Effects of Arthritis Exercise Programs on Functional Fitness and Perceived Activities of Daily Living Measures in Older Adults With Arthritis

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**Abstract**

**Objective.** To ascertain the effectiveness of the National Arthritis Foundation (NAF) aquatic and on-land exercise programs on functional fitness and perceived ability to perform activities of daily living (ADL) measures in older adults with arthritis.

**Design.** The effects of aquatic and on-land exercise intervention programs were analyzed by repeated-measures analysis of variance by using a planned comparison approach with an independent 3 2 (group by test) design. Two analyses were used to ascertain the relative treatment magnitude of each dependent variable.

**Results.** Aquatic and on-land exercise subjects showed significant improvements on 9 of 12 functional fitness, 3 of 4 ADLs, and 7 of 8 hand-held isometric strength tests after their respective exercise programs. No significant changes were found in any of these measures for the control group.

**Conclusion.** Both NAF exercise programs appear to be effective in improving functional physical fitness and perceived ability to perform ADL measures in older adults with arthritis.

Americans over the age of 65 years represent an expanding proportion of the population within the United States, with their numbers projected to increase as the baby boom generation ages. Although many older adults in the United States are healthy and physically active, others have chronic illnesses and require assistance, either from family members or from public support systems, to manage their everyday lives. Approximately one quarter of these individuals will be seen by primary care physicians for a musculoskeletal condition. Among those age 65 years or older, the most prevalent disease reported is an arthritic condition of some nature.

The prominent presence of arthritis in the older population has many believing that chronic pain and functional difficulties are undeniable consequences of aging. Although research has shown that arthritic conditions can cause pain, limit daily activities, diminish measures of physical fitness, and reduce quality of life, an emerging body of evidence shows that light to moderate-intensity physical activity may play a restorative role in combating declines in these measures caused by chronic diseases such as arthritis.

In an extensive review of literature involving exercise and arthritis, the American Geriatrics Society (AGS) proposed several clinical guidelines for exercise prescription for older adults with arthritis. Their suggestions indicate that mild- to moderate-level exercise does not exacerbate arthritis pain; that exercise programs should be individualized to address the specific needs of the patient; and that the exercise program should focus on controlling pain, improving ability to perform activities of daily living (ADLs), increasing flexibility, and improving muscular strength and endurance. The AGS panel also concluded that, to help persons with arthritis, an effective exercise program should go beyond improving overall fitness levels for exercise participants and should include education about joint protection, weight counseling for obese individuals, development of pain-coping skills, and enhancement of social support.

Currently, the National Arthritis Foundation (NAF) provides 2 programs that meet the guidelines recommended by AGS. NAF offers the largest standardized exercise program to persons with arthritis via 2 community-based, nonclinical exercise programs that involve group participation. The on-land exercise program is called People with Arthritis Can Exercise (PACE); the aquatic exercise program is called the Arthritis Foundation Aquatic Program (AFAP). In the United States in 1997, in 50 chapters, the PACE program was administered to over 25,500 persons with arthritis, whereas the AFAP was administered, in 57 chapters, to more than 141,000 persons with arthritis. The PACE on-land program involves 72 range-of-motion (ROM), strengthening, endurance, and mobility exercises that can be performed in sitting, standing, or floor positions. The premise espoused is that joint protection techniques, taught and performed wisely, will increase physical function, flexibility, strength, endurance, balance, and mobility for those who practice them. The AFAP consists of 72 ROM, strengthening, endurance, and mobility exercises to be performed in water (temperature range,
The premise is that exercise in water decreases joint loading by reducing the effect of gravity, and that increased buoyancy in water, along with possible increased circulation, will result in increases in these measures. In addition to providing well-detailed exercise descriptions, both programs contain a strong educational component, in which participants can learn about arthritis and how to manage it. A more thorough explanation about these exercise programs can be found in their respective published instructors’ manuals.

Although studies have shown some physical benefits from participating in these programs on isolated parameters such as isometric strength and ROM, the effectiveness of these programs on functional fitness measures has not been shown. In addition, the effects of these programs on functional fitness measures have not been widely reported in the literature. The purpose of our investigation was to ascertain the effectiveness of the NAF aquatic and on-land exercise programs on functional fitness and ADL measures in older adults with arthritis.

**Methods**

**Participants:** Subjects were recruited via newspaper advertisements and flyers to area physicians, Young Men’s Christian Association centers, and various agencies for aging. Eligibility criteria for this investigation were men or women between the ages of 60 and 79 years, a diagnosis of rheumatoid arthritis or osteoarthritis from either a rheumatologist or an orthopedic physician, no medical condition precluding increased physical activity, no involvement in an organized exercise program in the past 3 months, and a stable medication regimen for at least 3 months before entering the study.

In addition, to be eligible for this investigation, subjects had to obtain medical clearance through their primary physician to participate either in on-land or aquatic exercise classes. The AFAP physician information form developed by the NAF’s Medical and Scientific Committee was used as the medical consent form. Subjects who had knee or hip joint replacements, spinal conditions that contraindicated physical activity, uncontrolled high blood pressure, or a history of heart disease were excluded from the study. Exercise and health histories of each subject were ascertained by using the protocol developed by Osness et al. Our research protocol was approved by the human investigation review committee at the University of Wisconsin, Stevens Point, WI.

Initially, 48 subjects were screened for participation. Ultimately, 32 subjects met the criteria and were randomly assigned into 1 of 3 groups. Eleven subjects were placed in the aquatic exercise group, 11 in the on-land exercise group, and 10 in the control group. Before completion of the project, 1 subject from each of the exercise groups dropped out for reasons not related to the investigation. The final subject pool for this study consisted of 8 women and 2 men in each of the 3 experimental groups.

All subjects who completed the requirements of this investigation were paid for their participation. In addition, subjects in the control group were offered the opportunity to participate in one 8-week session of either exercise protocol, free of charge, at the conclusion of the study.

**Test Apparatus and Testing Procedures.** ADLs were evaluated by using a modified version of the Functional Capacity Evaluation developed by Jette. In this modified tool, 2 dimensions of ADL function—difficulty in performing specified ADLs and pain experienced in performing specified ADLs—were evaluated. Within each of these dimensions, 29 questions were asked in 5 functional categories: personal care, physical mobility, home chores, transfers, and shopping and yard work. Each question was rated on a 4-point Likert scale, with 1 equal to no pain or difficulty and 4 equal to severe pain or difficulty. The total points derived from the 29 questions within each dimension served as the dependent measure. A pilot study from this laboratory, which used this modified ADL tool on 10 older adults without arthritis, showed test-retest reliability coefficients of .90 and .83, for difficulty and pain ADL measures, respectively.

The functional fitness assessment tool for adults older than 60 years developed by Osness was used to measure the parameters of fitness and to evaluate the ability to perform certain ADLs. The test items contained in this battery were identified through test design analyses as having the ability to measure that given parameter of fitness. The 5 parameters of fitness studied in our investigation were flexibility, balance and agility, coordination, strength and endurance, and cardiorespiratory endurance. The following is a brief description of each of the tests conducted. A more detailed description of the test protocols can be found in the Osness study.

**Flexibility.** Flexibility was measured by a modified sit-and-reach test. The subject, seated on floor with legs extended, reached forward with the hands, one placed on top of the other, and held the terminal position for at least 2 seconds. Two practice
trials were given, followed by 2 test trials. The highest number of inches reached during the 2 test trials represented the dependent measure.

**Coordination.** Coordination was evaluated by using the “soda-pop” test. Seated at a table on which 6 circles had been drawn along a straight line, with cans of soda pop placed in 3 of the circles, the subject was instructed to successively turn the cans upside down onto the adjacent circle and then to return them to their original position. Two practice trials were performed, followed by 2 test trials. The fastest time recorded on a trial served as the dependent measure.

**Agility and dynamic balance.** Agility and dynamic balance were assessed by having the subject rise from a chair and walk around a cone placed 3.3m (11ft) diagonally to the right of the chair, return to a full seated position, and repeat the walking portion around a second cone placed at the same distance to the left of the chair. One trial consisted of 2 complete circuits of the agility course. After an explanation and demonstration, the subject was allowed to walk the course to show comprehension. Two test trials were performed with a 30-second rest between trials. The trial with the least time required to execute the test served as the dependent measure.

**Strength and endurance.** Strength and endurance were measured by having the subject sit in a chair and lift a weight (women, 1.8kg [4lb]; men, 3.6kg [8lb]), starting with the dominant arm extended toward the floor and contracting the biceps through the full ROM until the lower arm touched the hand of the evaluator, which had been placed on the subject’s biceps. Each subject performed 2 or 3 repetitions as a warm-up before the test. One trial per arm was performed, and the dependent measure was the number of complete repetitions recorded within a 30-second period.

**Cardiorespiratory endurance.** Cardiorespiratory endurance was evaluated by an 880-yd walk test (792m). The 880-yd walk test was conducted on a 220-yd (198m) indoor track (4 laps 880yd). All subjects wore comfortable athletic shoes and were instructed to walk as fast as they could without running. Each subject performed the test individually and was not allowed to gather information regarding their pace. One trial was performed, and the amount of time required to walk 880yd was the dependent measure.

Reliability studies conducted on each of the 5 tests were conducted by the test developers and yielded test-retest reliability indices ranging from .82 to .99 on the various test items. In addition, Bravo et al found moderate to high validity values for these test items conducted on elderly women (Pearson correlation coefficient r range, .58–.94). In addition to the functional fitness assessment test items, isometric tests of hip and shoulder abduction were conducted. Isometric assessment was conducted by using the Nicholas Manual Muscle Tester. Three trials were administered for each isometric test on each limb. The mean score of the 3 trials served as the dependent measure. Descriptions of specific test positions and test protocols are detailed in an earlier investigation. Hip and shoulder isometric strength tests were selected for assessment, because these motions would be least likely to be practiced by subjects during normal daily activities and, therefore, were more likely to reflect a training effect. An earlier study showed that these measures could be reliably assessed on older subjects with arthritis (intraclass correlation coefficient [ICC] range, .84–.99).

All tests were conducted in the indoor track facility at the University of Wisconsin, Stevens Point. All tests were assessed on the same day. The ADL evaluation was administered first by the investigator reading the questions and recording the responses of each subject. This test lasted approximately 20 minutes. After completing the ADL evaluation, subjects were assessed on isometric strength tests, followed by the functional fitness test battery. The test order of the functional fitness assessment varied by subject, but the order of tests was identical for all subjects on each pre- and posttest evaluation. To avoid fatigue, the 880-yd walk was the last test item performed by each subject.

**Treatment.** The investigation took place during the months of April, May, and June. The aquatic exercise intervention program was conducted at the university in a therapeutic pool that had a water depth of 3.5ft (1.05m) and a water temperature of 89°F (31.7°C). The frequency, intensity, and duration of this program were based on AFAP protocol. The instructors for these classes were 2 certified AFAP instructors with more than 3 years of AFAP instructional experience and who held graduate degrees in medical or educational fields.

The on-land exercise program was conducted at an older adult activity center located in the community. The frequency, intensity, and duration of this program were based on PACE guidelines. The instructor for these classes was a certified PACE instructor.
with 1 year of PACE instructional experience and who held certification as an athletic trainer.

For both exercise programs, no attempt was made to alter the exercise regimen for this investigation. Subjects were placed in established community AFAP and PACE classes, and instructors were unaware of their participation in the study. Classes for both exercise intervention programs were conducted in 2-weekly 45-minute training sessions for 8 weeks. Subjects in both exercise intervention programs were required to attend a minimum of 1 class per week for the 8 weeks and a minimum of 10 classes (62.5%) of the 16 classes offered. Subjects in the exercise intervention groups were also asked to refrain from any other type of organized physical activity program for the duration of the study. Control subjects were asked to refrain from engaging in any organized physical activity program and from beginning any new physical activity program for the duration of this investigation. All subjects were assessed on the ADL self-report, physical fitness, and handheld isometric strength test items in 1 test session, 48 hours before and after their respective intervention program.

Data Analysis. Measurements of the manual muscle tester were converted to newton meters by calculating newtons from kilograms and multiplying by the length of the moment arm. To examine intrarater consistency among trials, ICCs were computed on the isometric peak torque scores obtained with the manual muscle tester. A within-subjects (subject by trial) analysis of variance (ANOVA) model was used to calculate ICC.16

Discussion

Reliability of the hand-held dynamometry tests for this investigation was high (ICC range, .95–.99). The ICCs obtained in this investigation were similar to values (ICC range, .84–.99) obtained in 2 earlier studies 11,18 on older adults with arthritis using similar protocols. The reliability indices obtained in this investigation further document the use of handheld dynamometry as a reliable method for assessing strength in persons with arthritis.

The w2 analyses used on the dependent measures to help determine the relative treatment magnitude indicated an overall large treatment effect. According to Keppel17 a “large” effect in behavioral sciences is an w2 value of .15 or greater. In our study, a w2 value of .15 or greater was obtained on 10 of the 12 dependent measures. Because a relatively small sample size was used in each experimental group, the w2 values obtained indicated that an acceptable amount of the total population variance was accounted for by the experimental treatments.

Overall exercise compliance rates for the aquatic and on-land subjects were 79% and 90%, respectively. This finding is similar to that of an earlier study,11 but it is high in comparison with compliance rates (50%–70%) usually found in exercise programs for persons with arthritis.19-21 Factors thought to contribute to this high rate were the relatively short duration of the exercise treatment program (8wk), the time of the year (spring), the fact that subjects were paid to participate, and perhaps the nature of the 2 exercise programs. Both NAF aquatic and on-land arthritis exercise programs stress the educational and social aspects of exercising with arthritis. Although these components were not evaluated in our study, one might speculate that exercise environments emphasizing these attributes might have led to the high subject compliance with exercise rates.

Significant increases in isometric strength measures, ranging from 11.8% to 18.6%, were found on 3 of the 4 joint tests for the aquatic exercise group and on all 4 joint tests for the on-land exercise group. The increases in isometric strength showed by both exercise groups reflect isometric strength gains obtained in previous exercise intervention studies on this population. 11,21,22 Although the functionality of isometric strength assessment is sometimes questioned,23 the ability to detect strength changes because of exercise intervention programs via this assessment mode is important, because some patients with arthritis cannot tolerate the excessive joint loads or forceful muscle contractions required in other types of strength assessment.24,25

On the functional fitness measures, both exercise groups showed significant improvements on flexibility (aquatic, 8.8%; on-land, 12.1%), eye-hand coordination (aquatic, 18.4%; on land, 23.6%), and arm curl (aquatic: right arm, 21.4%; left arm, 20.2%; on-land: right arm, 17.7%; left arm, 21.5%) tests. In addition, the on-land exercise group also significantly improved on the balance and agility measure (12.4%), whereas no difference on this measure was found for the aquatic group (5.5%). Neither exercise group recorded significant increases in the cardiorespiratory test (880-yd walk) after the exercise intervention.

The finding that cardiorespiratory endurance was not enhanced for either exercise group after the intervention program is not surprising, because this component is not emphasized in either exercise protocol. Although other aquatic and on-land exercise
intervention studies4,21,26 have shown increases in functional ability tests for this population, to our knowledge no studies have been published comparing the effects of the 2 NAF exercise protocols on these measures. The results obtained in our study on the remaining physical fitness test items appear to validate the claims made by both exercise programs that physical function, flexibility, strength, balance, and mobility will be improved in persons with arthritis who participate in NAF exercise protocols.

A significant finding of our study was the decreased perception of pain and difficulty in performing specific ADLs experienced by both exercise groups after the exercise intervention. In performing specific ADL tasks, the aquatic group significantly reduced their perception of both pain (12.8%) and difficulty (17.2%) measures, whereas the on-land group significantly reduced their level of pain (15.7%) measure. Research has identified the ability to perform ADLs with less pain and difficulty as major priorities for the older population with arthritis.5,20 Whether the reductions of these ADL measures were the result of the actual physical activities performed in each exercise program or as the result of some of the educational components (ie, joint protection, body awareness, activity modification, coping with stress strategies) was not determined in this investigation.

The results of our investigation support the premise that older adults with arthritis can increase functional fitness measures and the ability to perform ADLs by participating in either NAF aquatic or on-land exercise protocols. It should be noted, however, that in our study, the participants were individuals with arthritis who were able to perform ADLs on a daily basis with only moderate difficulty and who were exercising on their own at least once a week. In addition, baseline categorization of the subject’s performance levels in each of the 5 fitness tasks indicated that the subject’s physical fitness capacity was about average for their age and sex. The effectiveness of NAF programs on these measures for individuals with arthritis with lower or higher levels of physical function may be different. However, because the population used in this study may be reflective of those individuals currently enrolled in such programs, and the protocols used for each of the exercise interventions were not changed for this investigation, the effectiveness of each program for its participants is promising.

Conclusion

The data in this investigation indicate that both NAF aquatic and on-land exercise programs are effective in promoting increases in functional fitness and ADL measures for older adults with arthritis. Although these increases may result from the physical activities practiced within each program, further study into the effects of the educational and social components of these programs may be warranted.

References

26. Templeton MS, Booth DL, O'Kelly WD. Effects of aquatic therapy on joint flexibility and functional ability tests for this population, to our knowledge no studies have been published comparing the effects of the 2 NAF exercise protocols on these measures. The results obtained in our study on the remaining physical fitness test items appear to validate the claims made by both exercise programs that physical function, flexibility, strength, balance, and mobility will be improved in persons with arthritis who participate in NAF exercise protocols.