those with "osteoarthritis," a self-report of a healthcare provider's diagnosis of "osteoarthritis" might be required. Similarly, in clinical and epidemiologic studies that include x-ray assessments, "osteoarthritis" might be defined radiographically, but a definition of "symptomatic osteoarthritis" would also require the presence of self-reported symptoms.

Source: Moskowitz, RW, Altman, RD, Buckwalter, JA, Goldberg, VM, Hochberg, MC. Osteoarthritis: Diagnosis and medical/surgical management. 4th ed. Lippincott Williams & Wilkins (LWW), 2007.

Overweight: Excessive body weight with a body mass index (BMI) of 25 to 29.9.

Source: National Heart, Lung, and Blood Institute (NHLBI). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report. Obesity Research 1998: 6:51S209S.

Pain: *A* sensory and emotional experience of discomfort. It is usually associated with actual or threatened tissue damage and is influenced by cognitive processes as well as the social and cultural context in which it is embedded.

Source: Sarafino, EP. Health psychology: Biopsychosocial interactions. New York: John WILEY & Sons, 1994.

Physical Activity: Any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level. Among the ways physical activity can be categorized is according to mode, intensity, and purpose.

Mode: The type of activity or exercise that is being performed. Biking, walking, rowing, and weight lifting are all examples of different modes of activity.

Frequency: The number of times an exercise or activity is performed. Frequency is generally expressed in sessions, episodes, or bouts per week.

Intensity: How much work is being performed or the magnitude of the effort required to perform an activity or exercise.

Purpose: The context in which physical activity is performed. Commonly used categories include occupational, leisure-time or recreational, household, self-care, and transportation or commuting activities. In some studies, sports participation or "exercise training" is assessed and analyzed separately from other leisure-time activities.

Source: 2008 Physical Activity Guidelines for Ameri cans.. Washington, DC: U.S. Department of Health and Human Services, 2008. Available at http://www.health.gov/paguidelines/guidelines/glossary.aspx

Prevention

***Primary prevention*:** Identifying factors that increase the risk of osteoarthritis and intervening to reduce the occurrence of osteoarthritis

***Secondary prevention*:** Screening and utilizing other means to assure early diagnosis and treatment of osteoarthritis (perhaps even before it becomes symptomatic) to prevent subsequent pain and disability associated with osteoarthritis.

Tertiary prevention: Utilizing interventions, including medical and self-management strategies, to limit the long term impact of pain, disability and other effects of the disease once it is established.

Source: National Arthritis Action Plan http://www.arthritis.org/naap.php#prevention

Public Health Intervention: An intervention (activity) that prevents disease, injury, or disability or promotes health in a group of persons. These interventions are distinguished from individual clinical interventions.

Source: Adapted from The Community Guide to Preventive Health Services http://www.thecommunityguide.org/

Public Health Practitioners: Persons responsible for providing public health services to groups of individuals in a variety of settings, such as public health agencies, managed care plans, community health centers, and academic institutions. Persons who occasionally contribute to public health activities in the course of fulfilling other responsibilities are not included under this term.

Source: The Community Guide to Preventive Health Services http://www.thecommunityguide.org/

Self Management: The tasks that the individuals must undertake to live well with one or more chronic conditions. These tasks include having the confidence to deal with medical management, role management, and emotional management of their conditions.

Source: Adams K, Greiner AC, Corrigan JM. (Eds) Report of a summit. The 1st annual crossing the quality chasm summit—A focus on communities. 2004. Washington DC National Academies Press.

Self Management Education: Interactive educational interventions specifically designed to enhance patient self-management. Self-management education is patient driven and focuses on building generalizable skills such as goal setting, decision making, problem solving, and self-monitoring.

Source: Adapted from Chapter on Self Management Education and Support from the Clinical Care in the Rheumatic Diseases

Self Management Support: The systematic provision of education and supportive interventions by health care or other providers to strengthen patients' skills and confidence in managing their health problems; includes regular assessment of progress and problems, goal setting, and problem solving support

Source: Adapted from Adams K, Greiner AC, Corrigan JM. (Eds) Report of a summit. The 1st annual crossing the quality chasm summit—A focus on communities. 2004. Washington DC National Academies Press.

Therapeutic Exercise: The purposeful interaction of the patient/client with an appropriately trained health professional that includes examination and evaluation resulting in an individualized plan for systematic performance of physical movements, postures or activities intended to: a) remediate or prevent impairments, b) enhance function, c) reduce risk, and d) optimize overall health and fitness.

Source: Adapted from Guide to Physical Therapist Practice, Second Edition. Phys Ther 81: 1, January 2001.

Weight Management: The adoption of healthful and sustainable eating and exercise behaviors indicated for reduced disease risk and improved feelings of energy and well-being in order to achieve the best weight possible in the context of overall health. This concept recognizes that not all people need to lose weight, people at a healthy weight should strive to maintain their weight, and underweight individuals may need to increase their weight. General goals for weight management for those who are overweight or obese include: reduce body weight, maintain a lower body weight over the long term, and prevent further weight gain (a minimum goal).

Source: U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary Guidelines for Americans 2005. 6th Edition, Washington, DC. US Government Printing Office, January, 2005 and www.healthierus.gov/dietaryguidelines HHS Publication number: HHS-ODPHP-2005-01-DGA-A.

http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/nutrition_5417_ENU_HTML.htm

Workplace Intervention: A method (or methods) used in the workplace that is designed to reduce the incidence or severity of osteoarthritis in that given occupational group.

ATTACHMENT C

Literature Review Search Strategy

Due to very tight time constraints, the literature search strategy used to review the literature on the 10 chosen areas of interventions will need to be systematic, but feasible. To best use the time of the work group, a 3 phase search strategy has been proposed:

1. Search Cochrane database for systematic reviews that may inform any of the 10 intervention categories
2. Search Medline for other published systematic reviews for each of the 10 intervention areas; if no reviews available, then search other study designs
3. Conduct systematic searches using a standardized search strategy

Inclusion/Exclusion criteria for each intervention category need to be developed to apply to the search results.

Following 3 search strategies should be used for all intervention area searches.

The Interventions are:

1. Physical activity
2. Self-management education
3. Weight control
4. Injury prevention
5. Mind/body activities (meditation,)
6. Acupuncture
7. Nutritional Interventions (fortification, natural supplements, nutriceuticals)
8. Environmental modifications
9. Occupation/workplace accommodations
10. Early diagnosis and early treatment
11. Biomechanical interventions

Priority Interventions:

1. Self-management education
2. weight control
3. Injury prevention

****

1. Standard search strategy for OA (this is the strategy Reba Norman, CDC librarian, created for osteoarthritis for the Physical Activity Guidelines Advisory Group)

*osteoarthritides/ OR *osteoarthrosis/ OR *Osteoarthroses/ OR *Arthritis, Degenerative/ OR *Arthritides, Degenerative/ OR *Degenerative Arthritides/ OR *Degenerative Arthritis/ OR *Osteoarthrosis Deformans
AND
arthroplasty/
AND
exp osteoarthritis/

****

2. Standard search strategy for Review/SR/MA (from National Library of Medicine)

(systematic review [ti] OR meta-analysis [pt] OR meta-analysis [ti] OR systematic literature review [ti] OR (systematic review [tiab] AND review [pt]) OR consensus development conference [pt] OR practice guideline [pt] OR cochrane database syst rev [ta] OR acp journal club [ta] OR

health technol assess [ta] OR evid rep technol assess summ [ta])
OR
((evidence based[ti] OR evidence-based medicine [mh] OR best practice* [ti] OR evidence synthesis [tiab])
AND
(review [pt] OR diseases category[mh] OR behavior and behavior mechanisms [mh] OR therapeutics [mh] OR evaluation studies[pt] OR validation studies[pt] OR guideline [pt]))
OR
((systematic [tw] OR systematically [tw] OR critical [tiab] OR (study selection [tw])

3. Standard search limits for all searches

Language: English
Date range: 1980 – 2008
Age groups: Humans, adults 19+ years
International studies can be included
****

Intervention Search Terms

1. Physical Activity (this is the strategy Reba Norman, CDC librarian, created for physical activity/exercise for the Physical Activity Guidelines Advisory Group)

***Please search for articles before 1995 and after 2008 only for physical activity*

*motor activity/ or *exercise/ or *exertion/
AND
exp *leisure activities/ or *energy metabolism/ or *physical endurance/ or "physical education and training"/
AND
*anaerobic threshold/ or *tai ji/ or *yoga/

2. Self Management Education
self management
self management education
patient education
arthritis education
psycho-educational interventions
behavioral interventions
behavior change interventions
self care
self help
self management training
patient empowerment

3. Weight Control
exp weight loss (MeSH)/ or exp body weight (MeSH)/ or exp overweight/ or exp obesity/ or body mass index/ or skinfold thickness/ or waist-hip ratio/ or bmi.tw. or obes$.tw. or weight$.hw,tw. or body fat.tw. or overweight.mp/ or exp diet/ or exp diet therapy
OR
(diet$ or nutrition$ or food$).hw,tw AND (reduc$ or restrict$ or decreas$ or limit$).hw.tw
NOT
surgery (subheading) OR drug therapy (subheading)

(Exclusions: drug/pharmaceutical treatments for obesity and surgical treatment for obesity)

4. Injury Prevention
"Dislocations"[Mesh] OR "Athletic Injuries"[Mesh] OR "Fractures, Bone"[Mesh] OR "Fractures, Cartilage"[Mesh] OR "Hand Injuries"[Mesh] OR "Hip Injuries"[Mesh] OR "Leg Injuries"[Mesh] OR "Neck Injuries"[Mesh] OR "Soft Tissue Injuries"[Mesh] OR "Spinal Injuries"[Mesh] OR "Sprains and Strains"[Mesh:NoExp]
AND
"Cartilage"[Mesh] OR "Ligaments, Articular"[Mesh] OR "Skeleton"[Mesh]
AND
"prevention and control "[Subheading] OR "Primary Prevention"[Mesh] OR "Accident Prevention"[Mesh]

5. Mind/Body Activities (meditation)
mind-body medicine, relaxation, hypnosis, visual imagery, meditation, yoga, biofeedback, tai chi, qi gong, cognitive-behavioral therapies, group support, autogenic training, spirituality.

6.Acupuncture
acupuncture

7. Nutritional Interventions
dietary supplements, nutritional supplements, supplements

8. Environmental Modifications
built environment
physical environment
community characteristics
neighborhood characteristics
community infrastructure
neighborhood infrastructure
man-made environment
residential context residential community context

9. Occupation/Workplace Accommodations
workplace/worksite; job; jobsite; employment... accommodation
workplace/worksite; job; jobsite; employment; equipment... modification
universal design
ergonomics
ergonomic design

with a lesser focus on:
worksite health; worksite health promotion; worksite health intervention; worksite health program; worksite & health, etc...

10. Early Diagnosis and Early Treatment
early diagnosis, early intervention, screening, prevention and control.

11. Biomechanical Interventions
patella taping or bracing
osteotomy
braces
orthoses
orthotics
heel wedge
shoes
cane

ATTACHMENT D

Intervention Literature Review Evaluations

ACUPUNCTURE

1. What is the evidence regarding the effectiveness of this practice?

Since 2006, there have been 2 systematic qualitative reviews[1,3] and 2 meta-analyses[2,4] that discuss in aggregate 16 randomized controlled trials of various acupuncture protocols performed on more than 1200 subjects with knee osteoarthritis compared with usual care, no care, or a sham procedure. These RCTs were published between 1988 and 2006. In general, studies which compare acupuncture to no care indicate effectiveness of the procedure in reducing pain and improving function. The effects are smaller for studies comparing acupuncture to usual care and very small or not significant in studies comparing acupuncture to a sham procedure.

One meta-analysis cited 3 RCTs of acupuncture in less than 90 subjects with hip OA and 1 RCT of acupuncture in 6 subjects with thumb OA.[4] The evidence supporting acupuncture for hip and thumb OA was judged to be sparse and weak.

There have been no public health trials which have utilized acupuncture as an intervention.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

While there may be evidence to support the use of acupuncture as a clinical intervention in knee OA, the workgroup concluded that there is not sufficient evidence to support this practice as a public health intervention. Major reasons for this conclusion are: 1) the uncertainty of how large acupuncture's effect on pain and function was, 2) the need for acupuncture to be given individually precluding more population-based dissemination, 3) the lack of a standard acupuncture regimen that could serve as a basis for dissemination, and 4) the lack of acupuncture practitioners to service the needs of the population with OA.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Not applicable

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Not applicable

5. What more research is needed on this practice to address gaps in evidence?

While further research may be helpful in better defining what acupuncture protocol is most helpful in treating individual patients with OA, the committee concluded that because of the large barriers discussed above, further public health related research would not be useful in addressing gaps in public health related evidence.

References

1. Selfe TK, Taylor AG. Acupuncture and osteoarthritis of the knee: A review of randomized, controlled trials. *Fam Community Health* 2008;31:247–254.
2. Manheimer E, Linde K, Lao L, Bouter LM, Berman BM. Meta-analysis: Acupuncture for osteoarthritis of the knee. *Ann Intern Med* 2007;146:868-877.
3. White A, Foster N, Cummings M, Barlas P. The effectiveness of acupuncture for osteoarthritis of the knee – a systematic review. *Acupuncture Med* 2006;24(Suppl):S40-48.
4. Kwon YD, Pittler MH, Ernst E. Acupuncture for peripheral joint osteoarthritis: A systematic review and meta-analysis. *Rheumatology* 2006;45:1331–1337.

BIOMECHANICAL INTERVENTIONS

1. What is the evidence regarding the effectiveness of this practice?

Osteotomy: A systematic review investigated realignment osteotomy in persons with uni-compartmental knee OA with malalignment.[1] It examined various osteotomy operative techniques but did not address the efficacy of realignment osteotomy, instead comparing various osteotomy operative techniques. The review concluded that there is limited evidence of the efficacy of osteotomy.

Patella taping: One systematic review and meta-analysis examined the use of patella taping among persons with symptomatic OA of the knee.[2] The review concluded there was evidence that tape applied to exert a medially-directed force on the patella produces a clinically meaningful change in chronic knee pain. The effect size for VAS pain on movement at 3 weeks from the Hinman trial[3] was 0.35 (-0.03 to 0.73).

Knee bracing: Based on one meta-analysis[4] of two RCTs examining the use of braces among persons with medial tibiofemoral knee OA there is limited evidence for the effectiveness of knee braces. The effect size for VAS pain at 6 months was 0.05 (-0.32 to 0.41).

Heel wedges: One meta-analysis[4] and a systematic review[5] found limited evidence for the effectiveness of lateral heel wedges for medial tibiofemoral OA. The effect size for WOMAC pain at 6 months was -0.32 (-0.63 to 0.00). A recent RCT found evidence of an effect of medial wedges for lateral tibiofemoral OA.[6]

Insoles, shoes: Barefoot walking[7,8] and a shoe simulating barefoot mobility[9] have been shown to reduce knee loads. Shoes with moderately high heels (1.5 in) significantly increase knee torques thought to be relevant in the development and/or progression of knee OA.[10] Toe out positioning[11] and shoes with variable-stiffness[12] can reduce medial compartments loading. Shock absorbing insoles[13] and Masai Barefoot Technology (MBT) shoe[14] can reduce pain in subjects with symptomatic knee OA.

Cane: Whilst canes, forearm crutches and walkers are frequently used in clinical practice and recommended in guidelines the evidence to support their efficacy is limited. There is evidence that the use of a cane in the hand contralateral to the knee affected reduces medial knee loading.[8,15] There is no data from well designed trials supporting their efficacy in reducing symptoms of OA.

In sum many of these interventions have good biomechanical data to support their efficacy but not enough clinical data on relevant outcomes.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Based upon current literature there is insufficient evidence to endorse the more widespread practice of osteotomy, knee bracing, lateral heel wedges, and canes as public health interventions. In contrast there is good evidence that would support further use of patella taping however this at present requires administration by a trained health professional so that more widespread dissemination of this intervention as a public health intervention is limited. There is also some clinical evidence for the efficacy of medial wedge orthotics for lateral tibiofemoral OA, shock absorbing insoles and Masai Barefoot technology that warrants replication before more widespread use. Similar to the caveat for patella taping administration of these interventions would at present require a health professional be involved to make the appropriate diagnosis, and to give the recommendation of the appropriate intervention for this diagnosis.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

At present the effectiveness of the aforementioned interventions in a public health setting has been tested. Any comments pertaining to these interventions and their recommendations thus should be framed in the light that at present they are being delivered by health professionals. The following comments are delivered with this perspective in mind.

- The use of medial directed patella taping leads to clinically important effects on pain and function with little risk.
- The use of medial heel wedges may be an appropriate low risk intervention in persons with symptomatic lateral tibiofemoral OA. It provides salutary improvements in pain and function with little risk.
- The use of shock absorbing insoles and Masai Barefoot technology appears to be associated with small effects with little adverse effect.

There is no evidence that any of these interventions have an effect on disease incidence or structural progression in the presence of prevalent disease.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Before any of the interventions could be implemented and sustained as a community based intervention there is a need for the prior efficacy results to be replicated first in this setting before recommending widespread use.
In order to facilitate use of patella taping a person would first have to be appropriately diagnosed with symptomatic knee OA. Once diagnosed the intervention can be administered by a trained physical therapist. This practice is already widespread however further promotion of the taping technique and dissemination of the evidence supporting this intervention would be recommended.

Of the interventions with less substantive data to warrant their more widespread implementation the following recommendations would be applicable. In order to facilitate use of medial heel wedges a person

would first have to be appropriately diagnosed with symptomatic lateral tibiofemoral OA. Once diagnosed the intervention can be administered by a trained podiatrist.

The use of shock absorbing insoles and Masai Barefoot technology could be instituted commercially once the condition is diagnosed.

5. What more research is needed on this practice to address gaps in evidence?

The pivotal importance of mechanical factors to OA symptoms and progression are undeniable. Whereas evidence of the benefits of biomechanical interventions for OA patients continues to grow, there are several areas relevant to this topic that warrant future inquiry. First and foremost the effectiveness of the interventions that have demonstrated efficacy (patella taping, medial wedge orthotics for lateral tibiofemoral OA, shock absorbing insoles and Masai Barefoot technology) needs to be tested in a public health setting. For the most part these interventions carry little risk but it is unclear if their administration on a broader public scale is effective or practical. Many of these interventions could be administered quite feasibly with little or no health care professional instruction such as shock absorbing insoles.

There is now substantial data suggesting that certain interventions such as barefoot walking, canes, soft orthoses and modified shoes have important effects on mechanical loading. Similarly there is some data suggesting that high heeled shoes increase mechanical loading. Whilst there is a substantive biomechanical literature there is little if any data from clinical trials assessing the efficacy of these interventions for either symptom relief in the presence of OA, or in impacting disease incidence. Many/ most of these interventions entail little risk and potentially have substantive efficacy if appropriately trialed.

There is already some data supporting the efficacy of shock absorbing insoles and Masai Barefoot technology for knee OA, and medial heel wedges for symptomatic lateral tibiofemoral OA. These studies warrant replication before more widespread implementation.

References

1. Brouwer RW, Jakma TS, Bierma-Zeinstra SM, Verhagen AP, Verhaar J. Osteotomy for treating knee osteoarthritis. [Review] [36 refs]. *Cochrane Database of Systematic Reviews* 2005, CD004019.

2. Warden SJ, Hinman RS, Watson MA, Jr., Avin KG, Bialocerkowski AE, Crossley KM. Patellar taping and bracing for the treatment of chronic knee pain: a systematic review and meta-analysis. [Review] [49 refs]. *Arthritis & Rheumatism* 2008;59**:**73-83.

3. Hinman RS, Crossley KM, McConnell J, Bennell KL. Efficacy of knee tape in the management of osteoarthritis of the knee: blinded randomised controlled trial. *BMJ* 2003;327**:**135.

4. Brouwer R, Jakma T, Verhagen A, Verhaar J, Bierma-Zeinstra S. Braces and orthoses for treating osteoarthritis of the knee. *Cochrane Database of Systematic Reviews* 2005;2: CD004020.

5. Reilly KA, Barker KL, Shamley D. A systematic review of lateral wedge orthotics--how useful are they in the management of medial compartment osteoarthritis?. [Review] [33 refs]. *Knee* 2006;13**:**177-183.

6. Rodrigues PT, Ferreira AF, Pereira RM, Bonfa E, Borba EF, Fuller R. Effectiveness of medial-wedge insole treatment for valgus knee osteoarthritis. *Arthritis & Rheumatism* 2008;59:603-608.

7. Shakoor N, Block JA. Walking barefoot decreases loading on the lower extremity joints in knee osteoarthritis. *Arthritis & Rheumatism* 2006; 54**:**2923-2927.

8. Kemp G, Crossley KM, Wrigley TV, Metcalf BR, Hinman RS. Reducing joint loading in medial knee osteoarthritis: Shoes and canes. *Arthritis & Rheumatism* 2008;59:609-614.

9. Shakoor N, Lidtke RH, Sengupta M, Fogg LF, Block JA. Effects of specialized footwear on joint loads in osteoarthritis of the knee**.** *Arthritis & Rheumatism* 2008; 59:1214-1220.

10. Kerrigan DC, Johansson JL, Bryant MG, et al. Moderate-heeled shoes and knee joint torques relevant to the development and progression of knee osteoarthritis. *Archives of Physical Medicine & Rehabilitation* 2005;86**:**871-875.

11. Maly MR, Culham EG, Costigan PA. Static and dynamic biomechanics of foot orthoses in people with medial compartment knee osteoarthritis. *Clinical Biomechanics* 2002;17**:**603-610.

12. Erhart J, Mündermann A, Elspas B, Giori N, Andriacchi T. A variable-stiffness shoe lowers the knee adduction moment in subjects with symptoms of medial compartment knee osteoarthritis. *Journal of Biomechanics* 2008:41(12):2720-2725.

13. Foxworth JL. Effects of shock absorbing insoles on knee pain, functional mobility, and lower extremity biomechanics in persons with symptomatic knee osteoarthritis. *Dissertation Abstracts International: Section B: The Sciences and Engineer*ing 2008;68(12-B):7966

14. Nigg BM, Emery C, Hiemstra LA. Unstable shoe construction and reduction of pain in osteoarthritis patients. *Medicine & Science in Sports & Exercise* 2006;38**:**1701-1708.

15. Chan GN, Smith AW, Kirtley C, et al. Changes in knee moments with contralateral versus ipsilateral cane usage in females with knee osteoarthritis**.** *Clinical Biomechanics* 2005;20**:**396-404.

EARLY DIAGNOSIS AND TREATMENT

1. What is the evidence regarding the effectiveness of this practice?

At this time, there is no evidence supporting early diagnosis and treatment of osteoarthritis. While several risk factors have been identified that are associated with the onset and progression of knee OA (and to a lesser extent other joints affected by OA), no prevention research to date has proven that early diagnosis via screening coupled with alteration of these risk factors leads to better OA radiologic or clinical outcomes. The reviewed literature did identify knee pain as an important predictor of subsequent functional loss.[1] This factor could become a part of a future effective screening and early treatment (secondary) prevention strategy for knee OA.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

There is no clinical or public health evidence to support early diagnosis and treatment as a public health intervention.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

While there is no empirical evidence that early diagnosis and treatment would benefit any particular population, the general literature does indicate that the benefits of treatment may be greater for younger adults with OA. For instance, physical activity interventions might be more effective for younger adults recently diagnosed with knee OA than for older adults with longstanding knee OA, since younger adults are inclined to be more physically active than older adults.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Not applicable

5. What more research is needed on this practice to address gaps in evidence?

Research initiatives pertaining to early diagnosis and treatment of OA would be greatly enhanced by the identification of valid and responsive markers of OA structural damage. Current research on treatments aimed at reducing radiologic progression of OA is hampered by the insensitivity of x-rays to detect important changes in joint structure. The availability of valid biologic or imaging markers that are more sensitive to change would be particularly useful in clinical trials of potential disease modifying agents for OA. Additionally, these markers might prove to be useful as screening tools for early diagnosis.

An important step in creating an effective secondary prevention strategy for OA is the discovery of treatments that can reduce the structural progression and the pain, activity limitations, and participation restrictions associated with the disease. Once these treatments are established, then further research testing a variety of symptom, physical exam, imaging, and other biomarker approaches to screening for early OA would be warranted.[2-3] Finally, prevention research evidence that screening and early treatment prevents (or reduces) radiologic progression and the pain, activity limitations, and participation restrictions associated with OA would be needed.

References

1. Jinks C, Jordan K, Croft P. Osteoarthritis as a public health problem: the impact of developing knee pain on physical function in adults living in the community: (KNEST 3). *Rheumatology* 2007;46:877-881.
2. Karachalios T, Zibis A, Papanagiotou P, Karantanas AH, Malizos KN, Roidis N. MR imaging findings in early osteoarthritis of the knee. *Europ J Radiol* 2004;50: 225-230.
3. Wolheim FA. Early stages of osteoarthritis: the search for sensitive predictors. *Ann Rheum Dis* 2003;62:1031-1032.

ENVIRONMENTAL MODIFICATIONS

In the search for information relevant to the incidence and progression of knee osteoarthritis (OA), we generally have considered factors pertaining to the individual in terms of bodily structures and functions. There is some evidence available relating obesity, joint alignment/strength, sports participation, joint injury/surgery and occupation to knee OA. The incidence or progression of knee OA also may be influenced by the built environment in which an individual functions. The nature of weight bearing surfaces and environments requiring stair climbing are two examples of potential direct risk factors. An environment that reduces ability to be physically active and maintain appropriate weight and lower extremity strength may be indirect risk factors for knee OA. As interest grows in the built environment's influence on physical activity and health, questions regarding the relationship of the built and knee OA need to be defined and studied as well.

INJURY PREVENTION

Search Strategy and Evidence Synthesis

The first literature search used the standard search strategies for OA and systematic reviews and meta-analyses defined above, combined with a set of terms to capture 'injuries' and 'prevention' produced 37 hits. Review of all 37 abstracts revealed none provided relevant information. A revised, expanded, search strategy returned a total of 11,985 hits. The OA Summit Intervention Workgroup members felt that triaging this number of abstracts was an unmanageable task.

This phenomenon, systematic literature searches on injury prevention topics either producing too little or too much, has been documented by others.[1-2] Hence, the Workgroup decided to review the injury prevention intervention area using an example-based approach. This section differs from other sections, in that a few select examples are presented to illustrate the potential for injury prevention strategies to reduce the incidence of OA. This is not a comprehensive list or review of effective public health injury prevention strategies.

Background

Traumatic injury is a recognized risk factor for the later development of OA and accounts for approximately 12% of OA prevalence.[3] Dislocations, peri-articular fractures, complete ligamentous rupture, and fibro or hyaline cartilage injuries have been shown to result in later OA.[3-10] An estimated 5.6 million US adults have posttraumatic OA of the knee, hip or ankle and the corresponding financial burden is estimated at $3.1 billion annually, accounting for approximately 0.15% of the total US direct health care costs.[3]

Fractures and sprains are particularly common among all age groups. Annually, there are 3.4 and 5.6 million emergency department visits attributed to fractures and sprains/strains respectively. Over 50% of all injury-related hospital discharges are attributed to fractures alone.[11] Most of these joint injuries occur to the lower extremity (35-50%) and happen during leisure and household activities (excluding sports; 40%), sports and exercise (18%), paid work (15%), and in motor vehicle accidents (8%).[11]

Lifetime risk of knee OA is 57% among persons with a history of prior knee injury,[12] although risk estimates vary depending on the injury definition used, e.g., any knee injury, an injury requiring physician attention, etc. and the joint site (ankle, knee, hip, etc.) A decade ago, Felson et al[13] estimated that almost 25% of incident symptomatic knee OA could be prevented by preventing knee injuries among men (women, 14%). No similar, population attributable risk estimates are available for hip, ankle, hand, or spine OA, but preventing any OA-related joint injury would likely reduce the incidence of posttraumatic OA.

Specific injuries, such as anterior cruciate ligament (ACL) ruptures and ankle fractures, have been clearly linked to incident OA.[3-10] Posttraumatic OA onset occurs at younger ages than primary OA. For example, within 10-20 years of ACL injury, 50% of patients have evidence of radiographic OA regardless whether the joint was surgically reconstructed or not.[10] Still unclear is the role of other injuries, such as minor joint sprains (e.g., incomplete ligament ruptures), muscle/tendon strains, chronic inflammatory conditions (tendinitis, tenosynovitis, bursitis, etc.), in the development of OA.

As such, interventions and policies that reduce joint and joint-related injuries are a potential tool in the quest to reduce the population burden of OA. Long term studies showing the effectiveness of injury prevention measures in reducing OA are not available, as the injury literature and evaluations have focused on the more proximate issue of the effectiveness of the interventions and policies in reducing rates of injury. However, given the strong relationship between injury and subsequent OA it is reasonable to conclude that injury control will eventually result in less OA.

To effectively control OA-related injuries, we need information about where the injuries occur (place, setting, context), how they occur (mechanisms, activities), when (time, life period, seasonal) and to whom (person characteristics). Unfortunately for many of the injuries that have been associated with OA, there is insufficient information available to inform such injury prevention initiatives and a full review of this topic is out of the scope of this paper. However, the potential role of injury prevention strategies in the primary prevention of OA can be illustrated by using ACL injury and ankle sprain/fractures that occur during sports and recreation activities as examples.

Anterior Cruciate Ligament Injury Prevention: Neuromuscular Conditioning Programs

Each year, an estimated 112,000 incident cruciate ligament injuries occur each year resulting in over 577,000 physician visits, and 75,000 outpatient surgical ACL reconstructions.[14] Cruciate injuries most commonly happen to adolescents and young adults (aged 15-24 years, 33%) and while engaged in sports and recreational activities (79%).[14] Although 56% of all cruciate ligament injuries occur among males[14] females have 3-5 times higher rates of noncontact ACL injuries compared to males in select sports such as soccer and basketball.[15-16] In collision sports such as American football, most ACL injuries are caused by contact with another player and have been linked to specific tackling procedures (e.g., clipping). These different mechanisms of ACL injury (noncontact versus contact) have different prevention strategies, but the most recent research has concentrated on noncontact ACL injuries.[17]

Although many potential risk factors for noncontact ACL injury have been hypothesized (anatomical, hormonal, environmental, etc.), by far the most researched are the biomechanical factors.[17] Notable gender differences in biomechanical factors (lower extremity kinetics and kinematics) have been identified which are hypothesized to be linked to an increased risk of non-contact ACL injuries. For example, when landing from a jump, females land with a straighter knee, less trunk flexion, more internal hip rotation, and more knee valgus compared to males.[17-18] These biomechanical anomalies effectively exert excess shearing and rotational forces on the ACL which can result in rupture during activity. Neuromuscular conditioning programs targeting these specific biomechanical factors have been developed and evaluated in the sports of soccer, basketball and handball.[18-19]

1. What is the evidence regarding the effectiveness of this practice?

There is moderate to strong evidence of effectiveness for neuromuscular conditioning programs (50-70% reduced risk of ACL injury), particularly in the sport of soccer. In a meta-analysis of 6 randomized controlled trials with a total of 8,156 subjects (soccer, handball and basketball), Hewett et al[19] report an overall 60% reduction (odds ratio 0.40, 95% confidence interval 0.26 -0.61) in incident ACL injuries in the intervention group. A recent, large randomized controlled trial provides additional support for neuromuscular conditioning programs in women's collegiate soccer.[20] Neuromuscular conditioning programs have recently been recommended to reduce training-related injuries in the military by the Joint Services Physical Training Injury Prevention Work Group.[21]

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Given the impact of the acute ACL injury and the likelihood of OA development following ACL injury, primary prevention is the ideal. Neuromuscular conditioning programs have demonstrated effectiveness in reducing the risk of ACL injury in select settings. To date, neuromuscular conditioning programs for ACL injury prevention have not been tested as a potential public health intervention per se (e.g., research, dissemination, and/or evaluation on a population level) but it could be feasibly accomplished. Neuromuscular conditioning programs could be disseminated as a public health intervention through a 'system' that has access to the target population at risk. For example, sports organizations such as USA Soccer or the National Collegiate Athletic Association could endorse and institute rules/policies mandating and monitoring their use.
A number of hurdles exist to implementation that will need to be overcome. Currently no standardized program has been identified as "best practice" and instructor training and dissemination infrastructures are highly variable, which limits the ability of this intervention to reach the targeted population. One program that has been evaluated, is proprietary, and has substantial training and licensing fees which also may be a barrier to implementation in some settings. In addition, national sport governing bodies and health/safety organizations have yet to endorse these programs. Last, expected benefits depend upon an individual athlete's compliance to the prescribed program which has been reported to be low to moderate.[17-20]

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Neuromuscular conditioning programs for ACL injury prevention have only been tested in limited sports and recreation environments and populations. Current evidence suggests these programs are most effective for females in the sport of soccer played at the high school and collegiate levels in the US and for handball in Europe. The ideal timing, length, and composition of these programs have not been identified. Few studies have included males. There is limited effectiveness for the sport of basketball at any level (few studies) and no evidence for other sports that have a moderate or higher risk of noncontact ACL injury (gymnastics, lacrosse, volleyball, etc.). In addition, these programs have not been tested in any community-based sports programs for children under the age of 14 or in professional or adult recreational sport settings.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

The importance of safe participation in physical activity for health promotion has been proactively addressed by the U.S. Department of Health and Human Services in the *2008 Physical Activity Guidelines for Americans*.[22] However, despite scientific evidence of effectiveness, neuromuscular conditioning for ACL injury prevention evaluated in research studies have yet to be effectively translated to practice. Neuromuscular conditioning programs typically involve 4 components; 1) muscle strengthening, 2) plyometrics (jump training), 3) balance exercises, and 4) proper technique coaching.[17-20] However, currently there is no consensus on the optimal composition, dose, timing, and length of program and little training and delivery infrastructure exists or methods and tools developed for monitoring program delivery and compliance.

Endorsement of neuromuscular conditioning programs for the prevention of ACL injury by health and safety organizations and sports governing bodies would possibly help communities and schools recognize the need for broad implementation of these programs. To date, no one organization has taken on the standardization, training and implementation of these evidence-based programs in a manner that can effectively reach a large

portion of the at-risk population for a reasonable cost. Until a coordinated effort across multiple organizations, government, and individuals has commenced, little progress in this area will be realized.[23]

5. What more research is needed on this practice to address gaps in evidence?

- Development and maintenance of integrated surveillance systems to monitor the incidence of major ligament and meniscal injuries including expanded descriptive epidemiology of the mechanisms, activities at time of injury, and modifiable risk factors.
- Identification of subgroups with the highest risk of ACL injury, including identification of the contribution of multiple risk factors, for targeted program development and implementation.
- Delineation of specific components of the neuromuscular conditioning programs that produce the desired benefits.
- Standardization of program components (composition, dose, timing, length of program, etc.), development of training and delivery infrastructure, fidelity monitoring plan, etc.
- Testing effectiveness of intervention in more diverse populations including different sports, age groups and competition levels.
- Consumer research (parents, athletes, coaches, administrators, etc.) on feasibility and barriers/facilitators to implementation.
- Cost effectiveness studies.

Ankle Fracture/Sprain Prevention: Breakaway Bases

Injuries to the ankle joint are one of the most common musculoskeletal injuries, affecting persons of all ages and activity levels.[16, 24-27] An estimated 55-78% of ankle OA can be attributed to prior trauma, such as fractures and severe ligament sprains.[4-6] Ankle injuries can occur during many different activities, but are particularly common in sports and recreation activities.[26] Ankle injury prevention strategies can be designed and implemented in many ways. For example, targeting a particular injury mechanism in a specific sport (e.g., base-related ankle injuries in baseball and softball) is one approach. Below, is an example that illustrates a potential public health approach to sport-related ankle injury prevention that may have future impact on the prevention of posttraumatic OA.

In sports and recreation activities ankle injuries often occur from jumping, landing, cutting and twisting mechanisms and sports such as baseball, softball, volleyball, basketball, football and soccer have the highest rates of ankle injuries.[16, 25-27] Over 40% of all sports-related emergency department visits were for fractures (21%) and sprains/strains (22%) and these sports injuries were more likely to affect the feet and ankles compared to non-sport injuries.[26-27] Ankle sprains alone account for almost 15% of all collegiate sports injuries.[16] In the US, millions of persons participate in baseball and softball each year at all levels resulting in more than 240,000 emergency department visits yearly (almost 10% of all sport-related visits).[26] In collegiate baseball and softball, contact with a fixed base accounted for 8.2% and 8.7% of all injuries respectively compared to contact with a breakaway base (baseball =0.6%, softball = 1.1%).[28-29] Ankle ligament sprains accounted for 43% softball fixed base injuries.[29] Bases that release or break away upon impact have been shown to reduce lower extremity injury rates.[30-34]

1. What is the evidence regarding the effectiveness of this practice?

There is sufficient scientific evidence supporting the use of breakaway bases to reduce the rate and severity of base-related injuries in baseball and softball. In a study of breakaway (633 games) and stationary (627 games) bases in softball, the frequency of sliding-related injuries was reduced 96% on fields using breakaway bases.[30] Additional studies support this finding in interscholastic, intercollegiate, recreational, intramural and minor league professional settings.[31-34] Twenty years ago, the Centers for Disease Control and Prevention estimated that installing breakaway bases on all US baseball and softball fields could prevent 1.7 million injuries and save $2.0 billion annually in direct medical costs.[30] Instituting and enforcing policies requiring the installation of breakaway bases at all levels of baseball and softball could be an effective public health intervention.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

There is sufficient scientific evidence to support the use of breakaway bases in baseball and softball that release upon impact (e.g., breakaway, quick release, or impact bases) as a public health intervention. This intervention strategy has been evaluated across various levels of play (recreational, scholastic, intercollegiate, and professional), among different age groups, and among both males and females. Installation of breakaway bases (~$300-500 per field) may be slightly more expensive than stationary bases (~$100-300 per field), but are still highly cost effective when compared to the cost of ankle injuries (~$1200/per injury).[32] In addition, use of these bases during game situations does not cause excessive delays in the length of game[30] or complicate judgment calls by umpires.[30-31]

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Although the entire general population is not at risk for base-related baseball and softball injuries, the target population for this intervention strategy is large, and includes not only the participants (players at all levels), but facility managers, coaches, parents, school and recreational sports administrators, insurers, risk managers, health care providers and facilities, etc.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Despite the fact that scientific evidence demonstrating the effectiveness of breakaway bases to reduce injuries in baseball and softball has existed for almost 20 years, uptake of this intervention at the population level is mostly unknown. In 2006, Little League Baseball instituted a policy requiring the use of breakaway bases on all fields to be effective January 1, 2008.[35] It is too early to determine if this new policy has been fully implemented (100% uptake) or resulted in the intended reduced rates and severity of injuries related to base running. In addition, no other baseball or softball governing body (National Federation of High School Sports, National Collegiate Athletic Association, Amateur Softball Association, Major League Baseball, etc.) has implemented similar mandatory policies, although the NCAA rules for both sports do state that breakaway bases are allowable in NCAA play, but not required. A Position Statement from the American Academy of Orthopedic Surgeons recommends breakaway bases be used at all levels of baseball and softball and may be the only medical professional organization with a written policy.[36] Implementation and enforcement of policies mandating use of breakaway bases across all levels of baseball and softball could significantly expand reach of this effective intervention.

There are three primary reasons why this strategy for injury prevention may be sustainable. First, the intervention is targeted to specific sports (baseball and softball) as well as implemented in clearly defined settings/facilities (community recreation leagues, scholastic and collegiate sports, professional, etc.). Second, there are 'systems' (Little League Baseball, Amateur Softball Association, National Collegiate Athletic Association, etc.) that can be tapped to support the implementation and enforcement of breakaway base policies. Third, this intervention strategy is directed at the sport and setting/facility instead of at individuals, and subsequently does not rely on individual motivation and behavioral choices. For example, an individual does not have to actively choose to buy and wear some type of protective equipment. This approach may improve compliance, fidelity, and sustainability.

5. What more research is needed on this practice to address gaps in evidence?

- Development and maintenance of surveillance systems to monitor the incidence and outcomes of ankle sprains and fractures.
- Identify mechanisms and risk factors for ankle sprain/fracture injuries that occur in the home and leisure setting (excluding sports).
- Consumer research (players, coaches, facilities managers, etc.) to identify barriers to implementation.
- Evaluation of rule/policy changes to document effective reduction in injuries, cost savings and other outcomes (intended and unintended).
- Identification of the percent uptake at all levels of play

Other Intervention Strategies

Sports and recreation. Several additional interventions that have moderate to strong evidence to reduce sport-related lower extremity injuries in general, but not specifically ACL or ankle injuries. These include: changes to footwear or surface interface (e.g., minimizing cleat length, ski binding adjustment), rule/policy changes (making clipping illegal, limiting contact in practice, pitch counts, etc.), education (risk avoidance, coach training), and proper facility/field maintenance. (Table 1) There is insufficient evidence to support the effectiveness of lateral knee braces in preventing knee injuries. Of these, rule/policy changes aimed at safety, industry standards for athletic surfaces and facility management, and education programs may have the most potential as future public health interventions.

Motor vehicle. Motor vehicle-related injuries that can lead to OA are a result of: frontal crashes, side impacts, and pedestrian/motor vehicle collisions. More people survive automobile crashes due to improvements in motor vehicle restraints (seat belts and air bags), but can suffer costly and debilitating lower extremity injuries.[37-39] According to the crash injury Research and Engineering Network, 55% of occupants in vehicular crashes suffered ankle/foot fractures, 22% of whom are still unable to return to work at 1 year.[39] Pedestrians hit by motor vehicles can also sustain severe lower extremity injuries, most often to the knee.[40] Interventions that prevent motor vehicle crashes in general (Table 2), as well as new automobile design and restraint systems can subsequently result in reduced rates and severity of injuries.

Home and leisure. The vast majority (40%) of fractures and sprains occur as a result of leisure and household activities (excluding sports).[11] Intervention strategies to address potential OA-related injuries in the home and leisure setting are even less developed than in the sports and recreation setting. Future research should focus on the descriptive epidemiology of home and leisure injuries that may contribute to OA and the development and testing of interventions in this setting.

Summary

Two examples of effective interventions for OA-related injuries that occur primarily in sports and recreation settings include neuromuscular conditioning programs for noncontact ACL injuries and breakaway bases for ankle injuries. Primary prevention of OA thru injury prevention is extremely complex because injuries happen during a variety of activities (sports and recreation, home and leisure, motor vehicle accidents, occupation, etc.), have different mechanisms (contact/noncontact, falls, etc.), and interventions can be targeted to different entities (individual, communities, industry, etc.). Even within the sports and recreation domain, the same sport can be played with different rules and equipment, at different levels of intensity (professional, collegiate, high school, community, sandlot, etc.), be governed by different organizations, and have different injury patterns. In addition, interventions deemed 'effective' may be difficult to disseminate in traditional public health settings (e.g., neuromuscular conditioning programs for soccer) due to lack of standardization of intervention components and

underdeveloped infrastructure systems. Despite this, rule/policy, educational, and facility/industry standard interventions show potential for reducing the burden of OA-related injuries but much work is still needed.

Summary Recommendations

- We support the dissemination and implementation of evidence-based injury prevention strategies (neuromuscular conditioning programs, breakaway bases, seat belts, child/infant seats, etc.) in sports and recreation settings and motor vehicle occupant and pedestrian crashes.
- Expansion of injury research funding to describe the epidemiology of and evaluate potential prevention interventions for OA-related injuries.

Table 1: Effectiveness of select sports and recreation joint injury prevention strategies adapted from Gilchrist et al[41] and the Joint Services Physical Training Injury Prevention Work Group recommendations[21]

Activity/Intervention	Evidence for Effectiveness *	Target Joint
General activities		
Fitness conditioning	Proven	All
Semi-rigid ankle stabilizers†	Proven	Ankle
Ankle disk training†	Proven	Ankle
Return to play guidelines	Promising	All
Attention to play parameters	Promising	All
Pre-exercise stretching	Unproven	All
Baseball/Softball		
Breakaway bases	Proven	Ankle/Lower extremity
Reduced impact balls	Proven	All
Pitch count limits	Promising	Upper extremity
Bat design/ball exit speed	Insufficient	All
Chest protectors	Unproven	Thorax/cardiac
Basketball		
Preventive knee braces	Unproven	Knee
Football		
Playing field maintenance	Proven	All
Preseason conditioning	Proven	All
Rules changes (e.g., clipping, spearing)	Proven	Knee
Minimize cleat length	Proven	Knee
Lateral knee braces	Unproven	Knee
Limiting contact during practice	Insufficient	All
Ice hockey		
Rule changes (e.g., high sticking)	Proven	All
Increased ice size	Proven	All
Enforcement of rules	Promising	All
Discouraging fighting	Promising	All
Body pads	Unproven	All
Inline skating/skateboarding		
Wrist guards	Proven	Wrist
Elbow/knee pads	Proven	Elbow/knee
Skiing/Snowboarding		
Education to avoid risk situations	Proven	All
Binding adjustment	Proven	Knee
Wrist guards (snowboarding)	Proven	Wrist
Soccer		
Neuromuscular conditioning	Proven	Knee/Lower extremity
Anchored, padded goalposts	Proven	All
Shin guards	Proven	Anterior Lower Leg

* Proven = sufficient scientific data showing effectiveness from multiple, high quality studies; Promising = some evaluation data supporting intervention is effective, needs confirmatory research from high quality studies; Insufficient = some evaluation data, but insufficient information to evaluate whether intervention is effective or not effective, needs additional research; Unproven = has been evaluated, but no evidence to support effectiveness.

† Both semi-rigid ankle stabilizers and ankle disc training are most effective for persons with a history of previous ankle injury.

Table 2. Effectiveness of select motor vehicle crash interventions to reduce occupant deaths and injuries adapted from the Guide to Community Preventive Services[42]

Domain/Intervention	Evidence for Effectiveness *
Use of child safety seats	
Child safety seat laws	Proven
Community-wide information and enhanced enforcement	Proven
Distribution and education campaigns	Proven
Incentive and education programs	Proven
Education programs when used alone	Insufficient
Use of safety belts	
Safety belt laws	Proven
Primary enforcement laws	Proven
Enhanced enforcement	Proven
Reducing alcohol-impaired driving	
0.08 blood alcohol concentration (BAC) laws	Proven
Lower BAC laws for young or inexperienced drivers	Proven
Minimum legal drinking age laws	Proven
Sobriety checkpoints	Proven
Intervention training programs for servers of alcoholic beverages	Proven
Mass media campaigns	Proven
School-based programs	
School-based instructional programs	Proven
Peer organization programs	Insufficient
Social norming programs	Insufficient
Designated driver programs	
Population-based campaigns	Insufficient
Incentive programs	Insufficient
Multi-component interventions with community mobilization	Proven
Ignition interlocks	Proven

* Proven = sufficient scientific data showing effectiveness from multiple, high quality studies; Insufficient = some evaluation data, but insufficient information to evaluate whether intervention is effective or not effective, needs additional research.

References

1. Blackhall K. Finding studies for inclusion in systematic reviews of interventions for injury prevention; the importance of grey and unpublished literature. *Inj Prev* 2008;13:359.

2. Blackhall K, Ker K. Searching for studies for inclusion in Cochrane Systematic Reviews on injury prevention. *Inj Prev* 2008;14:137-138.

3. Brown TD, Johnston RC, Saltzman CL, Marsh JL, Buckwalter JA. Posttraumatic osteoarthritis: A first estimated of incidence, prevalence, and burden of disease. *J Orthop Trauma* 2006;20(10):739-744.

4. Valderrabano V, Hintermann B, Horisberger M, Fung TS. Ligamentous posttraumatic ankle osteoarthritis. *Am J Sports Med* 2006;34(4):612-620.

5. Valderrabano V, Horisberger M, Russell I, Dougall H, Hintermann B. Etiology of ankle osteoarthritis. *Clin Orthop Relat Res* 2008; Oct 2, Epub ahead of print.

6. Horisberger M, Valderrabano V, Hintermann B. Posttraumatic ankle osteoarthritis after ankle-related fractures. *J Orthop Trauma* 2009;23(1):60-67.

7. von Porat A, Roos EM, Roos H. High prevalence of osteoarthritis 14 years after an anterior crucitate ligament tear in male soccer players: A study of radiographic and patient relevant outcomes. *Ann Rheum Dis* 2004;63(3):269-273.

8. Lohmander LS, Ostenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitation in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis Rheum* 2004;50(10):3145-3152.

9. Kessler MA, Behrend H, Henz S, Stutz G, Rukavina A, Kuster MS. Function, osteoarthritis and activity after ACL-rupture: 11 years follow-up results of conservative versus reconstructive treatment. *Knee Surg Sports Traumatol Arthrosc* 2008;16(5):442-448.

10. Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequences of anterior cruciate ligament and meniscus injuries: Osteoarthritis. *Am J Sports Med* 2007;35(10):1756-1769.

11. Bergen G , Chen LH, Warner M, Fingerhut LA. Injury in the United States: 2007 Chartbook. Hyattsville, MD: National Center for Health Statistics; 2008.

12. Murphy L, Schwartz TA, Helmick CG, et al. Lifetime risk of symptomatic knee osteoarthritis. *Arthritis Rheum*, 2008;59(9):1207-1213.

13. Felson DT, Zhang Y. An update on the epidemiology of knee and hip osteoarthritis with a view to prevention. *Arthritis Rheu*, 1998;41(8):1343-1355.

14. Marshall SW, Padua DA, McGrath ML. Grant information summary: Descriptive epidemiology of injury to the cruciate ligaments. National Athletic Trainers Association, Research and Education Foundation, 2007. Available at: http://www.natafoundation.org/pdfs/07Marshall.pdf.

15. Prodromos CC, Han Y, Rogowski j, Joyce B, Shi K. A meta-analysis of the incidence of anterior cruciate ligament tears as a function of gender, sport, and a knee injury-reduction regimen. *Arthroscopy* 2007; 23(12):1320-1325.

16. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: Summary and recommendations for injury prevention initiatives. *J Athl Train* 2007;42(92):311-319.

17. Griffin LY, Albohm MJ, Arendt EA, et al. Understanding and preventing noncontact anterior cruciate ligament injuries: A review of the Hunt Valley II meeting, January 2005. *Am J Sports Med* 2006;34(990): 1512-1532.

18. Shultz SJ, Schmitz RJ, Nguyen AD. Research Retreat IV: ACL injuries – the gender bias; Consensus Statement, Neuromuscular and biomechanical factors. *J Athl Train* 2008;43(5):530-533.

19. Hewett TE, Ford KR, Myer GD. Anterior cruciate ligament injuries in female athletes: Part 2, a meta-analysis of neuromuscular interventions aimed at injury prevention. *Am J Sports Med*, 2006;34(3):490-498.

20. Gilchrist J, Mandelbaum BR, Melancon H, et al. A randomized controlled trial to prevent noncontact anterior cruciate ligament injury in female collegiate soccer players. *Am J Sports Med* 2008;36(8):1476-1483.

21. Department of the Army, U.S. Army Center for Health Promotion and Preventive Medicine. Recommendations for prevention of physical training (PT)-related injuries: Results of a systematic evidence-based review by the Joint Services Physical Training Injury Prevention Work Group (JSPTIPWG), USACHPPM REPORT NO. 21-KK-08QR-08, 2008.

22. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC: U.S. Department of Health and Human Services; 2008.

23. Timka T, Finch CF, Goulet C, Noakes T, Yammine K. Meeting the global demand for sports safety. *Sports Med* 2008;38(10):795-805.

24. Fong DT, Hong Y, Chan LK, Yung PS, Chan KM. A systematic review on ankle injury and ankle sprain in sports. *Sports Med* 2007;37(1):73-94.

25. Nelson AJ, Collins CL, Yard EE, Fields SK, Comstock RD. Ankle injuries among United States high school sports athletes, 2005-2006. *J Athl Train* 2007;42(3):381-387.

26. Burt CW, Overpeck MD. Emergency visits for sports-related injuries. *Ann Emerg Med*, 2001;37(30):301-308.

27. Centers for Disease Control and Prevention. Nonfatal sports- and recreational-related injuries treated in emergency departments – United States, July 2000 – June 2001. *Morb Mort Weekly Rep* 2002;51(33):736-740.

28. Dick R, Sauers EL, Agel J, et al. Descriptive epidemiology of collegiate men's baseball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train* 2007;42(2):183-193.

29. Marshall SW, Hamstra-Wright KL, Dick R, Grove KA, Agel J. Descriptive epidemiology of collegiate women's softball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train* 2007;42(2):286-294.

30. Centers for Disease Control and Prevention. Softball sliding injuries – Michigan, 1986-87. *Morb Mort Weekly Rep* 1988;37(11):169-170.

31. Centers for Disease Control and Prevention. Sliding-associated injuries in college and professional baseball – 1990-1991. *Morb Mort Weekly Rep* 1993;42(12):229-230.

32. Janda DH, Wojtys FM, Hankin FM, Benedict Me, Hensinger RN. A three phase analysis of the prevention of recreational softball injuries. *Am J Sports Med* 1990;18(6):632-635.

33. Janda DH, Maguire R, Mackesy D, Hawkins RJ, Fowler P, Boyd J. Sliding injuries in college and professional baseball: A prospective study comparing standard and breakaway bases. *Clin J Sports Med* 1993;3(2):78-81.

34. Sendre RA, Keating TM, Hronak JE, Newitt PA. Use of the Hollywood Impact Base and standard stationary base to reduce sliding and base-running injuries in baseball and softball. *Am J Sports Med* 1994;22(40):450-453.

35. Little League Baseball Online. Disengage-able Base Rule. Available at: http://www.littleleague.org/Learn_Nore/rules/Disengage-Able_Base_Rule.htm.

36. American Academy of Orthopaedic Surgeons. Position statement: Use of breakaway bases in preventing recreational baseball and softball injuries. Revised June 2005, number 1140. Available at: http://www.aaos.org/about/papers/position/1140.asp.

37. Dischinger PC, Read KM, Kufera JA, et al. Consequences and costs of lower extremity injuries. *Annu Proc Assoc Adv Automot Med* 2004;48:339-353.

38. Estrada LS, Alonso Je, McGwin G, Metzger J, Rue LW. Restraint use and lower extremity fractures in frontal motor vehicle collisions. *J Trauma* 2004;57(92):323-328.

39. Read KM, Kufera JA, Dischinger PC, et al. Life-altering outcomes after lower extremity injury sustained in motor vehicle crashes. *J Trauma* 2004;57(4):815-823.

40. Peng RY, Bongard FS. Pedestrian versus motor vehicle accidents; an analysis of 5,000 patients. *J Am Coll Surg* 1999;189(4):343-348.

41. Gilchrist J, Saluja G, Marshall SW. Interventions to prevent sports and recreation-related injuries. In: Doll LS, Bonzo SE, Mercy J, Sleet DA, (eds), *Handbook of Injury and Violence Prevention*. New York: Springer; 2007.

42. Guide to Community Preventive Services, Motor Vehicle Occupant Injury. Available at http://www.thecommunityguide.org/mvoi/default.htm.

MIND-BODY INTERVENTIONS

1. What is the evidence regarding the effectiveness of this practice?

Mind-body (MB) interventions represent a diverse group of therapeutic approaches including meditation, biofeedback, guided imagery, progressive muscle relaxation, tai chi, and yoga. There have been 2 systematic reviews[1-2] and fewer than 12 randomized controlled trials (RCTs) addressing the efficacy of various mind-body intervention approaches in the treatment of osteoarthritis (OA) patients since 2000. The majority of RCTs in this area have focused upon the effects of tai chi,[2] yoga[3,4] progressive muscle relaxation,[5-6] guided imagery,[6] and hypnosis.[7] Approximately half of all RCTs conducted in this area to date have addressed the effects of tai chi.[2] No RCTs to date have examined the influence of meditation, hypnosis, or biofeedback within samples of persons with OA. Evidence from the limited number of studies is mixed but generally favorable suggesting that select MB interventions result in modest improvements in relevant clinical OA outcomes such as pain symptoms and physical function. Effect sizes accompanying these changes in these outcomes were quite variable across the various MB interventions ranging from small effects (d = .20) for relaxation[5] to moderate effects (d = .65) for Tai Chi,[2] to large effects for hypnosis (d = 1.34)[7] and yoga (d = 1.57) respectively.[3-4] In interpreting the effect sizes accompanying these MB interventions two important considerations should be acknowledged. First, several of the studies examining MB interventions failed to provide sufficient information to calculate effect sizes. Hence, the number of effect sizes addressing MB interventions remain limited at the present time. Second, there was only one study reporting effect size estimates for the efficacy of hypnosis[7] and yoga[4] and both studies were characterized by small sample sizes. Accordingly, the magnitude of these effects should be interpreted cautiously.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Although initial findings suggest select MB interventions may result in favorable changes in some relevant clinical OA outcomes, there is presently insufficient empirical evidence to determine if MB approaches represent efficacious public health interventions for individuals burdened with OA. There are several limitations evident in the extant literature that contribute to this conclusion. Most notably, many of the RCTs examining the efficacy of MB interventions utilized samples comprised of various chronic pain patients.[1] Thus, evidence directly addressing the utility of MB approaches in persons with OA remains limited at the present time. Several of the RCTs that have examined MB techniques among persons with OA have also been characterized by small sample sizes, the implementation of short duration interventions, and the use of potentially inappropriate comparison groups and follow-up assessments. Additionally, it is notable that many studies have integrated multi-component MB interventions (i.e., progressive muscle relaxation combined with guided imagery) which preclude the ability to appropriately evaluate the efficacy of specific MB approaches.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Based on the limited amount of evidence addressing the efficacy of MB approaches, it is premature to develop recommendations to frame these interventions. However, there have been 5 RCTs examining the efficacy of Tai Chi,[2] the most of any MB approach. Findings of these trials have been mixed but those studies yielding favorable results demonstrated that Tai Chi was associated with meaningful improvements (d = .65) in pain and physical function that were comparable to effect sizes accompanying other common self-management approaches such as NSAID use and exercise. These studies point to the potential benefit of this specific MB approach for OA patients. Nonetheless, evidence supporting this intervention remains too sparse to draw definitive conclusions regarding public health recommendations. Furthermore, in light of the limited amount

of data specifically addressing the benefits of these interventions in OA patients, appropriate conclusions regarding what outcomes should be targeted or individual differences that may determine the patients who benefit most from these approaches have yet to be adequately delineated.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

There are currently no trials of community-based MB interventions targeting people with OA. There is limited and mixed evidence suggesting that MB interventions result in modest improvements in relevant clinical outcomes in OA patients. Preliminary findings suggest that MB interventions are safe, well-tolerated, and feasible to conduct. Nonetheless, these findings are from RCTs characterized by small sample sizes, relatively short duration interventions, potentially inappropriate comparison groups, lack of standardization of intervention procedures across studies, potentially inappropriate attention to intervention fidelity, and an absence of long-term follow-up assessments. It is important to recognize, however, that improvements in a broader array of psychosocial outcomes have been documented with MB interventions in studies addressing other chronic pain samples.[1] Thus, whereas MB there is limited evidence of efficacy of MB interventions upon common OA outcomes, the benefits of MB interventions documented in samples of patients with different chronic pain conditions suggest that these approaches could result in meaningful improvements in other psychosocial outcomes that are of value to persons with OA. This possibility warrants future inquiry. The limited empirical evidence presently available suggest that select MB approaches may represent promising interventions for future public health applications. However, while many of these techniques can be self-administered, MB approaches also require considerable training to learn and repetitive practice to master which could act to impede the public health utility of these approaches. The extent to which these factors may impact the efficacy of integrating MB interventions into public health practice have yet to be adequately delineated.

5. What more research is needed on this practice to address gaps in evidence?

Although research addressing the benefits of MB research for individuals with OA is sparse, preliminary findings provide evidence that select MB approaches show promise as a complementary therapeutic approach. Nonetheless, there are several areas relevant to this topic that warrant future inquiry.

- Given the dearth of evidence supporting the beneficence of MB interventions, more RCTs specifically targeting persons with OA are needed to determine the efficacy of these approaches in this population. Particularly in light of the positive psychosocial outcomes observed accompanying MB interventions in other chronic pain populations.[1]
- Furthermore, given the methodological limitations evident in existing research, future RCTs should include larger sample sizes, longer intervention durations, and appropriate follow-up assessments. Given that many studies in the extant literature employed multi-component MB interventions, future RCTs must also be designed to determine the effect of individual MB techniques in order to appropriately tease apart the effects associated with specific interventions.
- It is also important to acknowledge that MB techniques often require education/training from a qualified professional and consistent practice-related proficiency on the part of the participant to benefit from these techniques. The extent to which these considerations may impact either the feasibility of delivering these interventions or the efficacy of integrating MB approaches in the treatment of OA patients remains unclear and warrants further investigation.
- Finally, the potential feasibility and benefits of MB interventions in samples of persons with OA characterized by different age groups and more cultural diversity have yet to be determined and should be the focus of future inquiry.

References

1. Morone NE, Greco CM. Mind-body interventions for chronic pain in older adults: A structured review. *Pain Med* 2007;8:359-375.
2. Lee MS, Pittler MH, Ernst E. Tai chi for osteoarthritis: A systematic review. *Clin Rheumatol* 2008;27:211-218.
3. Kolasinski SL, Garfinkel M, Tasai AG, et al. Iyengar yoga for treating symptoms of osteoarthritis of the kness: A pilot study. *J Altern Complement Med* 2005;11:689-693.
4. Garfinkel MS, Schumacher HR, Husain A, et al. Evaluation of a yoga based regimen for treatment of arthritis of the hands. *J Rheumatol* 1994;21:2341-2343.
5. Rybarczyk B, Demarco G, Delacruz M, Lapidos S, Fortner B. Comparing mind-body wellness interventions for older adults with chronic disease: Classroom vs home instruction. *Behav Med* 1999;24:181-190.
6. Baird CL, Sands L. A pilot study of the effectiveness of guided imagery with progressive muscle relaxation to reduce chronic pain and mobility difficulties of osteoarthritis. *Pain Manag Nurs* 2004;5:97-104.
7. Gay MC, Philippot P, Luminet O. Differential effectiveness of psychological interventions for reducing osteoarthritis pain. *Eur J Pain* 2002;6:1-16.

NUTRITION

1. What is the evidence regarding the effectiveness of this practice?

Nutrition interventions include those related to day-to-day food choices and the resulting nutrient intake, as well as the use of dietary supplements, nutraceuticals and functional foods. There is growing recognition that factors related to nutrient intake and nutritional status may play a role in the development, progression and management of OA. There is widespread use of preparations across the spectrum of dietary components including macro and micronutrients, whole foods and food components, and other dietary supplements including nutraceuticals, functional foods and herbal preparations, but there is little good evidence to inform appropriate use with regard to dosage, safety and expected outcomes.

There are very few RCTs, and those that have been conducted frequently have quality concerns with regard to design and number of participants. In considering dietary supplements it is important to know about the composition of those compounds and how they relate to nutritional requirements and related compounds used in pharmaceutical treatment. For example, a number of herbal preparations from bark have been found to have positive effect in pain management. However, a major component of those preparations is salicin which is converted in the body to salicylic acid.[1] Several other materials of animal origin such as the extracts from the Green-lipped mussel contain significant amounts of omega 3 fatty acids that may account for their effects.[2] In cases such as these we need to evaluate the effectiveness of the key compound and then secondarily other compounds that may accompany it that vary with the source. Variability in content may explain inconsistent results.

Preliminary data cross-sectional data indicates that Vitamin C may affect development and or progression of OA. The levels of vitamin C evaluated in these studies would be met by current dietary recommendations for fruits and vegetables. Longitudinal and intervention trials are needed.[3-4]

The role of Vitamin D in bone and joint health beyond bone mineralization as well as its broader relationship to chronic disease risk is an area of intense study at present. Recent studies suggesting that our recommendations for intake for Vitamin D are too low, issues with appropriate standards for measurement of Vitamin D, and the need to re-evaluate the kinetics of Vitamin D metabolism and assessment of toxicity levels make it difficult to make any recommendations beyond those recommending higher intakes for general health.[5-6]

Observational studies have shown evidence that omega-3 polyunsaturated fatty acids alleviate the progression of OA. However, RCTs evaluating outcomes other than pain are lacking and there is insufficient information to make recommendations specific to people with OA so the population recommendation to shift to foods rich in omega-3 polyunsaturated fatty acids to prevent other chronic conditions is also appropriate for people with OA.[3,7-8]

The most studied dietary supplements are glucosamine and chondroitin. Meta analysis of RCTs demonstrate moderate to large effects, but quality issues and likely publication bias suggest these effects may be an overestimation. The data is strongest with regard to positive effects in pain management, with possible demonstration of structural effects on narrowing of joint space that is stronger with glucosamine than chondroitin. There are conflicting results in RCTs and additional long term study is needed to clarify the relationships between structural and symptomatic changes with better control for baseline status.[9-10] Additionally, more definition is needed on dose and chemical preparation. Although both have a good safety profile, there are concerns about a possible link between glucosamine and insulin resistance that needs further study.[11] The most recently published results of the GAIT and STOPP trials, showing no clinically important effects of glucosamine compared to placebo and potential but not clear disease-modifying effects of chondroitin, provide the clearest results and suggest key research and methodological questions for further

evaluation such as appropriate preparation and dosage of supplement, length of study needed to examine long term results, and identification if key endpoints to evaluate structural change.[12-13]

Avocado/soybean unsaponifiables, most commonly available as Piascledine has been demonstrated in 4 RCTs to decrease NSAID intake in the short term, but long term effectiveness is not clear. Additionally, the RCTs were characterized by small sample sizes. The only long-term study was evaluating structure-modifying effects and was largely negative.[1,7]

S-adenosylmethionine, is derived from two metabolites, the amino acid methionine and adenosine triphosphate (ATP) and is found naturally in the body. It has been investigated in a significant number of RCTs and shown to have an effect better than placebo and similar to NSAIDs. However, the ptimal dosage has not been clearly established. The mechanism of action is not defined and animal studies suggest there may be structural effects, but additional research is needed to define the clinical effectiveness and safety of SAMe.[7,11,14]

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Current dietary recommendations for population health to promote health and prevent chronic conditions meet the needs of people with OA based on current evidence with the possible exception of recommendations for Vitamin D. Dietary components that have been studied include sources of dietary fat with particular attention to omega 3 fatty acids and dietary protein with consideration to fish and fish oils and red meat. A general recommendation for consuming a diet that is adequate in omega 3 and other essential fatty acids is appropriate for people with OA. None of the current evidence supports a strong effect of fatty acids in the treatment of OA and recommendations related to fish consumption and dietary fat choice are appropriate to address potential co-morbidities of a mid-life and older adult population. Similarly, the relationship with red meat has been studied, but the data is currently insufficient to make recommendations that differ from general dietary guidance to limit intake of red meat.[3,5-8,11]

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Dietary recommendations for adults with OA need to be considered in the context of the broader relationships between diet and chronic disease prevention and management. As the relationships between OA and other co-morbid chronic diseases with respect to overall management of health evolve, the relationships with regard to dietary recommendations and management with a holistic view of health promotion will become clearer.

When considering recommendations related to dietary supplements, current lack of regulation and the resulting safety risks need to be made clear. For those supplements currently available and those that will be developed, we need to evaluate them for their effects on relevant OA outcomes against placebo and also against other current treatments so that the best recommendations with regard to long term effectiveness, safety, acceptability and cost can be assessed. Better assessment of risk of supplements and inclusion of that information for consumers is essential. And, while the term "dietary supplement," has a regulatory definition recognized by the FDA, the definition is so broad and inclusive that it has lost relationship to components that would reasonably be called part of a usual diet. There is no consensus and no regulatory definition of the terms nutraceutical, functional food or probiotic. Consequently, consumers and professionals alike are at a loss to effectively identify products of value.[7,15-16]

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Changes in policies related to evaluation, monitoring and regulation of dietary supplements for safety and efficacy are needed as well as improvements in current policies around definition and promotion of food and supplement products. Guidance for consumers and professionals is needed with regard to those products demonstrated to be ineffective as well as those that are effective.

5. **What more research is needed on this practice to address gaps in evidence?**
There is great potential in increasing our understanding of the relationship between dietary intake and OA outcomes as well as gaining greater understanding of the potential use of food and food components in preventive and therapeutic ways. In all these areas clear conclusions are lacking and more research is needed to add detail and definition to understanding the basic science of achieving and maintaining nutritional sufficiency.

Consideration in the design and conduct of research needs to be given to:

- Examine the nutritional status of the subjects in relation to the supplements being used. It is important to consider whether the protocol a) provides nutrients at a level to remedy an insufficiency and the effects seen are those that would be expected if an individual had appropriate intake, or b) whether the amount provided represents a therapeutic level of intake that might be expected to have effects over and above those of nutrient sufficiency.
- Assessing background nutrient intakes to evaluate the true level of metabolites available.
- Development and use of relevant biomarkers for nutrition and OA disease outcomes including accurate, reproducible and accessible markers of nutrient sufficiency, deficiency and toxicity and OA symptoms and structural changes.
- Gaining better understanding of the function of nutritional and supplement compounds in relation to the etiology, development and progression of OA symptoms and structural changes.
- Use of standardized preparations of test compounds that are comparable across studies and populations and evaluated with regard to safety as well as efficacy.
- Carrying out intervention studies for sufficient lengths of time to evaluate long term safety, efficacy and interaction.

The variety of plant and animal based preparations used as dietary supplements offer potential as therapeutic agents that may have fewer side effects and better safety profiles than available pharmaceutical preparations. However, dietary supplements need to be evaluated in the same rigorous way as pharmaceutical preparations for safety and efficacy and comparative use and value. Consideration also needs to be given to potential additive and synergistic effects when multiple preparations and treatment modalities are used. Currently, many people using nutraceuticals and other dietary supplements do not inform their health care providers. There is significant risk for interaction among provider-prescribed medications and self-prescribed supplements. These risks need to be evaluated.

References

1. Arthritis Research Campaign. Complementary and alternative medicines for the treatment of rheumatoid arthritis, osteoarthritis, and fibromyalgia; 2009, www.arc.org.
2. Cobb CS, Ernst E. Systematic review of a marine nutraceutical supplement in clinical trails for arthritis: The effectiveness of the New Zealand green-lipped mussel Perna Canaliculus. *Clin Rheumatol* 2006;25:275-284.
3. Wang Y, Wluka AE, Hodge AM, et al. Effect of fatty acids on bone marrow lesions and knew cartilage in healthy, middle-aged subjects without clinical knee osteoarthritis. *Osteoarthritis and Cartilage* 2007; 16:579-583.

4. McAlindon TE, Biggee BA. Nutritional factors and osteoarthritis: Recent developments. *Curr Opin Rheumatol* 2005;17:647-652.

5. Perez-Lopez FR. Vitamin D and its implications for musculoskeletal health in women: A review. *Maturitas*2007; 58:117-137.

6. Grant WB. Epidemiology of disease risks in relation to Vitamin D insufficiency. *Prog Biophysics and Molecular* Bio 2006;92:65-79.

7. Ameye LG, and Chee WSS. Osteoarthritis and nutrition. From nutraceuticals to functional foods: A systematic review of the scientific evidence. *Arthritis Research and Therapy* 2006, 8:R127.

8. Rayman MP, Pattison DJ. Dietary manipulation in musculoskeletal conditions. Best Practice and Research *Clinical Rheumatology* 2008;22(3):535-561.

9. McAlindon TE, La Valley MP, Gulin JP, Felson DT. Glucosamine and chondroitin for treatment of osteoarthritis. A systematic quality assessment and meta-analysis. *JAMA* 2000, 283(11):1469-1475.

10. Richy F, Bruyere O, Ethgen O, Cucherat M, et al. Structural and symptomatic efficacy of glucosamine and chondroitin in knee osteoarthritis. A comprehensive meta-analysis. *Arch Intern Med* 2003;163:1514-1522.

11. Clark K. Nutritional considerations in joint health. *Clinics in Sports Medicine* 2007*;*26(1):101-118.

12. Sawitzke AD, Shi H, Finco MF, et al. The effect of glucosamine and/or chrondroitin sulfate on the progression of knee osteoarthritis: A report from the glucosamine/chondroitin arthritis intervention trial. *Arthritis and Rheumatism* 2008;58(10):3183-3191.

13. Kahan A, Uebelhart D, De Vathaire F, Delmas PD, Reginster J-Y. Long-term effects of chrondriotins 4 and 6 sulfate on knee osteoarthritis. *Arthritis and Rheumatism* 2009;60(2):524-533.

14. Blewett HJH. Exploring the mechanisms behind S-Adenosylmethione (SAMe) in the treatment of osteoarthritis. *Critical Reviews in Food Science and Nutrition* 2008;48:458-463.Goggs R, Vaughan-Thomas A,

15. Halsted C. Dietary supplements and functional foods: 2 sides of a coin? *Am J Clin Nutr* 2003;77(suppl):1001S-1007S.

16. Clegg PD, et al. Nutraceutical therapies for degenerative joint diseases: A critical review. *Critical Reviews in Food Science and Nutrition* 2005;45:145-164.

1. Goggs, R, Vaughan-Thomas, A, Clegg, PD, et. Al. Nutraceutical Therapies for Degenerative Joint Diseases: A Critical Review. Critical Reviews in Food Science and Nutrition, 45:145-164, 2005.

2. Ameye, LG, and Chee, WSS. Osteoarthritis and nutrition. From nutraceuticals to functional foods: a systematic review of the scientific evidence. Arthritis Research and Therapy, 2006, 8:R127

3. Rayman, MP, Pattison, DJ. Dietary manipulation in musculoskeletal conditions. Best Practice and Research Clinical Rheumatology 22(3):535-561, 2008.

4. Arthritis Research Campaign. Complementary and alternative medicines for the treatment of rheumatoid arthritis, osteoarthritis, and fibromyalgia. 2009, www.arc.org

5. Perez-Lopez, FR. Vitamin D and its implications for musculoskeletal health in women: a review. Maturitas 58(2007):117-137.

6. Grant, WB. Epidemiology of disease risks in relation to Vitamin D insufficiency. Prog Biophysics and Molecular Bio 92(2006):65-79.

7. McAlindon, TE, La Valley, MP, Gulin, JP, Felson, DT. Glucosamine and Chondroitin for Treatment of Osteoarthritis. A systematic quality assessment and meta-analysis. JAMA 2000, 283(11):1469-1475

8. Richy, F, Bruyere, O., Ethgen, O, Cucherat, M, et. Al. Structural and Symptomatic Efficacy of Glucosamine and Chondroitin in Knee Osteoarthritis. A comprehensive meta-analysis. Arch Intern Med 2003;163:1514-1522.

9. Cobb, CS, Ernst,E. Systematic review of a marine nutraceutical supplement in clinical trails for arthritis: the effectiveness of the New Zealand green-lipped mussel Perna Canaliculus. Clin Rheumatol (2006) 25:275-284.

PHYSICAL ACTIVITY

1. What is the evidence regarding the effectiveness of this practice?

There is strong scientific evidence from at least 14 systematic reviews and meta-analyses supporting the safety and effectiveness of both aerobic and muscle strengthening exercise, alone or in combination, for adults with hip or knee OA.[1-14] Regular physical activity does not worsen symptoms or hasten disease progression. Beneficial outcomes of various exercise regimes in knee and hip OA patients include reduced pain and disability, and improved function, mental health, quality of life, muscle strength, and balance. Both aerobic and strengthening exercise has been shown to have independent benefits on pain and function.[8,12] Similar effect sizes are also noted across individualized, group classes, and home-based delivery formats.[8,12] The effect sizes for reduced pain are similar to effect sizes reported for analgesic medications (ES = 0.21 for acetametophen and ES = 0.32 for non-steroidal anti-inflammatory drugs). Patients with OA should be counseled to engage in both types of exercise to maximize benefits.

Aerobic activity. The majority of studies measured pain and function using the Western Ontario and McMaster Universities Index of Osteoarthritis (WOMAC) or visual analog scales (VAS). The effect sizes are for aerobic activity (walking, cycling, water exercise, mixed aerobics, etc.) and pain outcomes are small-to-moderate (range 0.32 - 0.52).[5, 6, 12] Walking interventions (ES 0.48, 95% CI 0.13 – 0.83)[12] seemed to have slightly stronger effects on pain compared to water-based exercise programs (ES 0.25, 95% CI 0.02 – 0.47).[6] Effect sizes for function outcomes with aerobic interventions ranged from 0.22 to 0.49,[3-6, 12] with stronger effects reported for objectively measured function (ES 0.49, 95% CI -0.18 – 1.15) versus subjective function (ES 0.14, 95% CI 0.02 -0.26).[5] Programs with combined muscle strengthening and aerobic interventions had slightly stronger effects (ES 0.42; 95% CI 0.18 – 0.65)[12] compared to aerobic walking only (ES 0.35, 95% CI 0.11 – 0.58)[12] and water-based programs (ES 0.23, 95%CI 0.00 – 0.45).[4, 6] Programs (home, group, or individual) with 12 or more supervised contact sessions were significantly more effective (pain ES 0.46, 85% CI 0.32 – 0.60; function ES 0.45, 95% CI 0.29 – 0.62) than programs with less than 12 supervised contacts (pain ES 0.28, 95% CI 0.16 – 0.40; function ES 0.23, 95% CI 0.09 -0.370.[12] Effect sizes for other outcomes were also small-to-moderate (0.17 for stiffness, 0.32 to 0.46 for disability, and 0.32 for quality of life, 0.69 for physical activity behavior).[3-6]

Muscle strengthening. Small-to-moderate effects (ES range 0.29 – 0.53) are also noted for muscle strengthening exercise programs (e.g., simple quadriceps strengthening, global lower limb muscle strengthening).[2, 6, 10, 12] For pain outcomes, global lower limb strengthening seems to have somewhat stronger effects (ES 0.53, 95% CI 0.27 -0.79) than simple quadriceps exercises (ES 0.29, 95% CI 0.06 – 0.51).[12] Effects are similar for function outcomes (ES range 0.24 -0.58),[6, 12] with stronger effects also noted for global lower limb exercise programs (ES 0.58, 95% CI 0.27 -0.88) than simple quadriceps exercises (ES 0.24, 95% CI 0.06 – 0.42).[12] Muscle strengthening programs produced, consistent but variable increases in muscle strength, ranging from 10-50% (average ES 0.38).[2]

Other activities. Both yoga and Tai Chi interventions can be classified as having an exercise component as well as a mind/body component. These interventions are also discussed in the Mind/Body section. Four systematic reviews[6, 7, 9, 12] explicitly stated studies of Tai Chi interventions were included and one systematic review evaluated Tai Chi in OA patients specifically.[3] Due to the small number and size of Tai Chi studies, no definitive conclusions can be drawn regarding reduced pain or improved function outcomes. One small study of yoga in hand OA patients,[15] reported significant reductions in hand pain during activity.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

There is overwhelming evidence to endorse moderate intensity aerobic physical activity and muscle strengthening exercise as a public health intervention for adults with osteoarthritis of the hip and/or knee, but the optimum dose has yet to be determined. However, improved function and muscle strength have been noted with as little as 60 minutes per week of aerobic activity. In general, adults with osteoarthritis should avoid physical inactivity and be encouraged to participate in any amount of moderate intensity aerobic and/or muscle strengthening activities in addition to their usual daily activities.

Different types of low impact aerobic activity (walking, water exercise, cycling, etc.) and strengthening activity (isometric, isotonic and isokinetic) have been shown to benefit pain and function and have been delivered in a variety of formats (home, group, individualized). No single type of activity or delivery format has been determined to be more effective than another. Exercise programs that had 12 or more supervised contact sessions with participants, regardless of delivery format, are likely more effective. Although the optimal dose of physical activity has not been determined, the 'typical' physical activity profile shown to produce health benefits for adults with OA includes:

Aerobic exercise program components,

- Frequency: 3-5 days per week
- Duration: 20-60 minutes per session (total 120-180 minutes/week)
- Intensity: Moderate to vigorous (60-80% maximum)
- Type: Low impact

Muscle strengthening exercise program components (global lower limb),

- Frequency: 2-3 days per week
- Duration: 8-12 repetitions; all major muscle groups
- Intensity: Moderate to vigorous (60-75% of 1 repetition maximum)
- Type: isotonic/iometric/isokinetic

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Most evidence for the effectiveness of exercise is for adults with hip and knee OA. Other types and sites of OA (hand, ankle, spine, upper extremity, etc.) have not been well studied. Aerobic and muscle strengthening exercise has been shown to be safe and effective for both men and women, and adults of all ages and body weights with OA. Few studies have assessed the effectiveness of physical activity in different race/ethnic groups, however, there does not seem to be a physiologic rationale to suggest differential effectiveness based on race/ethnicity.[1]

For most adults with mild to moderate OA, moderate intensity aerobic and muscle strengthening activities are safe and produce substantial health benefits. As such, most persons can self-initiate and monitor their activity

without professional advice. However, persons with special issues (e.g., severe lower extremity malalignment, multiple co-existing chronic conditions) should consult with a health care professional before initiating physical activity.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Since some people may not have access to or desire to participate in group exercise programs, expanding the delivery format options for effective physical activity programs for adults with OA may have the most public health impact. To achieve this, research intervention protocols need to be translated into 'packaged' programs that can be delivered in a variety of community-accessible formats. Characteristics of programs that may best be translated to public health interventions include:

a. Group exercise programs that use certified fitness instructors or other certified group exercise instructors (e.g., not physical therapists, nurses or other health care providers) or self-directed physical activity programs
b. Participant has control over the type of activity (low impact such as walking, cycling, swimming, etc.) and self-paced intensity level
c. Programs that contain $\geq$12 contacts with trained personnel

5. What more research is needed on this practice to address gaps in evidence?

- Identification of the optimal dose of both aerobic and muscle strengthening exercises that produces clinically relevant and patient-oriented outcomes.
- Translation of research protocols into community-based programs.
- Assessing effectiveness of physical activity for OA in joints other than the knee and hip.
- Clinical research on the effects of physical activity effects in persons with moderate to severe tibiofemoral malalignment.

Summary Recommendations

- Aerobic and muscle strengthening exercise has been shown to be safe and effective for both men and women, and adults of all ages and body weights with OA.
- Adults with osteoarthritis should avoid physical inactivity and be encouraged to participate in any amount of moderate intensity aerobic and muscle strengthening activities in addition to their usual daily activities.

References

1. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC: U.S. Department of Health and Human Services; 2008.

2. Lange AK, Vanwanseele B, Fiatarone Singh M. Strength training for treatment of osteoarthritis of the knee: A systematic review. *Arthritis Care Res* 2008:59(10):1488-1494.

3. Lee MS, Pittler MH, Ernst E. Tai chi for osteorarthritis: A systematic review. *Clin Rheumatol* 2008;27:211-218.

4. Bartels EM, Lund H, Hagen KB, Dagfinrud H, Christensen R, Danneskiold-Samsoe B. Aquatic exercise for the treatment of knee and hip osteoarthritis. *Cochrane Database of Systematic Reviews* 2007; Issue 4, No. CD005523.

5. Conn VS, Hafdahl AR, Minor MA, Nielsen PJ. Physical activity interventions among adults with arthritis: Meta-analysis of outcomes. *Seminar Arthr Rheum* 2008:37(5):307-316.

6. Zhang W, Moskowitz RW, Nuki G, Abramson s, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, Part I: Critical appraisal of existing treatment guidelines and systematic review of current research evidence. *Osteoarthritis Cartilage* 2007:15:981-1000.

7. Vignon E, Valat JP, Rossignol M, et al. Osteoarthritis of the knee and hip and activity: A systematic international review and synthesis (OASIS). *Joint Bone Spine* 2006;73:442-455.

8. Roddy E, Zhang W, Doherty M, et al. Evidence-based recommendations for the role of exercise in the management of osteoarthritis of the hip or knee – the MOVE consensus. *Rheumatology* 2005;44;67-73.

9. Brosseau L, Pelland L, Wells G, et al. Efficacy of aerobic exercises for osteoarthritis (Part II): A meta-analysis. *Physical Ther Rev* 2004;9:125-145.

10. Pelland L, Brosseau L, Wells G, et al. Efficacy of strengthening exercises for osteoarthritis (Part II): A meta-analysis. *Physical Ther Rev* 2004;9:77-108.

11. Roddy E, Zhang W, Doherty M. Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. *Ann Rheum Dis* 2005;64:544-548.

12. Fransen M, McConnell S. Exercise for osteoarthritis of the knee. *Cochrane Database of Systematic Reviews*, 2008 Issue 4, No. CD004376.

13. American Geriatrics Society Panel on Exercise and Osteoarthritis. Exercise prescription for older adults with osteoarthritis pain: Consensus practice recommendations. *J Am Geriatri Soc* 2001;49;808-823.

14. van Baar ME, Assendelft WJ, Dekker J, Oostendorp RAB, Bijlsma JWJ. Effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee. *Arthritis Rheum* 1999;42(7):1361-1369.

15. Garfinkel MS, Schumacher HR, Husain A, Levy M, Reshetar RA. Evaluation of a yoga based regimen for treatment of osteoarthritis of the hands. *J Rheumato* 1994;21:2341-2343.

SELF MANAGEMENT EDUCATION

Search Strategy

Standard search strategy was modified. Four meta-analyses were conducted 2003-2006. These formed the original basis for the review. We re-ran the search using the same search terms but limiting the time period to 2003 to present, and also included studies identified through hand search of relevant literature.

Inclusion Criteria

- Intervention described meets the definition of self management education (Self management education: Interactive educational interventions specifically designed to enhance patient self management. Self management education focuses on building generalizable skills such as goal setting, decision-making, problem-solving, and self monitoring.)

- Participants include people with Osteoarthritis, unspecified forms of arthritis, or mixed types of arthritis that include OA or unspecified. Interventions that are specific to another form of arthritis (not OA) would be excluded. (this means RA alone studies would be excluded)
- Report includes some quantifiable data (for decisions on efficacy/effectiveness) OR some process evaluation descriptors (for recommendations on supporting structures); this includes full and brief reports.
- Report is available in English
- Intervention was offered in English speaking country (US, UK, Canada, Australia, New Zealand) regardless of language of intervention delivery

1. What is the evidence regarding the effectiveness of this practice?

- These meta-analyses used unspecified or broad definitions of self management education, and generally included multiple formats of education from information dissemination to 1:1 education, and small group sessions. The heterogeneity of both interventions and participating populations makes the results hard to interpret, and the benefits of more efficacious programs may be masked.
- In general, the four meta-analyses[1-4] conducted between 2003 and 2006 found small statistically significant changes in pain (ES 0.06- 0.12) and disability (ES 0.04- 0.07), which most authors thought of questionable clinical significance. Pain and disability/function were the primary outcomes used in most of the meta-analyses.
- One meta-analysis also examined psychological outcomes[2] found a significant moderate effect size (0.20) for psychological outcomes and a small but significant (0.11) effect size for overall impact of OA, which the authors considered "a modest, yet clinically important, influence on patients' well-being."
- Eleven individual studies published since 2003 also show positive benefits, and include a wider range of outcomes. Many of these studies (most of which are randomized and examine the Stanford small group model of self management education) show positive effects on pain, self efficacy, and mental health/behavioral/psychological benefits such as reductions in anxiety, depression, and health distress. Some of them also show positive benefits in activity limitation or function and exercise behaviors.[5-16]
- In contrast to the earliest studies of the small group model of self management education, neither the meta-analysis or the more recent individual studies show significant decreases in health care utilization from these self management education interventions.
- Very little is known about dose effects of self management education. One study[17] compared the effects of 6 and 3 week versions of self management education classes with a 1.5 hour version. The 3 week version showed changes in health distress and self efficacy but not health outcomes or health behaviors,; the 1.5 hour class showed increases in self efficacy, knowledge, and contact with AF.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Yes, there is evidence to support self management education as an effective public health intervention. While the effects on pain and disability, as determined by meta-analyses, were small, these small effects can be collectively large when evaluated on a population basis. Further, evidence suggests that these types of programs can produce mental health/psychological benefits such as reductions in anxiety, depression, and health distress, outcomes most of the meta-analyses did not investigate. These benefits, along with the absence of side effects, make self management education a valuable public health intervention and a useful adjunct to care delivered in a clinical setting.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

The evidence on effectiveness of self management education in diverse populations is limited. Most of the research has been conducted on older Caucasian women with higher education, although a recent study of predominately African Americans in rural North Carolina,[9] and a Spanish version of the Arthritis Self Management Program[16] both produced positive effects. Similarly a pre-post evaluation of CSDMP delivered to African American seniors produced outcomes consistent with other groups.[8]

There is also a need to clarify which outcomes are most relevant for this intervention; a focus on traditional clinical outcomes (i.e., pain and disability) may overlook benefits in maintaining valued life roles and managing the emotional stress living with a chronic disease.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

Ongoing learning on the effect of these programs is important, particularly as they are delivered in new populations. This can be accomplished through the collection of pre and post intervention data as programs establish wide-spread use.

It is also important to develop alternative modes of program delivery, new venues of delivery, and new kinds of partnerships to support program delivery. Any organization whose mission includes fostering population health can be a viable program delivery partner.

Tools to support efficient and effective program implementation would be helpful. These include, but are not limited to, tools to guide an organization's decision to adopt a specific intervention program, foster quality improvement, engage participants in the organizational structure, calculate cost of program delivery, recruit participants, and support program implementers.

5. What more research is needed on this practice to address gaps in evidence?

It is important to:

- Explore the benefits and acceptability of the program in more culturally diverse populations through both systematic research and learning from experiences in the field.
- Identify effective strategies to reach diverse populations.
- Identify characteristics of people most likely to benefit from self-management education utilizing not only demographic characteristics but also health status and symptom levels. This information could be useful in targeting interventions to those most likely to benefit. One study[18] found that those with lower self efficacy and health related quality of life, and younger people, were most likely to benefit.
- Identify key characteristics or essential elements of effective interventions (i.e., the importance of modeling, problem-solving, goal-setting, motivational interviewing, follow up support and other program features) through both systematic research and practical learning in the field.
- Understand the interface between self management education programs and clinical care (e.g., is the effectiveness of self management education programs influenced by the degree of self management support provided in the clinical setting.)
- Systematically examine the benefits of specific self management education intervention rather than attempting to examine effects across multiple forms of intervention.
- Conduct cost studies to determine the costs of program delivery as well as cost-effectiveness studies comparing different forms of self management education interventions.

References

1. Chodosh J, Morton Sc, Mojica W, et al. Meta-analysis: Coronic disease self management programs for older adults. *Ann Inter Med* 2005;143:427-438.

2. Devos-Comby L, Cronan T, Roesch SC. Do exercise and self-management interventions benefit patients with OA of the knee: A meta-analytic review. *J Rheumatology* 2006;33:744-756.

3. Warsi A, LaValley MP, Wang PS, Avorn J, Solomon DH. Arthritis self management education programs: A meta-analysis of the effect on pain and disability. *Arthritis & Rheumatism* 2003; 48:2207-2213.

4. Warsi A, Wang PS, LaValley MP, Avorn J, Solomon DH. Self management education programs in chronic disease: A systematic review and methodological critique of the literature. *Arch Inter Med* 2004;164:1641-1649.

5. Blixen CE, Bramstedt KA, Hammel JP, Tilley BC. A pilot study of health education via nurse run telephone self management program for elderly people with OA. *Journal of Telemedicine and Telecare* 2004;10:44-49.

6. Buszewicz M, Rait G, Griffin M, et al. Self management in primary care: Randomized controlled trial. *BMJ* 2006; 879.

7. Dennis MP, Barlow J, Turner A, et al. An 8 Year follow up of Arthritis Self Management Program participants. *Rheumatology* 2009; 48:128-133.

8. Gitlan LN, Chernett NL, Harris LF, Palmer D, Hopkins P. Harvest Health: Translation of CDSMP for older African Americans in a senior setting. *The Gerontologist* 2008;48;698-705.

9. Goeppinger J, Armstrong B, Schwartz T, Ensley D, Brady TJ. Self management education for persons with arthritis: Managing co-morbidities and eliminating health disparities. *Arthritis & Rheumatism* (Arthritis Care & Research) 2007; 57:1081-1088.

10. Kennedy A, Reeves D, Bower P, et al. The effectiveness and cost effectiveness of a national lay-led self care support programme for patients with long-term conditions: A pragmatice randomised controlled trial. *Journal of Epidemiology and Community Health* 2007; 61:254-261.

11. Lorig K, Ritter P, Plant K. A disease specific self-help program compared with a generalized chronic disease self help program for arthritis patients. *Arthritis & Rheumatism* (Arthritis Care & Research) 2005; 53:950-957.

12. Lorig KR, Ritter PL, Laurent DD, Plant K. The internet-based arthritis self management program: A one year randomized trial for patients with arthritis or fibromyalgia. *Arthritis & Rheumatism* (Arthritis Care & Research) 2008;57:1009-1017.

13. Matire LM, Schulz R, Keefe FJ, et al. Feasibility of dyadic intervention for management of OA: A pilot study with older patients and their spousal caregivers. *Aging & Mental Health* 2003:7:53-60.

14. Martire L, Schulz R, Keefe FJ, Rudy TE, Starz TW. Couple-oriented education and support intervention: Effects on individuals with osteoarthritis and their spouses. *Rehabilitation Psychology* 2007; 52:121-132.

15. Osborne RH, Wilson T, Lorig KR, McColl G. Does self management lead to sustainable health benefits in people with arthritis? A 2 year transition study of 452 Australians. *Journal of Rheumatology* 2007;34:1112-1117.

16. Wong A, Harker JO, Lau VP, Shatzel S, Port LH. Spanish Arthritis Empowerment Program: A dissemination and effectiveness study. *Arthritis & Rheumatism* (Arthritis Care & Research) 2004;51:332-336.

17. Lorig K, Gonzales VM, Laurent DD, Morgan L, Laris BA. Arthritis self management program variations: Three studies. *Arthritis Care Res* 1998 Dec;11(6):448-54.

18. Reeves D, Kennedy A, Fullwood C, et al. Predicting who will benefit from an expert patient programme self management course. *Br J Gen Pract* 2008 Mar;58(548):198-203.

WEIGHT MANAGEMENT

1. What is the evidence regarding the effectiveness of this practice?

There are at least 4 systematic reviews[1-4] and 7 randomized controlled trials[5-11] addressing the efficacy of non-pharmacologic weight management approaches (physical activity, dietary modification, or both in combination) in the treatment of osteoarthritis (OA). Many of the available studies have focused upon knee OA. Collectively, the findings of these studies suggest that modest weight loss results in meaningful improvements in clinically-relevant OA outcomes such as physical function, self-reported disability, pain symptoms, and quality of life. The effect sizes accompanying the change in these outcomes were variable ranging from small (d = .21) to moderate (d = .72) in magnitude.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

Although there are still relative few RCTs examining the efficacy of weight management interventions in the treatment of overweight or obese OA patients, the somewhat limited amount of existing evidence supports the beneficial effect of weight control approaches on a variety of relevant OA outcomes. RCTs examining the benefits of weight loss interventions for the treatment of OA have primarily focused upon overweight or obese individuals with knee OA.[3,5,6] Thus, it should be recognized that the extent to which the benefits of weight management interventions may generalize to other segments of the OA population presently remains unclear. Additionally, it is unknown if the benefits of weight loss interventions observed in previous trials are attributable to weight loss, behavior change, or a synergistic combination of behavior change and weight loss. There is also considerable body of epidemiological evidence supporting the link between obesity and the risk of *developing* OA in the lower extremity joints, particularly knee OA.[12-15] Indeed, findings in the literature consistently demonstrate that higher body mass index (BMI) is strongly associated with increased risk of developing knee OA. Conversely, however, evidence supporting the relationship between BMI and the *progression* of OA in the lower extremity joints presently remains equivocal.[16-18] Thus, whereas there is strong evidence that BMI is linked with increased risk of incident knee OA, much less is known about the extent to which BMI may exacerbate the progression of OA in persons diagnosed with the disease. Together, these findings underscore the potential public health importance of implementing appropriate weight management approaches in the prevention and treatment of OA.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

In general, empirical evidence suggests weight management via physical activity and dietary modification yields benefits for relevant OA outcomes irrespective of affected lower extremity joint (i.e., hip or knee), gender, age, occupation or disease status.[3,4,5,6,14] However, there is presently little evidence directly addressing the potential moderating factors of weight loss interventions. It is notable that no randomized controlled trials have directed assessed if potentially relevant factors such as gender, age, disease status, physical activity status, or occupation may impact the extent to which weight loss interventions may benefit OA patients. It is also important to acknowledge that there is emerging evidence suggesting that body weight may be of greater concern among patients burdened with knee OA relative to patients diagnosed with hip OA.[16,17] Additionally, evidence from recent observational studies suggests that the role of knee joint alignment may influence the extent to which body weight impacts disease severity.[16,17] Nonetheless, no randomized trials have directly addressed if the benefits of weight loss interventions are consistent across OA patients characterized by differing limb malalignment. Collectively, contemporary extant evidence suggests the relationship between body weight and the development and progression of knee OA is complex.[4, 16-18] Accordingly, this relationship warrants further investigation to appropriately formulate recommendations for public health practice regarding the scope of the benefits of weight management interventions for OA patients.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

There are currently no trials of community-based weight management interventions targeting people with OA. Numerous evidence-informed community-based interventions designed to address population overweight and obesity through increasing physical activity and improving eating behaviors are currently underway across the US with state and federal funds. These efforts would be expected to also affect population members with OA. The success of these efforts in producing durable decreases in prevalence of overweight and obesity among any population groups is not yet known. And further the efficacy of any decreases in prevalence of overweight and obesity on relevant OA outcomes is not currently known.

5. What more research is needed on this practice to address gaps in evidence?

Whereas evidence of the benefits of weight management for OA patients continues to grow, there are several areas relevant to this topic that warrant future inquiry. Notably, *determining which patients may benefit the most from weight management interventions* is integral. Although current evidence suggests that weight management is a promising intervention that results in significant improvement in relevant OA outcomes irrespective of affected lower extremity joint (i.e., hip or knee), gender, age, occupation, or disease status, no randomized controlled trials have directly addressed the impact of these factors. Thus, future research is needed to determine the extent to which such factors may moderate the benefits of weight management approaches. Developing a more comprehensive understanding of the extent to which knee malalignment may influence the development and progression of OA and, subsequently, the efficacy of weight loss interventions in knee OA patients is also of particular importance. A second possible area for future research is defining how much weight loss is required to yield benefits for overweight OA patients. Extant findings suggest that, in studies primarily addressing knee OA patients, modest weight loss (approximately 5% of body weight) yields meaningful improvements in OA outcomes.[5,6] However, the amount of weight loss necessary to produce optimal improvements remains unclear and maintenance of weight loss remains a serious challenge for many patients [(4-6)]. Finally, although physical activity and dietary modification are effective weight management strategies for persons with OA, adoption and adherence to these behavior changes remains a primary barrier

to the efficacy of such approaches. Research determining the most effective approaches to promote adoption and self-regulation of these behavior changes is also warranted.

References

1. Fransen M, McConnell S, Bell M. Therapeutic exercise for people with osteoarthritis of the hip or knee: A systematic review. *J Rheumatol* 2002*;29:*1737-1745.
2. Petrella RJ. Is exercise an effective treatment for osteoarthritis of the knee? *Br J Sports Med* 2000;34*:*326-331.
3. Focht BC. Effectiveness of exercise interventions in reducing pain symptoms among older adults with knee osteoarthritis: A review. *J Aging Phys Act* 2006;14*:*212-235.
4. Focht BC. Obesity and knee osteoarthritis: Behavioral considerations in weight management. *Int J Adv Rheum* 2007;4:128-132.
5. Messier SP, Loeser RF, Miller GD, et al. Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis. *Arthritis Rheumatol* 2004; 50:1501-1510.
6. Miller GD, Nicklas BJ, Davis C, et al. Intensive weight loss program improves physical function in older obese adults with knee osteoarthritis. *Obesity* 2006;14:1219-1230.
7. Ettinger WH, Burns R, Messier SP, et al. A randomized clinical trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis. *JAMA 1997;277:*25-31.
8. Fransen M, Crosbie J, Edmonds J. Physical therapy is effective for patients with osteoarthritis of the knee: A randomized controlled trial. *J Rheumatol 2001;28:*156-164.
9. O'Reilly S, Muir KR, Doherty M. Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: A randomised controlled trial. *Ann Rheum Dis* 1999;58:15-19.
10. Petrella RJ, Bartha C. Home-based exercise therapy for older patients with knee osteoarthritis: A randomized clinical trial. *J Rheumatol* 2000;27:2215-2221.
11. VanBaar ME, Dekker J, Oostendorp RA, et al. Effectiveness of exercise in patients with osteoarthritis of the hip or knee: Nine months' follow-up. *Ann Rheum Disease* 2001;60:1123-1130.
12. Englund M, Lohmander LS. Risk factors for symptomatic knee osteoarthritis fifteen to twenty-two years after meniscectomy. *Arthritis Rheum* 2004; 50:2811-2819.
13. Oliveria SA, Felson DT, Cirillo PA, et al. Body weight, body mass index, and incident symptomatic osteoarthritis of the hand, hip, and knee. *Epidemiol* 1999;10:161-166.
14. Felson DT, Zhang Y, Anthony JM, et al. Weight loss reduces the risk for symptomatic knee osteoarthritis in women. The Framingham Study. *Ann Intern Med* 1992;116:535-539.
15. Schouten JS, van den Ouweland FA, Valkenburg HA. A 12 year follow up study in the general population on prognostic factors of cartilage loss in osteoarthritis of the knee. *Ann Rheum Dis* 1992;51:932-937.
16. Sharma L, Lou C, Cahue S, et al. The mechanism of effect of obesity in knee osteoarthritis: the mediating role of malalignment. *Arthritis Rheum* 2000;43:568-575.
17. Felson DT, Goggins J, Niu J, et al. The effect of body weight on progression of knee osteoarthritis is dependent on alignment. *Arthritis Rheum* 2004;50:3904-3909.

WORKPLACE INTERVENTIONS

The operational definition for workplace intervention is a method (or methods) used in the workplace that is designed to reduce the incidence or severity of osteoarthritis in that given occupational group.

Literature Search Process

A literature search was undertaken using the databases PubMed, Embase, CINHAHL, and the main NIOSH database (NIOSHTIC) for articles that investigated the effectiveness of workplace interventions for osteoarthritis. The keyword 'osteoarthritis' was used in conjunction with other terms that included workplace interventions, intervention effectiveness, occupation, work, jobs, job, employment, labor, laborer, epidemiology, etiology, economics, prevention and control, radiography, and diagnosis. The lists of articles retrieved were reviewed to select relevant articles. The search was limited to articles published in the English language for all years.

Background

There is a significant need for the development of workplace interventions for osteoarthritis because the burden of occupational OA is substantial. The prevalence of clinical osteoarthritis among US adults was nearly 27 million in 2005, up from the estimate of 21 million for 1995.[1] This prevalence is projected to rise to approximately 59.4 million people in 2020, an increase of 57% in number of persons affected.[1]

Workers in every occupational sector are affected. A high prevalence of OA has been reported among masons and other construction workers, and female cleaners have been shown to have a prevalence of OA that is more than six times higher than expected.[2-3] Workers having knee OA include shipyard laborers,[4-5] miners,[6] dockers,[4-5] and female cleaners.[2] Workers at high risk of hip OA include farmers and other agriculture workers,[7-10] material handlers, male drivers, and female employees in hotels, restaurants, and personal services.[2,11] Workers at high risk of hand OA include cotton workers and mill workers,[12-13] pneumatic drill operators,[14] and women in the clothing industry.[2] Miners have been observed to have higher prevalence of OA of the spine.[6]

1. What is the evidence regarding the effectiveness of this practice?

Among the relatively small number of retrieved publications and one review[15] that described worksite interventions, almost all focused on interventions for rheumatoid arthritis. One publication discussed occupational interventions for both rheumatoid arthritis (RA) and osteoarthritis (OA); however, it involved two meta-analyses, one on patient education interventions and the other on NSAID treatments for both types of arthritis.[16] The results of the meta-analysis for education interventions showed that psychobehavioral interventions were more efficacious (i.e., the effect size was greater) in improving RA and OA health outcomes than education interventions that only provide information. For example, the effect sizes for the psychobehavioral vs. the information only interventions were, pain, 0.18 vs. 0,07; disability, 0.05 vs. -0.19; and tender joint count, 0.43 vs. -0.12. It should be mentioned, however, that cointervention with medications was present in most of these trials.

A search of the website clinicaltrials.gov identified a randomized clinical trial conducted in 2003-2008 that investigated the efficacy of a worksite-based intervention for RA and OA (http://clinicaltrials.gov/ct2/show/NCT00485914?term=work+ interventions+ and+ osteoarthritis&rank=1). Persons with work difficulties related to RA or OA had an occupational therapist provide a worksite evaluation and training in strategies to improve job performance and satisfaction while participants in the control group were provided with educational materials for a self-initiated worksite evaluation. However, results that described the effectiveness of this intervention have not yet been published. NIOSH Publication No. 2008-130, Keeping Knees Healthy in Restricted Work Spaces, Applications in Low-Seam Mining was generated by NIOSH researchers, along with industry and academia, as a training package to educate the mining community about some possible interventions beyond kneepads that may be used to help decrease knee injury rates potentially related to osteoarthritis. However, the effectiveness of this training intervention has not been published.

2. Is the evidence sufficient to endorse this practice as a public health intervention? Why or why not?

At the present time, there is a paucity of workplace OA-specific interventions, and the effectiveness of those have not been published.

3. Are there specific populations and/or circumstances that should 'frame' a recommendation regarding this intervention? For example, what is the intended outcome of the intervention and for whom?

Based on the lack of evidence addressing the efficacy of workplace interventions, it is premature to develop recommendations to frame these interventions.

4. What tools, policies or other efforts should be recommended to implement and sustain this practice as a community-based intervention (e.g., to enhance fidelity; management/staff recruitment, training and retention; reach; feasibility)?

There is currently one trial of workplace OA intervention designed as a clinical trial. The results of this study have not yet been published. Thus, there is no evidence at this time suggesting that workplace interventions will reduce the incidence in high-risk occupations, delay disease progression, or lessen the effects (symptoms, functional impairment, disability, etc.) of OA.

5. What more research is needed on this practice to address gaps in evidence?

Several occupational risk factors are known to be associated with OA. They include heavy physical workload;[17-21] frequent knee bending;[17-18] squatting or kneeling >30 min/day, climbing >10 flights of stairs/day;[22] exposure to biomechanical stresses such as uncomfortable position of the joint, work in vibrating vehicle or with vibrating tools, continuous repetitive movements, work at a pace set by a machine;[2] and lifting heavy objects.[2] However, there is much we do not know regarding occupational OA. Additional research on these key areas is needed:

1. Need for an in-depth understanding of the underlying mechanisms involved with OA in order to develop effective interventions. This inquiry should address the continuum from biomechanical loading profiles to bone changes and bone mechanical properties, to cartilage mechanical properties and remodeling or pathogenesis kinetics, to the molecular pathways pertaining to inflammation, pain, and oxidative stress and those effects on cartilage integrity, the role of genetics in disease ontogeny, and possible countermeasures to maintain and promote cartilage health during the lifespan of the worker.

2. Need to investigate the progression or ontogeny of OA in the occupational lifespan of workers. Understanding the kinetics of OA progression, the dynamics of the OA susceptibility response with age, and how that curve is affected by job classification is important in order to design effective interventions. Included in this is how prior joint trauma such as meniscal tears, ACL ruptures, bone fractures, etc. increase the risk and progression of OA that has occupational ramifications.

3. Need for studies to evaluate intervention effectiveness in occupational settings as well as the role of the workplace as a setting to disseminate known effective interventions such as physical activity programs and self-management education.

Summary

Despite the heavy burden of OA on workers of every sector, no published studies could be found that describe or evaluate occupational interventions for OA. This gap presents considerable opportunity for investigators in occupational health to address underlying mechanisms and potential interventions for OA prevention and management. The implementation of effective interventions in the workplace could reduce pain and psychological anguish, improve productivity rates and morale, and decrease economic costs for employers.

Summary Recommendation

There needs to be an expansion of occupational research to describe the epidemiology of and evaluate potential prevention and management interventions for OA among the US workforce.

Potential Surveillance Activities

Surveillance systems should be developed or enhanced to collect data on OA among workers of various sectors.

References

1. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al, and the National Arthritis Data Workgroup. Estimates of the prevalence of arthritis andother rheumatic conditions in the United States. Part II. *Arthritis Rheum* 2008;58(1):26-35.

2. Rossignol M, Leclerc A, Allaert FA, et al. Primary osteoarthritis of hip, knee, and hand in relation to occupational exposure. *Occup Environ* Med 2005;62:772-777.

3. Rossignol M. Primary osteoarthritis and occupation in the Quebec national health and social survey. *Occup Environ Med* 2004;61:729-735.

4. Partridge RE, Duthie JJ. Rheumatism in dockers and civil servants. A comparison of heavy manual and sedentary workers. *Ann Rheum Dis* 1968;27:559-568.

5. Lindberg H, Montgomery F. Heavy labor and the occurrence of gonarthrosis. *Clin Orthop Relat Res* 1987;214:235-236.

6. Kellgren JH, Lawrence JS. Rheumatism in miners. Part II: X-ray study. *Brit J Ind Med* 1952;9:197-207.

7. Typpo T. Osteoarthritis of the hip. Radiologic findings and etiology. *Ann Chir Gynaecol Suppl* 1985;201:1-38.

8. Jacobsson B, Dalen N, Tjornstrand B. Coxarthrosis and labour. *Int Orthop* 1987;11:311-313.

9. Thelin A. Hip joint arthrosis: An occupational disorder among farmers. *Am J Ind Med* 1990;18:339-343.

10. Croft P, Coggon D, Cruddas M, Cooper C. Osteoarthritis of the hip: An occupational disease in farmers. *BMJ* 1992;304:1269-1272.

11. Cvijetic S, Dekanic-Ozegovic D, Campbell L, Cooper C, Potocki K. Occupational physical demands and hip osteoarthritis. *Arh Hig rada toksikol* 1999;50:371-379.

12. Lawrence JS. Rheumatism in cotton operatives. *Brit J Ind Med* 1961;18:270-276.

13. Hadler NM, Gillings DB, Imbus HR, et al. Hand structure and function in an industrial setting. *Arthritis Rheum* 1978;21:210-220.

14. Mahalik J, Shigaki CL, Baldwin D, Johnstone B. A review of employability and worksite interventions for persons with rheumatoid arthritis and osteoarthritis. *Work* 2006;26:303-311.

15. Superio-Cabuslay E, Ward MM, Lorig KR. Patient education interventions in osteoarthritis and rheumatoid arthritis: a meta-analytic comparison with nonsteroidal anti-inflammatory drug treatment. *Arthritis Care Res* 1966;9(4):292-301.

16. Copeman W. The arthritis sequelae of pneumatic drilling. *Ann Rheum Dis* 1940;2:141-146.

17. Anderson JJ, Felson DT. Factors associated with osteoarthritis of the knee in the First National Health and Nutrition Examination Survey HANES I.: evidence for an association with overweight, race and physical demands of work. *Am J Epidemiol* 1988;128:179-189.

18. Felson DT, Hannan MT, Naimark A, et al. Occupational physical demands, knee bending, and knee osteoarthritis: results from the Framingham Study. *J Rheumatol* 1991;18:1587-1592.

19. Vingard E, Alfredsson L, Goldie I, Hogstedt C. Occupation and osteoarthrosis of the hip and knee: a register-based cohort study. *Int J Epidemiol* 1991a;20:1025-1031.

20. Vingard E, Hogstedt C, Alfredsson L, Fellenius E, Goldie I, Koster M. Coxarthrosis and physical work load. *Scan J Work Environ Health* 1991b;17:104-109.

21. Roach KE, Persky V, Miles T, Budiman-Mak E. Biomechanical aspects of occupation and osteoarthritis of the hip: a case-control study. *J Rheumatol* 1994;21:2334-2340.

22. Cooper C, McAlindon T, Coggon D, Egger P, Dieppe P. Occupational activity and osteoarthritis of the knee. *Ann Rheum Dis* 1994;53:90-93.

ATTACHMENT E

Research Agenda

ACUPUNCTURE

While additional research to better define the role of acupuncture as a clinical intervention for OA appears justified, further research on the implementation of acupuncture as a public health intervention for OA is not warranted at present.

BIOMECHANICS

- Test the effectiveness of the clinical interventions that have demonstrated efficacy in reducing OA symptoms (patella taping, medial wedge orthotics for lateral tibiofemoral OA, shock absorbing insoles and Masai Barefoot technology) in a variety of public health settings
- Test the effect of interventions such as barefoot walking, canes, soft orthoses, reducing heel height, and modified shoes that have important effects on mechanical loading, entail little risk, and may have substantial impact in a public health setting if appropriately trialed

EARLY DIAGNOSIS AND TREATMENT

- Discover treatments that can reduce the radiologic progression and the pain, activity limitations, and participation restrictions associated with OA
- Test a variety of symptom, physical exam, imaging, and biomarker approaches to screening for early OA
- Gather evidence that screening and early treatment prevents (or reduces) radiologic progression and the pain, activity limitations, and participation restrictions associated with OA

INJURY PREVENTION

For Knee Ligament and Meniscal Injuries

- Develop and maintain integrated surveillance systems to monitor the incidence and outcomes of major ligament and meniscal injuries including expanded descriptive epidemiology of the mechanisms, activities at time of injury, and modifiable risk factors
- Identify subgroups with the highest risk of ACL injury, including identification of the contribution of multiple risk factors, for targeted program development and implementation
- Delineate specific components of the neuromuscular conditioning programs that prevent ligamentous and meniscal injuries

- Standardize program components (composition, dose, timing, length of program, etc.), develop training and delivery infrastructure, fidelity monitoring plan, etc.
- Test effectiveness of interventions in diverse populations including different sports, age groups and competition levels
- Conduct consumer research (parents, athletes, coaches, administrators, etc.) on feasibility and barriers/facilitators to implementation
- Support cost effectiveness studies of public health strategies to prevent ligamentous and meniscal injuries

For Ankle Sprains and Fractures

- Identify the prevalence of breakaway bases use at all levels of competitive and recreational baseball and softball play
- Conduct consumer research (players, coaches, facilities managers, etc.) to identify barriers to implementation of breakaway bases for baseball and softball
- Evaluate rule/policy changes to document effective reduction in ankle injuries, cost savings and other outcomes (intended and unintended)
- Develop and maintain surveillance systems to monitor the incidence and outcomes of ankle sprains and fractures
- Identify mechanisms and risk factors for ankle sprain/fracture injuries that occur in non-sports settings (e.g., home and leisure, excluding sports)

MIND/BODY

- Conduct further randomized control trials specifically targeting persons with OA to determine the efficacy of mind/body approaches to reduce pain, activity limitation, and participation restriction

In order to develop a public health intervention:

- Determine the potential feasibility and benefits of mind/body interventions in samples of persons with OA characterized by different age groups and more cultural diversity
- Examine the extent to which the feasibility of delivering mind/body techniques is impacted by the need for education/training from a qualified professional and consistent practice-related proficiency on the part of the participant to benefit from these techniques

NUTRITION

- Increase our understanding of the relationship between dietary intake and OA outcomes
- Evaluate the potential for therapeutic use of plant and animal based preparations used as dietary supplements in reducing OA associated pain, activity limitation, and participation restriction, with the same rigor as pharmaceutical preparations for safety and efficacy and comparative use and value

- Consider potential additive and synergistic effects when multiple preparations and treatment modalities are used, along with their risks

Physical Activity

- Assess effectiveness of physical activity to reduce OA associated pain, activity limitation, and participation restrictions in joints other than the knee and hip
- Identify the optimal doses of lifestyle physical activity and aerobic and muscle strengthening exercises that produce clinically relevant and patient-oriented OA outcomes
- Translate research protocols into community-based programs and test the effectiveness and cost-effectiveness of these programs in diverse OA populations

Self Management Education

- Explore the benefits and acceptability of self-management education program in more culturally diverse OA populations through both systematic research and learning from experiences in the field
- Identify effective strategies to disseminate self-management education programs to diverse OA populations
- Identify characteristics of people with OA most likely to benefit from self-management education utilizing not only demographic characteristics but also health status and symptom levels. This information could be useful in targeting interventions to those most likely to benefit
- Identify key characteristics or essential elements of effective self-management interventions for persons with OA (i.e., the importance of modeling, problem-solving, goal-setting, motivational interviewing, follow up support and other program features) through both systematic research and practical learning in the field
- Understand the interface between self management education programs and clinical care for persons with OA (e.g., the extent to which the effectiveness of self management education programs is influenced by the degree of self management support provided in the clinical setting)
- Systematically examine the benefits of specific self management education interventions on OA outcomes rather than attempting to examine effects across multiple forms of intervention
- Conduct cost studies to determine the costs of program delivery as well as cost-effectiveness studies comparing different forms of self management education interventions in OA populations

Weight Management

- Determine which persons with OA may benefit the most from weight management interventions (e.g., the extent to which knee malalignment influences the effect of weight loss on OA outcomes in overweight and obese persons with knee OA)
- Define how much weight loss is required to yield pain relief and disability prevention benefits for overweight persons with OA

- Determine the most effective client and population approaches to promote adoption and self-regulation of weight loss and similar behavior changes in persons with OA

WORKPLACE

- Develop an in-depth understanding of the underlying mechanisms involved with OA in order to develop effective interventions, addressing the continuum from biomechanical loading profiles to bone changes and bone mechanical properties, to cartilage mechanical properties and remodeling or pathogenesis kinetics, to the molecular pathways pertaining to inflammation, pain, and oxidative stress and those effects on cartilage integrity, the role of genetics in disease ontogeny, and possible countermeasures to maintain and promote cartilage health during the lifespan of the worker
- Investigate the progression or ontogeny of OA in the occupational lifespan of workers
- Evaluate intervention effectiveness in occupational settings as well as the role of the workplace as a setting to disseminate known effective interventions such as physical activity programs and self-management education

OVERALL

- Identify valid and responsive markers of OA structural damage
- Develop and perform research on a multiple risk factor intervention for the prevention of OA-associated structural damage, symptoms, activity limitation, reduced quality of life, and participation restriction for persons with knee OA and those at risk for knee OA