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The Effects of Aquatic and Traditional Exercise Programs on Persons With Knee Osteoarthritis

FRANK B. WYATT,[1] STACIE MILAM,[2] ROBERT C. MANSKE,[3] AND RANDALL DEERE[2]

[1]*Department of Health, Human Performance, and Recreation, Baylor University, Waco, Texas 76798;* [2]*Department of Physical Education and Recreation, Western Kentucky University, Bowling Green, Kentucky 42101;* [3]*Department of Kinesiology and Sport Studies, Wichita State University, Wichita, Kansas 67260.*

ABSTRACT

The purpose of the study was to detect if increases in functional levels for patients with osteoarthritis show differences between an aquatic exercise program and a land-based exercise program. Forty-six subjects between the ages of 45 and 70 years participated in 1 of 2 exercise groups. Pre- and posttest measurements included knee range of motion (ROM), thigh girth, subjective pain scale, and time for a 1-mile walk. Both exercise groups showed a significant ($p < 0.05$) increase in all measurements between pre- and posttests. There were no significant differences between the aquatic exercise group and the land-based exercise group pertaining to knee ROM, thigh girth, and time for a 1-mile walk. Subjective pain levels were significantly less in the aquatic group when compared with the land-based group. This study concludes that both aquatic and land-based exercise programs are beneficial to patients with osteoarthritis.

Key Words: articular, inflammatory, joint

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Introduction

Defined clinically as a progressive deterioration of a joint's hyaline cartilage, osteoarthritis (OA) causes the cartilage to fray, wear, or disappear completely. Bradley et al. (3) note that OA is a degenerative condition, which is the most common disorder of joints. Eighty percent of persons 45 years of age and older have OA in at least 1 joint. Osteoarthritis is the reason for more than 150,000 joint replacement operations in the United States each year. There are 2 basic types of osteoarthritis: primary (idiopathic) and secondary. Primary OA is the most common form of noninflammatory joint disease. It affects adult men more than adult women (10). Primary OA results from normal environmental and abnormal genetic factors, which combine with a family history of the disease. Secondary OA is due to elements such as injury to a joint or its components, overuse as in athletics, or changes in the body's biomechanics (17). Initially, OA involves only 1 or a few joints, and the onset is very gradual: forces placed on a joint exceed acceptable norms, and the cartilage is damaged, leaving a bone-on-bone situation within a joint.

Articular cartilage has a limited tolerance for inappropriate force. Its avascular and aneural status renders it unable to repair itself. Hyaline cartilage lacks a direct blood supply, receiving nutrition through the synovial fluid released because of normal movement and joint compression. George et al. (10) believe OA should not be considered a single disorder. It is a presentation of similar signs and symptoms resulting from differing disease processes.

Symptoms of OA include pain with activity, stiffness at the involved joint, thigh muscle atrophy, and tenderness upon palpation to the painful area (1). The following are conditions of OA progression: (a) articular components begin to show structural changes such as the evidence of crepitus or grinding; (b) joint enlargement occurs due to the stimulation of proliferative cells of bone and cartilage; and (c) ligamentous instability develops. Diagnosis of osteoarthritis primarily is dependent upon the symptoms and signs of the patient along with radiologic findings. Criteria for symptomatic diagnosis consist of pain from the affected joint for at least 3 months, limitation of joint motion, and decreased strength in the surrounding muscles (12). The joints most commonly affected by osteoarthritis are typically weight-bearing joints such as the spine, hips, knees, and ankles. These joints are vital to a person's ability to perform daily functions.

Treatment programs have traditionally included medication for pain control and some form of exercise. Bradly (2) found that pharmacologic intervention often begins with topical analgesics used with nonsteroidal, anti-inflammatory medication (NSAIDs). Management of pain with medication inserted directly into the joint through a cortisone injection reduces pain in osteoarthritic patients when administered periodically (9). Fleming (9) did note that NSAIDs and cortisone have side effects, such as gastrointestinal tract irritation and increased cartilage breakdown within the joint, respectively. Additional methods for pain relief in OA patients include the use of modalities. These include diathermy, ultrasound, transcutaneous nerve stimulation (TENS), and superficial hot/cold (5, 13, 15, 16, 18). Various forms of exercise interventions help manage osteoarthritis.

Fisher and Pendergast (8) note that aerobic power and muscle strength deteriorate to a greater degree with OA patients when compared with healthy, aging adults. Using 12 subjects with moderate knee OA, they did the following exercises 3 times weekly for 3 months: straight leg raises, short arc quads, hip adduction, hip abduction, hip extension, ankle pumps, and toe raises. They found that use of an exercise program improves endurance while doing daily activities with OA patients. Fisher et al. (6) showed significant increases in strength and endurance of patients with OA following only 1 month of an exercise program. These patients also showed an ability to climb stairs, walk, and rise from a chair.

There is general acceptance toward the effects of exercise with knee osteoarthritis. Yet there is no determined value of aquatic exercise. The advantages of water as an exercise medium are dependent primarily on the properties of water. The warm water in a therapeutic pool encourages relaxation, decreasing muscle guarding around the affected joint and increasing movement (4). Buoyancy of water allowed decreased body weight, which promoted greater movement of joints. Resistance is another property of water that encourages strengthening of all muscles equally about a joint (14). Because treatment exercise programs for OA patients have traditionally included land-based exercises, little research has been done on setting up an exercise regimen in a therapeutic pool. Therefore, this study has 2 objectives. The first is to decide if an aquatic exercise program with OA patients increases knee range of motion (ROM), thigh girth, and a reduced 1-mile walk time. Second, the study attempted to detect if differences exist between a traditional land-based exercise program and an aquatic exercise program with knee osteoarthritic patients.

Methods

Forty-six men and women, age 45–70 years, diagnosed as having moderate osteoarthritis of the knee with no other lower-extremity pathologies were recruited as subjects. Physician's diagnosis was obtained through medical history, signs and symptoms analysis, and radiological interpretation. Exclusion criteria included subjects with the following: inflammatory joint disease; significant arthritis in other joints likely to affect ability to exercise; and any neurologic, respiratory, or cardiovascular disease. All subjects signed an informed consent before participation in the study. Approval from the Humans as Subjects review board was obtained prior to data collection.

Random assignment of subjects to 1 of 2 exercise groups took place. Group A participated in a land-based exercise program, and group B participated in an aquatic exercise program. Pre- and posttest measurements consisted of the following: ROM of the affected knee assessed with a universal goniometer; thigh girth measurements taken with a standard tape; completing a visual 1 to 10 analog scale for subjective pain measurement; and a timed 1-mile walk. A physical therapist was the tester and was blinded to treatment groups.

Measurements included passive ROM for knee flexion and extension with the subject in a supine position. The bony landmarks for goniometer placement included the femoral head, midpatellar region, and the lateral malleolus. ROM measurements were in total degrees measured. For example, if the knee was in 5° hyperextension and was flexed 90°, the recorded score for knee flexion ROM was 95°. Thigh girth measurements took place with the subject positioned in the supine position using a point 6 inches proximal to the superior patellar pole.

Both groups exercised 3 times each week for 6 weeks. The exercise program consisted of the following: 2 sets of manual resistance (both land-based and aquatic) knee extension and knee flexion, 4-way straight leg raises, mini-squats, and walking 800 feet. Group A performed the exercise program in a gym, whereas group B executed the same program in a therapeutic pool of 5 feet depth at 90° F. All subjects were to do only routine activities for the 6-week treatment period.

A pretest/posttest design detected if differences existed between the subject values through the exercise program before and after intervention. Means (*SD*) were calculated for the pretest and posttest values for each group. The means were subjected to an independent, paired, 2-tailed *t*-test to detect if significant differences between pre- and posttest values existed for the entire sample. A 1-factor analysis of variance (ANOVA) determined if significant differences existed between the 2 exercise treatment groups. Significance was set with alpha at $p < 0.05$.

Results

Of the original 46 subjects, 42 completed the exercise treatment. Four subjects dropped out because of illness. Both exercise groups showed significant ($p \leq$

Table 1. Means (±*SD*) for pre- and posttest measures for both exercise groups.

Measure	Pretest mean (*SD*)	Posttest mean (*SD*)
Thigh girth (inches)	19.1 (1.8)	19.3 (1.7)
Range of motion (degrees)	105.4 (15.9)	119.9 (13.1)*
Timed 1 mile (minutes)	21.4 (1.9)	19.3 (1.8)*
Pain scale (0–10)	5.1 (1.5)	3.1 (1.7)*
Land-based thigh	19.4 (1.9)	19.5 (1.9)
Aquatic thigh	18.8 (1.5)	19 (1.5)
Land-based ROM†	108.9 (14.5)	120.8 (12)*
Aquatic ROM†	100.9 (17.1)	117.3 (14.2)*
Land-based 1 mile	21.9 (2.2)	19.7 (2.2)*
Aquatic 1 mile	20.8 (1.3)	18.9 (1.4)*
Land-based pain scale	5.6 (1.4)	3.8 (1.6)*
Aquatic pain scale	4.5 (1.4)	2.4 (1.6)***

† ROM = range of motion.
* Significant at $p \leq 0.05$.
** Significant between land-based and aquatic at $p = \leq 0.05$.

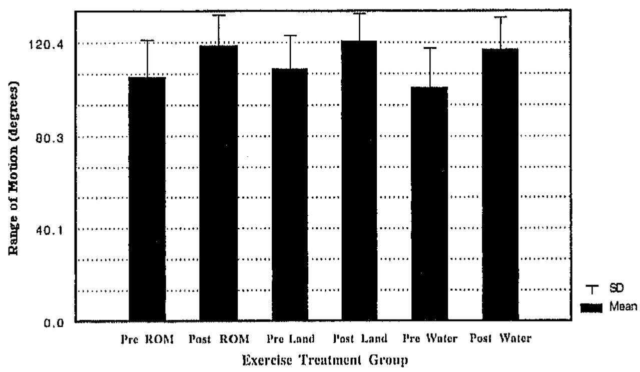

Figure 1. Range of motion (ROM) for pre-/posttests between groups.

0.05) differences between pre- and posttest measurements. Total knee ROM and thigh girth increased, whereas pain levels and 1-mile walk time decreased. Table 1 shows mean (*SD*) for pre- and posttest measurements. In comparing the differing exercise groups, there were no differences for ROM, thigh girth, or 1-mile walk time. However, the pain scale showed significantly lower mean values for the water exercise group compared with the land-based exercise group (2.4 ± 1.6 and 3.8 ± 1.6, respectively). Figures 1 through 4 show overall pre- and posttest measures, and comparisons between aquatic and land-based exercise groups for ROM, thigh girth, 1-mile walk time, and pain scale, respectively.

Discussion

Osteoarthritis is a common disorder in persons over 45 years of age that can significantly affect the quality

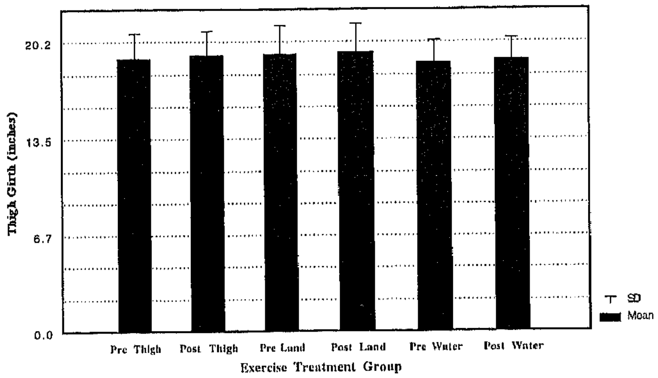

Figure 2. Thigh girth measures for pre-/posttests between groups.

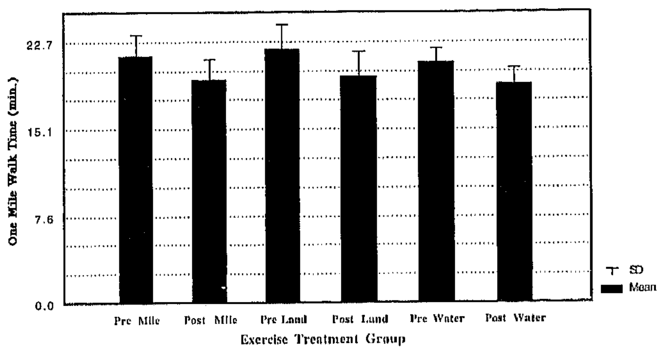

Figure 3. One-mile walk time for pre-/posttests between groups.

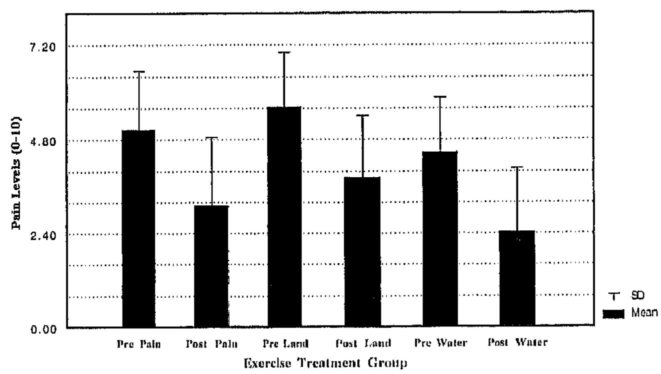

Figure 4. Pain level for pre-/posttests between groups.

of life. This research study addressed whether persons would benefit from exercising in a therapeutic pool more than they would by exercising in a traditional land-based format. Comparing differing exercise modalities enhances effective treatment of osteoarthritis.

This study did not show that the aquatic method was more conducive to increasing knee ROM, thigh girth, or 1-mile walk time. It did show a significant reduction in perceived pain levels with an aquatic exercise program. Based on previous research literature, the properties of water provide an environment that helps exercise for persons with a compromised musculoskeletal system (4, 14). Additionally, the buoyancy of the water reduces weight-bearing stresses to the joint, allowing for a decreased perceived pain level. Figures 1 through 4 show land and water programs equally benefit individuals with osteoarthritis. Research supports improvement in functional abilities and decreased complaints of pain with consistent exercise (2, 7, 11). Green et al. (11) found that aquatic therapy offered no additional benefit over performance of exercises executed at home or in a physical therapy setting. However, they concluded that simple exercise increased the functional levels of the measured parameters. This is consistent with the findings of this study.

Practical Applications

An exercise program 3 times per week will help in maintaining or increasing the present level of function of patients diagnosed with osteoarthritis. Use of a monitored exercise program is effective for preventing future loss of mobility, which is commonplace among affected persons. Exercise increases ROM, prevents thigh muscle atrophy, and decreases overall pain. This reduction in pain is significant to sufferers of osteoarthritis. Reduced pain is associated with increased movement function as well as exercise compliance.

With no significant differences between aquatic vs. land-based exercise programs, 2 demographic groups will benefit from these findings: (a) those with access to an aquatics program that may be inhibited by dry land movement patterns, and (b) those without access to an aquatics program not inhibited by dry land movement. This suggests a properly executed exercise regimen benefits patients with osteoarthritis.

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