Research Report
Aquatic Exercise for Pain Reduction in the Active Adult With Osteoarthritis

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Abstract
Background and Purpose. Osteoarthritis (OA) is the most common form of arthritis in the world, becoming more prevalent in the growing population of older adults. The literature demonstrates the effectiveness of aquatic exercise in this population for improving mobility and endurance, but there is little evidence in the literature focusing on the results of aquatic exercise on joint pain reduction for active older adults with OA. This research utilized data collected during an aquatic exercise program to help determine whether or not aquatic exercise is an appropriate intervention to reduce arthritic pain in the older adult.

Methods. This study was a pre and posttest quasi-experimental design conducted at the Del Webb Retirement Community pool in Mount Juliet, Tennessee by physical therapy students from Tennessee State University. A total of 12 active older adult participants (9 females and 3 males) with OA completed the program, ranging in age from 56 to 72 years. The total length of this study was 8 weeks, consisting of two 1-hour classes per week. Each class began with a 5-minute warm-up followed by a 50-minute routine focusing on cardiovascular endurance, major muscle group strengthening, flexibility, balance, and coordination, and concluded with a 5 minute cool-down. Approval was granted by the Tennessee State University Institutional Review Board. All participants completed a waiver of informed consent, as well as a demographic survey at baseline. Two-handed pain-free functional reach measurements were taken using a tape measure attached to the wall for recording the better of 2 trials before and after the 8-week course. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the visual analog scale (VAS) were used to determine the self-reported level of pain.

Results. A statistically significant difference between the pre and postcourse VAS was found using the Wilcoxon signed rank test for the nonparametric data (at the .05 level; P = .025). A statistically significant difference was also found at the .05 level (P = .031) for pre and postcourse pain-free functional reach using paired t tests. Although there was improvement when comparing pre and postscores on the WOMAC, this was not statistically significant. Based on the results of this study and the verbal reports from the participants, the aquatics program used in this study appears to have decreased joint pain from arthritis, and as a result, improved functional mobility for the participants involved. Further research is recommended to help determine the long-term effects of the program as well as the specifics of functional improvement.

Key Words: Aquatic, Water, Exercise, Arthritis, Joint mobility, Pain.

Introduction
Arthritis is one of the most common chronic diseases affecting the joints of older adults in the United States. According to the 2014 Centers for Disease Control (CDC) report, 52.5 million people in the United States have a diagnosis of arthritis.1 With the aging population of America increasing, this number is expected to rise. Osteoarthritis (OA) is considered to be one of the most prevalent musculoskeletal dis-
orders worldwide (26 million Americans in 2005) and has been described as the leading cause of long-term disability and restricted activity in older adults.\textsuperscript{1-3} Although OA may be associated with pain, swelling, decreased range of motion, bony deformities, disability, reduced quality of life, and risk of death, pain is still the most common symptom.\textsuperscript{4} People with OA are faced with managing their symptoms on a daily basis. Often, patients with OA become less active as a result of joint pain, which may cause weight gain, muscle weakening, swelling, and depression.\textsuperscript{5} The purpose of this paper was to measure the effectiveness of aquatic exercise for the reduction of pain in older adults with OA.

Aquatic Exercise
According to the Aquatic Physical Therapy Section of the American Physical Therapy Association (APTA), aquatic exercise utilizes buoyancy, support, accommodating resistance, and enhancing interventions for clients of all ages.\textsuperscript{6} Hydrotherapy, or aquatic therapy, is often recommended for patients with OA due to the weight-relieving property of water.\textsuperscript{7,8} This allows for decreased weight-bearing stress on skeletal joints for easier joint movement without pain. Also, it can have beneficial outcomes on aerobic capacity, muscle strength, and perceived pain in people with arthritis.\textsuperscript{9} Petursdottir, Arnadottir, and Halldorsdottir found that in the group setting, older adults with arthritis can gain the motivational support to maintain an active lifestyle.\textsuperscript{10} Although the above research supports the contention that aquatic exercise can help people with arthritis, only a few of these studies include pre and postpain measurements for older adults with OA.

The operational definition of “therapy” denotes that an individual has received an assessment leading to a therapeutic treatment intervention. This study does not look at aquatic exercise as part of a therapeutic intervention or treatment plan. Rather, it focuses on the potential pain relieving benefits of aquatic exercise in and of itself. This was done to solely concentrate on aquatic exercise and decrease the effects of extraneous variables. The aim of the research in this paper was to simply implement an aquatic exercise program for people with arthritis and to analyze collected data pertaining to pre and postpain measurements to help determine whether or not aquatic exercise was an appropriate intervention for reducing arthritic pain.

The Benefits of Aquatic Exercise
Aquatic exercise enables relaxing movement with less effort, decreased pain, and greater range of motion.\textsuperscript{11} Range of motion is increased in the water because the buoyancy decreases pressure on the larger weight bearing joints.\textsuperscript{5,8} The movement of the water enhances blood flow allowing people with arthritis to experience less discomfort.\textsuperscript{12} In addition to the effects of buoyancy, the warm temperature of the water used during aquatic therapy is proven to block nociceptors in the body that trigger the sensation of pain. The sensation of water movement helps block pain signals traveling to the spinal cord, which ultimately decreases pain via the gate control theory.\textsuperscript{12} To date, however, this effect has not been specifically studied with people who have pain from OA. Lin et al showed that a twice weekly water-based exercise program can produce a small but significant reduction in knee pain in participants who adhere with the therapy program.\textsuperscript{8} Hinman et al found that exercise, while standing in water at the anterior-superior iliac spine level, is capable of decreasing pain in patients age 50 and over (average of 63.3) with OA of the knee and hip.\textsuperscript{13} Silva et al found that people with OA reported a more pronounced reduction in knee pain after an aquatic exercise program when compared to the pain reduction reported by a group of participants who practiced land-based exercises.\textsuperscript{14}

While there is evidence in the literature indicating that aquatic therapy improves the symptoms associated with arthritis (ie, muscle weakness, reduced range of motion/balance, inhibited neuromotor control),\textsuperscript{15-16} there have been few recent studies showing significant advantage in the use of aquatic therapy to reduce the low back discomfort and upper and lower extremity joint pain often felt by individuals with OA. This study will look at differences in the pain felt in arthritic joints for participants over the age of 55 (average age 63) after completion of an 8-week aquatic exercise program.

Methods
This study was a pre and posttest quasi-experimental design conducted at the Del Webb at Lake Providence’s Community pool in Mount Juliet, Tennessee.

Participants
Participants were recruited to the study through emails from the activities coordinator at Del Webb. A total of 15 participants with OA signed up for the Aquifit Program at Del Webb. To meet the criteria for inclusion, participants were required to be over the age of 55 and have a diagnosis of OA in 1 or more joints. The participants were also required to be available to attend a minimum of 8 of the 16 sessions over the 8-week period to be included in the study. Participants were excluded from the study if they had another type of arthritic condition, such as rheumatoid arthritis, or if their health presented a contraindication for aquatic exercises. The participants completed baseline data, attended course sessions, and completed 8-week postcourse data. Twelve of the participants attended a minimum of 8 sessions (1 per week). The age of participants ranged from 56 to 72 years of age and included 9 females and 3 males. All 12 participants reported having pain from OA in the hips and/or knees. Five of the 12 also reported pain in the shoulders, and 6 reported pain in the back. Approval was granted from the Tennessee State University (TSU) Institutional Review Board. All participants completed a waiver of informed consent, as well as a demographic survey at baseline. Although there were some inconsistencies with attendance, most were present for 10
or more of the 16 sessions. The average number of sessions attended was 11.3 days.

The Aquatic Intervention
The total length of this study was 8 weeks, consisting of two 1-hour classes per week, and occurred in water set at approximately 85 degrees Fahrenheit. Each class began with a 5-minute warm-up followed by a 50-minute routine focusing on cardiovascular endurance, major muscle group strengthening, flexibility, balance, and coordination, and concluded with a 5-minute cool-down. All exercises were done to music. With the direction of their faculty advisor, 4 Doctor of Physical Therapy (DPT) students from Tennesse State University (TSU) developed and ran the program. To enhance program exercises, underwater weights were used for resistance, while beach balls were used for mobility and flexibility (Table 1). Pool temperatures ranged from 82 degrees to 88 degrees Fahrenheit (average of 85 degrees). Tilden et al outlined aquatic exercise programs detailing specific exercises to improve upper extremity ROM as well as muscle strength and endurance. Some of these exercises (completed in chest-high water) were used for the sessions, along with aerobic and strengthening strategies recommended by Baun (Table 1).

Testing Instruments
Three testing measurements were administered before and after the 8-week aquatic course. Two-handed pain-free functional reach measurements were taken using a tape measure attached to the wall. The researchers then recorded the better of 2 trials. Although this test has been shown to have predictive validity of falls for people who reach less than 10 inches, it was utilized in this study to look at changes in pain with mobility and to see if pain-free functional reach would change before and after the 8-week program. Nothing in the literature states that the functional reach test has ever been tested as a valid measurement of pain-free mobility, but it was still used for this purpose, as one of the chief complaints stated by the participants was the inability to bend forward due to arthritic pain (typically reported in the hips and knees). The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used for people with OA as a responsive measure of patient reported outcomes concerning pain, stiffness, and physical function. This is widely used as a linguistically validated tool to report pain for people with hip and knee OA. When measuring pain in patients with hip and/or knee OA, the WOMAC has been shown to have a higher level of internal consistency and concurrent validity than another well-known pain measurement tool, the Lequesne

<table>
<thead>
<tr>
<th>Exercises</th>
<th>Time</th>
<th>Exercises Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up</td>
<td>5 minutes</td>
<td>Slow breathing, gentle stretches, lateral trunk bends, trunk rotation</td>
</tr>
<tr>
<td>Core exercises</td>
<td>10 minutes</td>
<td>Side bends, back bends, long-arm slow trunk rotations, short-arm fast trunk rotations, supine bicycle, supine prone and side-lying flutter kicks, supine double-leg extensions (The exercises in this section were all done with participants holding bar-bell shaped water weights consisting of dense Styrofoam.)</td>
</tr>
<tr>
<td>Cardio</td>
<td>10 minutes</td>
<td>Marching, high knee steps, leg swings in all planes of motion, anterior/posterior pelvic tilts, gluteal sets, calf raises, squats, quick feet, side shuffle, squats with back kicks, knee raises with trunk rotation, pool walking in a circle, changing direction to create resistance, hamstring curls, jumping jacks, jogging, heel hops</td>
</tr>
<tr>
<td>Upper extremity exercises</td>
<td>10 minutes</td>
<td>Jab punch, cross punch, jab punch-cross punch combo, jab punch-cross punch-uppercut triple combo, speed bag, finger movements all planes, wrist movements all planes, elbow flexion/extension, shoulder movements all planes, shoulder D1/D2 PNF patterns, air guitar</td>
</tr>
<tr>
<td>Full body coordination</td>
<td>10 minutes</td>
<td>Opposite hand to foot, jogging with arm push, standing balance on noodle, beach ball toss</td>
</tr>
<tr>
<td>Cool-down</td>
<td>5 minutes</td>
<td>Slow breathing, gentle stretches, trunk bends, trunk rotation</td>
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Algofunctional Index. The visual analog scale (VAS) was used to determine the self-reported level of pain for participants with arthritis. Participants were asked to specifically report their current level of arthritic joint pain by using a 10-centimeter (cm) line representing a continuum from 0 (no pain) to 10 (highest level of pain). This tool has shown test-retest reliability for people with rheumatoid arthritis, and according to Hawker et al., has been found to be valid, with similarities to a five-point verbal descriptive scale. Kersten, White, and Tennant found the WOMAC and VAS to have internal validity, fitting Rasch model expectations. According to Younger, McCue, and Mackey, the VAS has a high level of both resolution and sensitivity as a single-item pain measure. Kersten, White, and Tennant recommended that researchers treat data collected from the VAS as ordinal with nonparametric analysis, however, for improved validity of results. The Wilcoxon signed rank test for nonparametric data was therefore utilized for the data analysis, per recommendations from Kersten et al., to help compensate for the ordinal nature of the VAS.

Results
Twelve of the participants (3 males and 9 females, with a mean age of 63 years old) who reported having pain from OA completed the program and attended a minimum of 8 sessions (range = 8 to 14, mean = 11.33, standard deviation (SD) = 2.309). A statistically significant difference at the .05 level ($P = .025$) between the pre and postcourse VAS was found using the Wilcoxon signed rank test for nonparametric data (Figure 1), per recommendations from Kersten et al. The mean difference between the pre- and post-VAS was .833, with a standard deviation of 1.115. A statistically significant difference was also found at the .05 level ($P = .031$) for pre and postcourse pain-free functional reach using paired $t$ tests (Figure 2). The mean difference between the prefunctional reach and postfunctional reach was 1.95455 inches, with a standard deviation of 2.58. Although there was improvement when comparing pre and postscores on the WOMAC (mean difference between the pre- and post-WOMAC = 1.917), this was not statistically significant ($P = .554$), and there was a wide variance, with a standard deviation of 10.883 (Figure 3). Qualitative statements from the participants regarding the program and the instructors were taken and can be seen in Table 2.

Figure 1. Mean Difference in the Visual Analog Scale (VAS) Reported by Participants Before and After Aquatic Exercise Program

Table 2. Qualitative Statements From Participants

<table>
<thead>
<tr>
<th>Participant Age</th>
<th>Participant Sex</th>
<th>Number of Arthritic Joints</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Female</td>
<td>2 (knees)</td>
<td>“This program really helped with my pain. I move a little better.”</td>
</tr>
<tr>
<td>67</td>
<td>Female</td>
<td>2 (knees)</td>
<td>“Instructors are awesome. I hurt a lot less. They have raised the bar so high. They will be a hard act to follow. Many thanks for your time and talent.”</td>
</tr>
<tr>
<td>66</td>
<td>Female</td>
<td>2 (knees)</td>
<td>“Love it. All the kids were fabulous and Natalie is a doll. Please come back!”</td>
</tr>
<tr>
<td>58</td>
<td>Male</td>
<td>2 (knees)</td>
<td>“Sometimes hard to keep in sync/pace as instructor, but good class! A little less pain, and I move better.”</td>
</tr>
<tr>
<td>68</td>
<td>Female</td>
<td>2 (hips)</td>
<td>“Loved this class and the instructors are great. Hold the class again in the future.”</td>
</tr>
</tbody>
</table>
Although the VAS and the qualitative comments are both subjective measures, they still add credence to the contention that aquatic exercise reduces pain for people with OA.

While there was evidence of improvement on the WOMAC (mean difference between the pre- and post-WOMAC = 1.917), this was not statistically significant ($P = .554$). Although the WOMAC is the most commonly used tool to measure pain and function in people with OA, it has been recommended that it be used in conjunction with performance-based measures, such as the Timed Up and Go (TUG) test, to gain a better understanding of the limitations experienced by the patient.25 Though the TUG was not used in this study, the functional reach test provided a clearer picture of the potential limitations experienced by participants.

Limitations of this study include the small sample size and the inability to collect follow-up data. There was also no control group, which limited generalizability. Although the participants all had pain from arthritis, they all had unique individual differences, such as the number of joints involved. The VAS has solid evidence to support its use to indicate general pain, but nothing was found in the literature regarding the test-retest reliability of using the VAS for people with pain specific to OA. This could be viewed as another limitation. Along similar lines, the functional reach test has been used as a valid instrument to assess balance,18 but not to assess pain-free mobility. Including the TUG might have provided a more comprehensive picture regarding change in functional mobility than the functional reach test, but these authors contend that the functional reach test displayed an indication of improved flexibility that participants attributed to a decrease in pain and discomfort. The most positive finding, however, was that all participants reported feeling an improvement in their freedom of mobility that they believed resulted from the aquatic exercise program.

**Conclusion**

The unique properties of water, specifically viscosity, buoyancy, and cooling effects, can often allow people to exercise with less discomfort, thus improving aerobic fitness.26 Although this research supports this contention, the long-term effects of this program are unknown. Further research, preferably with a control group, would be needed to determine the long-term effects of the specific exercise program used in this study. Fransen et al vouched for aquatic therapy as one intervention to promote large and sustained improvements for individuals with hip and/or knee OA.7 Tilden et al recommended an aquatic environment to accommodate exercise and rehabilitation after discharge from therapy.18 The authors of this paper strongly recommend that physical therapists (PTs) consider exploring the Certificate In Aquatic Physical Therapy Clinical Competency Program (CAPTCC) through the Aquatic Section

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**Discussion**

A statistically significant difference was found at the .05 level ($P = .031$) for pre and postcourse pain-free functional reach. Although the functional reach test is typically used to predict fall risk and not mobility, participants reported less pain and greater ease in performing this test after the completion of the 8-week sessions. This finding coincides with the research of Carlson et al,15 who also found improved functional reach scores after an aquatic exercise program.15

Following this program, participants reported feeling more freedom of movement with less pain during their daily activities. A statistically significant difference was found at the .05 level ($P = .025$) between the pre and postcourse VAS.
of APTA to improve clinical skills related to the provision of aquatic intervention, and that PTs continue to provide encouragement for self-management to any individual who benefits from an aquatic exercise program. Our hope is that the participants in this study will continue to use the exercises on their own and that they will use proper movement patterns while monitoring their own pulse and joint pain in an effort to maintain or to promote further improvement utilizing the unique properties of water.

References


