OSTEOARTHRITIS (OA) affects approximately 1 out of every 2 adults over age 65 and 85% of those 75 years and older.\(^1\) Approximately 21 million Americans have OA, with healthcare costs for its management in the United States exceeding $60 billion annually.\(^2\) The World Health Organization (WHO) has reported that knee OA is the fourth most important global cause of disability in women, and the eighth most important in men.\(^3\) Knee OA is the most common form of degenerative joint disease, which affects both men and women and has increasing prevalence with advancing age. When considering the aging population of today’s society, the economic burden of this musculoskeletal disorder is increasing at a staggering rate. The purpose of this report is to highlight the need for exercise interventions in the treatment of knee OA. Exercise can be beneficial for knee OA patients; however, the extent of the role exercise plays is dependent on the stage of disease severity and the age of the patient. This report provides information on the role exercise can play in the treatment of all levels of knee OA severity.

**Pathoetiology of Knee OA**

Knee OA can involve multiple structures of the joint complex; however, the primary pathological ailment is an alteration in the normal process of articular cartilage degradation and synthesis. This alteration results in erosion of the cartilage, which leads to a decrease in the cushioning of the joint articular surfaces. Concurrently, osteophytes develop at the joint margins and bone cysts develop adjacent to the articular cartilage. With the progression of hyaline cartilage degradation, the arthrokinematics of the joint become altered, which causes abnormal loading patterns and contact pressures on the joint surfaces. Ultimately, this induces chronic joint pain, chronic swelling, joint malalignment, and decreased function.

**Neuromuscular Consequences of Knee OA**

Many patients with knee OA exhibit atrophy of the muscles surrounding the joint, especially in the quadriceps muscle group. Quadriceps atrophy presents two clinical problems: diminished dynamic joint stability and decreased strength. The gradual decline in quadriceps strength seen in knee OA has been attributed in part to arthrogenic muscle inhibition, which is an impairment in the central nervous system’s ability to fully
activate the muscle. The quadriceps muscle group is the primary dynamic stabilizer of the knee joint; active contraction reduces displacement of the tibia on the femur. Therefore, quadriceps atrophy could lead to excessive loading of the knee during activities of daily living that require quadriceps activation for maintenance of knee stability (e.g., level walking, stair climbing). Increased loading can accelerate the degeneration of the joint surfaces and exacerbate joint pain. During gait, an eccentric contraction of the quadriceps muscle is required to attenuate impact loading at the knee articular surfaces. Research has demonstrated a 22–36\% lower isokinetic quadriceps peak torque to body weight ratio and a 30–40\% lower maximum voluntary contraction in patients with knee OA compared to healthy matched controls.

**Effectiveness of Exercise as an Intervention for Knee OA**

Because muscle weakness plays such an important role in the development of OA, it is increasingly evident that exercise plays a critical role in the management of the condition. Although activity avoidance by knee osteoarthritic patients is common, exercise is an effective nonpharmacological treatment for knee OA. The American College of Rheumatology (ACR) has approved regular exercise as a therapeutic approach for the management of knee OA. Systematic reviews of nonpharmacological interventions have documented the effectiveness of exercise in reducing pain and disability. Evidence suggests that stretching, strengthening, and aerobic exercise decrease pain and improve muscular strength, functional ability, and psychological well-being. Exercise increases muscle endurance, improves proprioceptive acuity, and decreases arthrogenic muscle inhibition of the quadriceps. These benefits can facilitate weight loss in the obese patient, lead to improvements in cardiovascular function, and produce significant increases in self-esteem and self-reported functional capacity. The available research evidence clearly supports implementation of exercise programs for OA patients.

**Exercise Programming for Knee OA**

An exercise program for the knee OA patient should consist of simple, practical, and progressive exercise protocols. These need to be individually designed to accommodate the level of the OA severity, and they must be continually revised to adapt to progression of the patient’s functional capabilities. Exercises will differ in frequency, intensity, and duration, depending on the individual's OA severity. Factors such as age, gender, weight, OA severity, and lifestyle should be considered. It is imperative that knee OA exercise programs should not involve high-impact loading.

Although simple activities are recommended, there are specific exercise goals for patients with knee OA (Figure 1). The exercise program should decrease pain, increase range of motion, increase strength, normalize gait, and improve the ease of daily activities. They should reduce joint stress by attenuating joint forces, improve joint biomechanics, and improve physical fitness level. Research has demonstrated that the benefits of exercise for knee OA patients may go beyond the strengthening of surrounding musculature. There is evidence that regular physical activity may strengthen knee cartilage. Dynamic loading of cartilage has a trophic effect that can cause cartilage to become thicker. Because decreased cartilage thickness is the hallmark pathologic indicator of OA, individuals who regularly engage in physical activity may be less susceptible to its development.

Many randomized trials and systematic reviews have addressed exercise program components for knee OA patients. Currently, there are no widely-recognized guidelines. A review of the available research suggests that the most effective exercise pro-

![Figure 1](goals_of_exercise_in_the_treatment_of_knee_oa.png)
grams incorporate a number of different components. Table 1 provides a summary of components for an effective knee OA exercise program, which includes the recommended frequency, intensity, and duration for each and examples of appropriate exercises. 9,11,13,15,16,18

Knee OA patients commonly complain of knee instability during activities of daily living. They report the feeling of their knee “giving way” during activities such as stair climbing, standing from a seated position, or stepping off of a curb. By integrating activities designed to enhance strength, endurance, flexibility, neuromuscular control of movement, postural balance, functional performance, and knowledge, the patient will be physically and psychologically prepared to meet the demands of daily living. Knee OA patients must be exposed to movement experiences that challenge knee stability, but this type of activity is not suitable for patients with severe structural instability. Careful monitoring of such activities is essential to ensure that symptoms are not exacerbated. The neuromuscular system must react rapidly and efficiently to maintain dynamic knee stability during activities of daily living. Utilizing agility and balance activities in the exercise program will help patients with knee OA develop the degree of neuromuscular coordination needed to protect the knees from excessive loads, and they will help increase functional capabilities and reduce the risk of falls.

It is imperative that an individualized program is designed for each patient, and that it provides gentle progression in intensity, so that the risk of overstretching painful, weak, and vulnerable joints is minimized. The patient must understand that pain will be experienced at times, but that he or she should progress on the basis of tolerance for symptoms and the positive results that are realized. It will be necessary to stop performing some exercises at times, and progression in the intensity or duration of other exercises may need to be adjusted. The patient should understand that the

<table>
<thead>
<tr>
<th>Exercise Goals</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Duration</th>
<th>Example Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility</td>
<td>Daily</td>
<td>Full stretch</td>
<td>3 sets of 30 seconds</td>
<td>Calf stretch, Hamstring stretch, Quadriceps stretch</td>
</tr>
<tr>
<td>Strength</td>
<td>Daily</td>
<td>Maximum voluntary contractions</td>
<td>3 sets 10 repetitions Hold 5 seconds 2-3 minutes rest between sets</td>
<td>Straight leg raises with cuff weight (prone and supine), Seated knee extensions with theraband, Calf raises, Wall squats with PhysioBall, Standing hamstring curls with cuff weights</td>
</tr>
<tr>
<td>Endurance</td>
<td>Daily</td>
<td>Submaximal</td>
<td>&gt; 30 minutes (can be accumulated)</td>
<td>Cycling, walking, gardening, housework, swimming, dancing</td>
</tr>
<tr>
<td>Control of Movement</td>
<td>3 × week</td>
<td>Submaximal</td>
<td>2-3 sets of 10-20 feet</td>
<td>Side stepping, Carioca stepping, Front and back cross over stepping, Forward/backward tandem walking</td>
</tr>
<tr>
<td>Balance and Coordination</td>
<td>3 × week</td>
<td></td>
<td>3 sets of 20 seconds</td>
<td>Eyes closed, 1 leg stand, Foam pad tandem stance, Balance board</td>
</tr>
<tr>
<td>Functional Performance</td>
<td>Daily</td>
<td></td>
<td>As often as desired</td>
<td>Sitting to standing, stair climbing, getting in and out of a car</td>
</tr>
<tr>
<td>Patient Education</td>
<td>Monthly</td>
<td></td>
<td></td>
<td>Pamphlets, telephone support regarding body weight, nutrition, activity, and pain control</td>
</tr>
</tbody>
</table>
key is to persevere and continually evaluate progress to realize optimal results from the exercise program.

A potentially beneficial exercise program for an individual with knee OA does not necessarily require access to a gym or performance of strenuous lengthy workouts. By definition, physical activity is any body movement that substantially increases energy expenditure.20 These activities can range from daily tasks such as walking, shopping, or gardening and to recreational activities, such as swimming, dancing, tennis, or cycling. The availability of inexpensive and readily accessible physical activity options may be important factors affecting long-term compliance and effective management of the condition. By providing cost-effective alternatives to other expensive and potentially harmful procedures, such as total knee arthroplasty or intra-articular injections, we may improve the physical and psychological well-being of knee OA patients.

Summary

Exercise programs for patients with knee OA severity should consist of simple, practical, and progressive activities. Although the frequency, intensity, and duration of specific activities will vary according to the severity of knee OA symptoms, a key consideration for all cases is long-term program compliance. Exercise will not cure knee OA, but it may retard articular cartilage degeneration, and increased functional capabilities can improve quality of life. Realization of the benefits of an exercise program requires a considerable investment of time and effort and a determination to persevere when challenges are encountered. Because the research evidence strongly supports the value of exercise for management of knee OA, athletic trainers should provide patients with education about its benefits and encouragement for long-term commitment to the prescribed program of exercises and physical activities.

References


Charlie A. Hicks-Little is a doctoral candidate in the Biomedicine Program and teaching assistant in the Department of Kinesiology at the University of North Carolina at Charlotte.

Tricia J. Hubbard is an assistant professor in the Department of Kinesiology and Center for Biomedical Engineering Systems at the University of North Carolina at Charlotte.

Mitchell L. Cordova is the Chair of the Department of Kinesiology and an associate professor in the Department of Kinesiology and Center for Biomedical Engineering Systems at the University of North Carolina at Charlotte. Dr Cordova is also the Director of the Biodynamics Research Laboratory.