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# **Effects of Aquatic Exercise Training on Pain, Symptoms, Motor Performance, and Quality Of Life of Older Males with Knee Osteoarthritis**

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## **ABSTRACT**

Clinical experiences indicate that aquatic exercises may have advantages for osteoarthritis patients. The purpose of this study was to examine the effects of aquatic exercise training on the knee pain and its symptoms as well as on the motor performance associated with daily living activities (ADL), sport-recreational activities, and the quality of life in men over 50. 30 men over 50 years old who suffered from knee osteoarthritis were selected voluntarily and were randomly assigned to aquatic exercise therapy and control groups. The means and standard deviations of age, height and weight of participants in each group were  $54.26 \pm 3.08$  and  $57.6 \pm 5.76$  yr;  $169 \pm 4.99$  and  $168.13 \pm 4.76$  cm; and  $76.33 \pm 8.11$  and  $71.53 \pm 8.09$  kg, respectively. Aquatic exercise training was carried out 3 times per week for 6 weeks. Knee pain, symptoms, motor function in daily activities and sport- recreation and quality of life were measured before and after exercise training. Results showed that the knee pain, symptoms, motor function in daily and sports – recreational activities and quality of life after the exercise protocol significantly improved in the aquatic exercise group ( $P < 0.05$ ); however, there was no significant change in control groups from pre to post-test ( $p > 0.05$ ). The results showed that aquatic exercises, as a safe and effective exercise method, could be incorporated to improve the pain, motor functions and quality of life in over-50-year-old males with knee osteoarthritis.

**Key Words:** Osteoarthritis, Knee Pain, Aquatic Exercises.

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## INTRODUCTION

Arthritis is the most common joint disease (1, 2). About a billion people around the world suffer from degeneration of joints (1). Osteoarthritis (OA) includes 50% of the problems of people over 65 and it has been estimated that 40% of people over age 70 suffer from osteoarthritis (3). Knee problems are the most common joint injuries after fingers and vertebrae. OA is the most common synovial joint disease that is often associated with structural changes (4) and is called in various names such as degenerative joint disease and aging arthritis. OA often occurs in the elderly people. Knee osteoarthritis (knee OA) usually starts with covering of hyaline articular cartilage (5). Osteoarthritis involves a series of clinical and laboratory signs and symptoms that occur due to different reasons. It seems that the loosening of the collagen network, abnormal development of proteoglycans and tissue swelling are the most important causes of the beginning of OA (6).

Common symptoms of OA can be pain, stiffness, decreased range of motion, joint deformity, muscle weakness, and atrophy. Common factors affecting the incidence of osteoarthritis are aging (6), gender, previous trauma, chronic stress over the joints, and obesity (7). Treatment options may include pharmacological treatment, non-pharmacologic treatments and surgery (8, 9). Among the non-pharmacological therapeutic methods, most studies have been assigned to exercise therapy (10, 11). Patients with knee osteoarthritis are reluctant to participate in these activities due to fear of a worsening condition. It has been shown that regular physical activity have significant benefits in the treatment of osteoarthritis, while inactivity and disuse of affected limbs can worsen the mechanical damage of joint and cause loss of joint fluid and inefficiency of the matrix which can accelerate the loss of cartilage (12).

Aquatic exercise can minimize the load on the joints in obese people or people who are seriously ill, and can be especially useful in the early stages of training on land. Minor (2003) suggested that patients who suffer knee osteoarthritis to exercise at least three days a week for 30 minutes of moderate intensity (metabolic equivalents 3 Met) (13). Bartles *et al.* (2007) compared the effect of aquatic exercise in treatment of knee and hip osteoarthritis with the other treatment methods and concluded that aquatic exercise improves function and quality of life (14). Figueira (2010) examined the effect of aquatic exercise on daily activities in patients with knee and hip OA and discovered that most people deal with fewer problems in daily tasks due to aquatic exercise (6).

National Institute of Arthritis in the United States (1997) suggested aquatic exercise program for the community arthritis patients (15). Aquatic exercise has many advantages, because water properties such as resistance, reducing weight and pressure affected on joints. Exercise will be done with less injury and easier to learn in water (16).

Quality of life is described as general well-being of individuals. Some of important indicators of it include physical and mental health, recreation and leisure time (6, 17). Aquatic exercise decreases pain and improves quality of life in these patients due to strengthening the muscles around the joint and reducing pressure on it (17). In South Korea, aquatic exercise training is widely used in recent years (18).

Wyatt *et al.* (2001), Cochrane, Davey, and Matthes Edwards (2005), Hinman, Heywood, and Day (2007), Silva *et al.* (2008) and Mehrabian *et al.* (2012) compared exercises on land to in water and concluded that aquatic exercise group reported less pain which means exercise in water is an effective treatment method for the management of knee osteoarthritis (17, 19-22). However, Lund *et al.* (2008) and Wang *et al.* (2011)

recommended that pain was only observed in land exercise group (23, 24). Lim, Tchai, and Jang (2010) designed two exercise programs, on land and in water to increase knee function and decrease body fat in obese patients with knee OA and concluded that body fat rate significantly decreased in the aquatic exercise group and pain, disability and quality of life significantly improved at the end of the protocol, even though, there was no significant difference in general traits in these people at first. Notably, pain decreased in water group more than land group (25).

Few studies have been conducted on the effects of aquatic exercise on the knee which have conflicting findings in some variables (22-24). So, on the basis of the emphasis of aquatic exercise benefits for strengthening of muscles and reducing of probable sport injuries on joints, the aim of this study was the effects of aquatic exercise training on knee pain, symptoms, motor performance in daily and sports – recreational activities and quality of life in men over 50 years with knee osteoarthritis.

## MATERIALS AND METHODS

**Participants.** Thirty middle-aged males were voluntarily selected on the basis of their medical histories that have had knee osteoarthritis for at least six months (d2). Participants were randomly divided into two aquatic (n=15) and control (n=15) groups.

**Protocol.** All subjects signed a written informed consent. As an initial assessment (pre-test), all participants filled knee and Osteoarthritis Outcome Scores (KOOS) questionnaire which has 42 patient-centered questions. This questionnaire contains 5 concepts about the situation of patients. Concepts included are pain (9 items), other symptoms (swelling, stiffness, and hardness) related to the disease (7 items), daily activities (up and down stairs, standing, and bathing) (17 items), sport - recreational activities (jumping, running,

and spinning) (5 items), and quality of life in relation to knee problems (4 items). Participants answered the questions based on 5 Likert pain scale (0= none, 1=slight, 2= moderate, 3= severe and 4= extremely severe) (26).

After the initial assessment, participants in the experimental group started exercise training for 6 weeks under the supervision of the researcher. Aquatic exercise program was performed three days per week for 50 minutes (22, 23). At the end of the sixth week, the final assessment (post-test) was executed, and participants again completed KOOS questionnaires. Some of the aquatic exercises are shown in figures 1 and 2.



Figure 1. Knee extension exercise



Figure 2. Squat exercise

Aquatic exercise program included strength, endurance, balance, and stretch exercises in moderate intensity that was recommended by the American Association

of Geriatric Medicine (27). Each session was included 50 minutes whose 10 minutes was allocated to warm up, 20 minutes to strength and endurance training, 5 minutes to balance exercises, 10 minutes to

stretching exercise, and 5 minutes to cooling down (22, 23). Type and duration of aquatic exercise program in each session are shown in table 1.

**Table 1. Aquatic exercise program**

Exercise	Duration (min)	Type of exercises
Warm up	10	Forward, backward, lateral walking and running
Strengthening/Endurance	20	Double-leg Squat, lunge, knee flexion and extension, hip flexion and extension, hip abduction and adduction and breast stroke leg
Balance	5	Double-leg calf raises and knee up
Stretching	10	Quadriceps and hamstring stretch, sitting knee flexors and extensors stretch

Two weigh ankle weights and elastic bands for strengthening and endurance exercises, chairs for sitting movements and kickboards to maintain the patients balance were used during aquatic movements.

None of the participants had a history of participating in aquatic exercise for treatment of their knee pain and did not take any oral drug in order to reduce their pain for at least 1 month before and during the study.

**Statistical Analysis.** The data were expressed as mean values and their standard deviation (SD). The significance of difference between control group and mastic intake group was analyzed using t-test at  $p < 0.05$ . The variables were analyzed by two-way analysis of variance (ANOVA)

with mastic intake and exercise as factors. When a significant interaction effect was found, Tukey post hoc tests were performed. When a significant mastic intake or exercise effect was found and the interaction effect was insignificant, one-way ANOVA was used to compare the means of the groups. The statistical significance level was set at  $p < 0.05$ .

## RESULTS

T-test revealed no significant difference between the mean of age, height, weight and duration of osteoarthritis with 95% in both aquatic exercise and control group. Table 2 shows the mean and standard deviation of the personal characteristics (table 2).

**Table 2. Participants' personal characteristics (Mean  $\pm$  SD)**

	Age (year)	Height (cm)	Weight (kg)	OA duration (year)
<b>Aquatic group</b>	54.26 $\pm$ 3.08	169 $\pm$ 4.99	76.33 $\pm$ 8.11	2.83 $\pm$ 1.43
<b>Control group</b>	57.6 $\pm$ 5.76	168.13 $\pm$ 4.76	71.53 $\pm$ 8.09	3.73 $\pm$ 1.38
<b>p</b>	0.058	0.605	0.116	0.092

Results showed that pain, symptoms, motor performance in daily and sports - recreational activities and quality of life got significantly improved in the aquatic exercise group after participating in the protocol. However, in the control group, no

significant difference was found in any of these variables. The mean and standard deviation of the KOOS questionnaire scores are shown in table 3 in two water exercise and control groups in pre and post-test assessment.

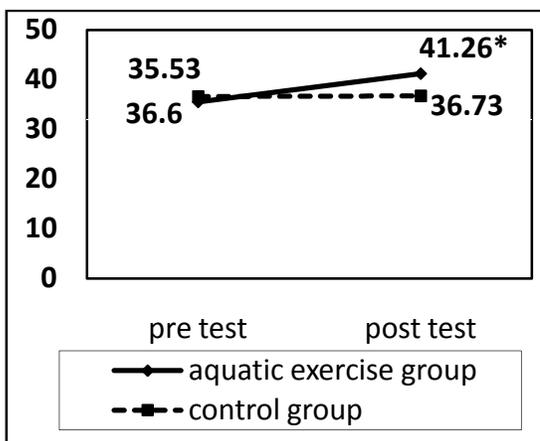


Figure 3. The comparison of pain scores. \*: significant difference from pre to posttest between groups ( $p < 0.05$ ).

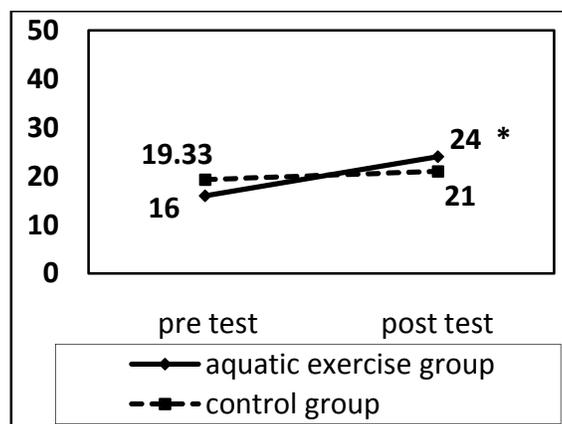


Figure 6. The comparison of sport and recreational activity scores. \*: significant difference from pre to posttest between groups ( $p < 0.05$ ).

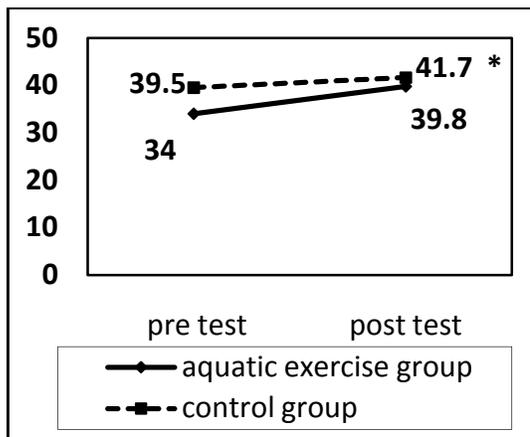


Figure 4. The comparison of symptoms scores. \*: significant difference from pre to posttest between groups ( $p < 0.05$ ).

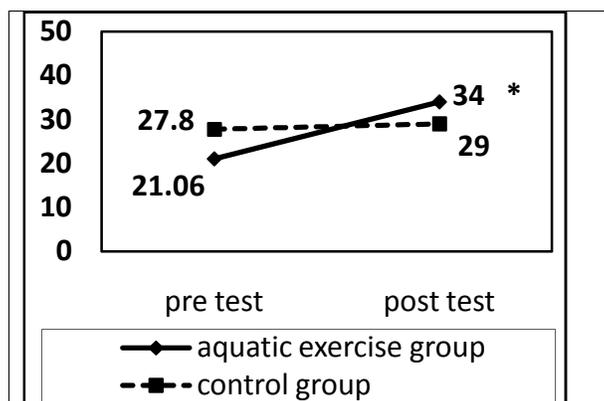


Figure 7. The comparison of quality of life scores. \*: significant difference from pre to posttest between groups ( $p < 0.05$ ).

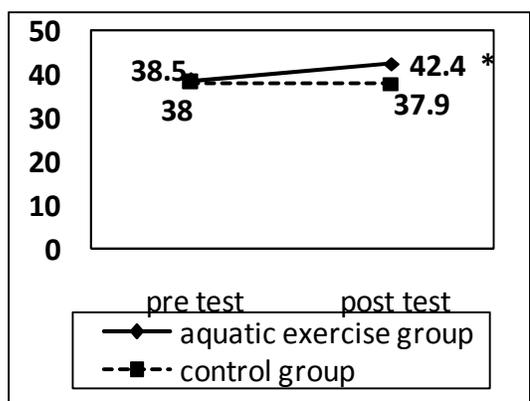


Figure 5. The comparison of daily activity scores. \*: significant difference from pre to posttest between groups ( $p < 0.05$ ).

One-way ANOVA was used for pre-test data in relation to measuring difference in aquatic and control groups, and it was found that there was a significant difference between the post-test scores of pain, symptoms, motor performance in daily and sports - recreational activities and quality of life (QOL) in two groups. One-way ANOVA test results for measuring the post-test differences in water and control groups are shown in Figures 3 to 7.

## DISCUSSION

Based on the findings and testing of these research hypotheses, results showed that

pain, symptoms, motor performance in daily and sports-recreational activities and QOL in participants significantly improved in water exercise group after performing the protocol, while no significant changes were observed in any of these variables in the control group.

Results showed that water exercise training for males over 50 with knee OA has a significant effect on reducing pain. The results of this study are in agreement with findings by Lim, Tchai, and Jang (2010), Wang *et al.* (2011), Silva *et al.* (2008), Bartles *et al.* (2007), Foley *et al.* (2003) and Wyatt *et al.* (2001) (14, 16, 19, 21, 24, 25). On the other hand, Lund *et al.* (2008) immediately at the end of the study and Wang *et al.* (2007) observed no significant differences in pain scores (23, 28). The probable reason for this difference may be due to a variety of training period, the type of equipment and the gender of participants.

It is noted that pain is the most important symptom of knee OA. So, the main goal of any treatment method is reducing the clinical signs. Silva *et al.* believed that strengthening of the thigh muscles caused these improvements (21), but we were not able to confirm this because we did not directly measure the thigh strength. Studies have shown that excess cytokine production in body is the cause articular cartilage loss and joint problems such as osteoarthritis. Physical activity reduces cytokine production, and then reduces pain and improves function (29). In addition, the other factor that may cause pain and loss of function is muscle atrophy which can be due to lack of activity (30, 31). Bartles *et al.* (2007) reviewed the effect of aquatic exercise on knee OA and showed that decreased pain and improved water function in patients with knee osteoarthritis is due to improved neuromuscular functions related to the movement of the muscles around the knee (increased power, strength and endurance) (14).

The results, also, showed that water exercise training has a significant effect on symptoms of knee osteoarthritis in men over 50 years old. It has been shown by Wang *et al.* (2011), Silva *et al.* (2008), Lim, Tchai, and Jang (2010) and Hinman, Heywood, and Day (2007) that a significant improvement was observed in the symptoms of knee osteoarthritis (17, 21, 24, 25), but it is the opposite of results by Mehrabian *et al.* (2012) and Lund *et al.* (2008) (22, 23). Possible reasons for this difference can be the gender of participants and the severity of osteoarthritis. Although the participants had 2 or 3 degrees of osteoarthritis, the number of people with 2 degree of OA was more in the current study compared to the other one. Finally, as said before, Lund used special equipment for aquatic exercise.

Symptoms of knee OA include stiffness, pain and inflammation in the areas mentioned. Symptom score decreased after 6 weeks of exercise in water. It can be probably due to more flexibility of soft tissues, less swelling and inflammation and strengthening the muscles around the knee area.

The findings of this study showed that aquatic exercise training improves motor performance in daily activities and sports - recreation of elderly men with knee osteoarthritis. This conclusion is the same of the results of Wang *et al.* (2011), Silva *et al.* (2008), Lim, Tchai, and Jang (2010) and Hinman, Heywood, and Day (2007) Cochrane, Davey, and Matthes Edwards (2005), Bartles *et al.* (2007) and Mehrabian *et al.* (2012) (14, 17, 20-22, 24, 25), but it is the opposite of Wang *et al.* (2007) and Lund *et al.* (2008) findings which have been shown no improvement in physical function (23, 28). Possible reasons for different results could depend on older participants and the type of used joint in the present study.

According to the physiological view, improvement of muscles around the knee by exercise can cause more consistent joint and

more absorption of forces on the joint by muscles and these can reduce pain and knee OA symptoms which can improve knee function to do daily activities (17, 30). In addition, physical exercise causes endorphins excretion, resulting in increased resistance to musculoskeletal injuries and pain threshold (32).

The results showed that aquatic exercise training has a significant effect on quality of life in males over 50 with knee OA. The result was the same as the results by Mehrabian *et al.* (2012), Wang *et al.* (2011), Lim, Tchaj, and Jang (2010), Bartels *et al.* (2007) and Hinman, Heywood, and Day (2007) (14, 17, 22, 24, 25), But with the Wang *et al.* (2007) and Lund *et al.* (2008) were in conflict (23, 28). The probable reason for this difference could be the gender of participants, the period of the research and the higher age average.

According to the physiological view, the effect of doing exercise is obvious on the central nervous system, soft tissue flexibility, tendons, and ligaments, balance, muscle strength and metabolism. Also, endorphin excretion and other hormonal

changes psychologically contribute to happiness (32) and increase hope which can affect quality and style of life.

Overall, the results of this study and other studies have shown that aquatic exercise in patients with knee osteoarthritis has beneficial effects on reducing pain and increasing motor performance and quality of life. Less strain on joints during water exercise is one of the benefits of it, too. However, randomized and controlled research on this subject is so few that we cannot give more suggestion to how to do it.

## CONCLUSION

In summary, the main finding of this study was that aquatic exercise program can reduce pain and improve symptoms, motor function in daily and sport recreational activities and quality of life. It is recommended that professionals and practitioners apply the results of this research in control and rehabilitation programs of patients with knee osteoarthritis who have the same conditions as these participants.

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تازه‌های علوم کاربردی ورزش

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# اثر تمرینات ورزشی در آب بر درد، علائم بیماری، عملکرد حرکتی و کیفیت زندگی مردان مسن مبتلا به استئوآرتروز زنانو

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## چکیده

شواهد بالینی نشان می‌دهد که تمرین در آب می‌تواند برای مبتلایان به استئوآرتروز مفید باشد. هدف پژوهش حاضر، بررسی آثار برنامه تمرین ورزشی در آب بر میزان درد زانو، علائم بیماری، عملکرد حرکتی در فعالیت‌های روزانه و ورزشی-تفریحی (ADL) و کیفیت زندگی مردان بالای ۵۰ سال مبتلا به استئوآرتروز زانو بود. تعداد ۳۰ مرد بالای ۵۰ سال مبتلا به استئوآرتروز زانو به صورت داوطلبانه، به عنوان نمونه انتخاب شدند و در یکی از دو گروه تمرین در آب و شاهد به صورت تصادفی قرار گرفتند. میانگین و انحراف استاندارد سن در دو گروه به ترتیب  $71/53 \pm 3/08$  و  $54/26 \pm 5/76$  و  $57/6 \pm 5/76$  سال، قد  $169 \pm 4/99$  و  $168/13 \pm 4/76$  سانتیمتر، وزن  $8/11 \pm 76/33$  و  $8/09 \pm 71/53$  کیلوگرم بود. شرکت کنندگان گروه اول، برنامه تمرینی ورزش در آب را به مدت ۶ هفته و ۳ جلسه در هر هفته زیر نظر محقق انجام دادند. موارد ارزیابی در دو مرحله قبل و بعد از ۶ هفته شامل درد زانو، علائم، عملکرد حرکتی فعالیت‌های روزانه و ورزشی-تفریحی و کیفیت زندگی بود. شدت درد زانو، میزان علائم بیماری، عملکرد حرکتی در فعالیت‌های روزانه و ورزشی-تفریحی و کیفیت زندگی پس از اجرای پروتکل به میزان معنی‌داری در گروه تمرین در آب بهبود یافته بود ( $p < 0/05$ )، در حالی که در گروه کنترل تغییرات معنی‌داری در هیچ یک از متغیرها مشاهده نشد ( $p > 0/05$ ). نتایج نشان داد که برنامه تمرینی ورزش در آب می‌تواند به عنوان یک روش تمرینی ایمن و مؤثر در بهبود درد، علائم، عملکرد حرکتی و کیفیت زندگی مردان بالای ۵۰ سال دارای استئوآرتروز زانو مورد توجه قرار گیرد.

واژگان کلیدی: استئوآرتروز، درد زانو، ورزش در آب.

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