

Meta-Analysis the Effect of Aquatic Therapy on Functional Ability in Patients with Knee Osteoarthritis

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ABSTRACT

Background: Knee OA can affect mobility in the elderly causing pain and impaired functional ability. This study aims to analyze the effect of aquatic therapy on functional ability in knee osteoarthritis patients based on the results of a number of previous primary studies..

Subject and Method: This study was conducted using a meta-analysis method with articles searched using the search keywords "knee osteoarthritis" OR "osteoarthritis genu" AND "aquatic therapy" OR "hydrotherapy" OR "water exercise" AND "functional ability" OR "WOMAC" AND "Randomized Controlled Trial" OR "RCT" from PubMed, google scholar and science direct and processed using RevMan 5.3.

Results: 9 RCT articles that fit into the inclusion criteria, with a total of 573 samples. Knee OA patients receiving aquatic therapy had a mean WOMAC score of 1.22 units lower than those without aquatic therapy, and the effect was statistically significant (SMD = -1.22; 95% CI -2.03 to -0.41; p = 0.003). In other words, aquatic therapy is effective in improving functional ability in knee OA patients.

Conclusion: Aquatic therapy has an effect on increasing functional ability in knee osteoarthritis patients.

Keywords: Osteoarthritis, aquatic therapy, WOMAC index

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Cite this as:

Puspita WH, Tamtomo DG, Prasetya H (2022). Meta Analysis the Effect of Aquatic Therapy on Functional Ability in Patients with Knee Osteoarthritis. *Indones J Med.* 07(02): 138-149. <https://doi.org/10.26911/theijmed.2022.07.02.03>.



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BACKGROUND

Osteoarthritis (OA) is a chronic degenerative inflammatory disease, which is characterized by changes in articular cartilage, osteophytes and subchondral bone thickening (Alcalde, 2017). Osteoarthritis is a major cause of pain and activity limitation in the elderly. Recent studies have shown that behavioral factors, neuromuscular factors, and medical factors predict the presence of

pain and activity limitations in OA (Dekker, 2014).

Osteoarthritis (OA) is a serious chronic disease that affects 1 in 7 adults in the United States 32.5 million people. OA is associated with aging and is more common in people with other chronic conditions, such as heart disease, diabetes, and obesity (Albright et al., 2020). In Brazil, the number of elderly people is 16%, surpassing the figure of 34 million in 2019. Long life brings

with it chronic degenerative diseases that limit the functional capacity of the affected population. OA is a chronic degenerative disease of high incidence, a musculoskeletal disorder that usually has an insidious, progressive and slow pattern, often affecting joints such as the hands, spine, hips, and knees (Garbi et al., 2021). In Indonesia, according to Riskesdas 2018, the prevalence of joint disease based on a doctor's diagnosis at the age of 15 years, the highest data was obtained, namely 18.9% at the age of 75+, 18.6% at the age of 65-74 years, and 15.5% at the age 55-64 years and mostly suffered by women.

Apart from aging, obesity, trauma, joint surgery, hormonal imbalance, genetics, nutrition and bone density are some of the factors that cause OA (Garbi et al., 2021). Signs and symptoms of OA experienced by the population are pain throughout the day and decrease with rest, swelling and tenderness in the joints with or without crypts, morning stiffness and reduced range of motion of the joints, with decreased aerobic capacity, and muscle weakness of the lower limbs. In addition to pain and stiffness, knee OA can affect mobility in the elderly causing impaired functional ability (Garbi et al., 2021).

The management of osteoarthritis is modified based on the updated ACR guidelines in 2000. The first stage is non-pharmacological therapy by providing education, physical activity, lifestyle changes. The second stage of pharmacological therapy (better when combined with non-pharmacological therapy) uses NSAIDs/NSAIDs. The third stage is knee replacement surgery (Albright et al., 2020). Many methods of exercise and the use of electrotherapy can be used to treat these symptoms. However, this therapy requires a long time for healing and for maintenance so that the OA condition

does not get worse. The main goals of exercise therapy are to reduce pain, improve function and restore the patient's quality of life. Physiotherapy has several methods to achieve this goal, namely kinesiotherapy, manual therapy, and electrotherapy. This training method can be given on land or in water. Several studies have reported that exercise in water (aquatic therapy) has a good effect on treating symptoms caused by OA.

The findings from several studies in the field reported that exercise in water can reduce pain, improve function, and balance in patients with knee osteoarthritis (KOA) (Lu et al., 2015; Alcalde et al., 2017; Taglietti et al., 2018; Assar et al., 2020). Aquatic therapy is a source of therapy that is widely used in the treatment of rheumatism because it promotes movement and reduces joint overload. Immersion can achieve therapeutic effects in warm water, such as muscle relaxation, pain relief, and reducing pressure on joints (Garbi et al., 2021).

Aquatic therapy uses the principles of water, known as hydrodynamics, to cause physiological changes. These principles are buoyancy, density, viscosity, thermodynamics, and hydrostatic pressure which act together to give the patient a unique sensory experience to facilitate range of motion (ROM), functional strength, and balance (Aquatic, 2016). In addition, it can also improve the patient's quality of life with the recreational and relaxing effects of exercise activities in aquatic therapy. Aquatic therapy can be given to individuals, classes, or groups. This study aims to analyze the effect of aquatic therapy on functional ability in knee osteoarthritis patients based on the results of a number of previous primary studies using a meta-analysis.

SUBJECTS AND METHOD

1. Study Design

This research was conducted using a meta-analysis research design with PRISMA flow chart guidelines. For data search, all searchable articles published before March 2022 were examined. The databases used in this search were Google scholar, Pubmed, and Scencedirect. Search articles using the term Mesh with the search keywords "knee osteoarthritis" OR "osteoarthritis genu" AND "aquatic therapy OR "hydrotherapy" OR "water exercise" AND "functional ability" OR "WOMAC" AND "Randomized Controlled Tria".

2. Inclusion Criteria

Inclusion criteria 1) full paper article using a Randomized Control Trial (RCT) study design, 2) The size of the relationship used is Mean SD, 3) Research subjects are patients with knee osteoarthritis, 4) The intervention given is aquatic therapy, 5) Comparison is without therapy or other therapy, 6) The study outcome is functional ability with WOMAC score.

3. Exclusion Criteria

The exclusion criteria for this study were: 1) articles published in languages other than English and Indonesian, 2) articles before 2011.

4. Study Variables

The independent variables is aquatic therapy and the dependent variable is functional ability.

5. Variable Operation Definition

Aquatic therapy is a treatment and exercise performed in water for rehabilitation, fitness and relaxation (Ferguson, 2021). The forms of exercise are cardiovascular exercises, stretching exercises, strengthening exercises, walking.

Functional abilities are about abilities that enable people to be and do what they

want to be (WHO, 2019). Measurement of functional ability using the WOMAC index.

6. Study Instrument

The results of the search for articles obtained from the database have been identified, then each study was assessed based on the eligibility criteria. The quality and design of the research analyzed in the meta-analysis is very important because it affects the results. Assessment of study quality using the Critical Appraisal Checklist for Randomized Controlled Trial.

7. Data Analysis

Research data were analyzed using the RevMan 5.3 application, to calculate the effect size and heterogeneity of the study. The results of data processing are presented in the form of forest plots and funnel plots.

RESULTS

The article selection process uses the PRISMA flow chart. A total of 883 articles consisting of 789 obtained from Google Scholar and 11 from Pubmed. A total of 146 articles were deleted because they were duplicate articles, leaving 737 articles. Then as many as 686 articles were issued on the grounds that the title was irrelevant, the article was not full text, was not an RCT study, and was not in English and Indonesian. The full text of the article that was declared worthy contained 51 articles. There were 13 articles eligible to be included in the qualitative synthesis, with 38 articles excluded because the outcome was not suitable. Finally, 9 articles were included in the meta-analysis (figure 1).

Primary research on the effect of aquatic therapy on the functional ability of knee osteoarthritis patients with a total of 9 studies located in America (USA), India, Thailand, Korea, Australia, Brazil, and Tunisia. Assessment of article quality using CASP for RCTs (Table 1). On average, the

research subjects were COA patients with middle age or >50 years, the provision of effective water exercise with 40-60 minutes

per exercise session with various forms of exercise (Table 2).

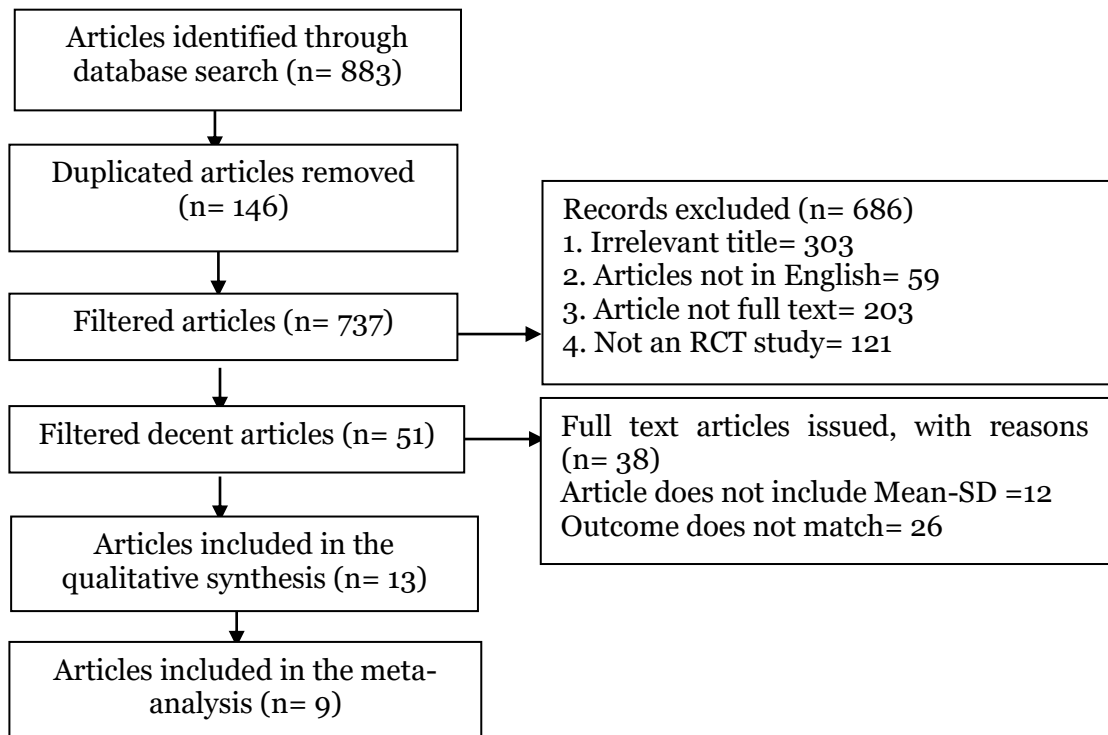


Figure 1. PRISMA Flowchart

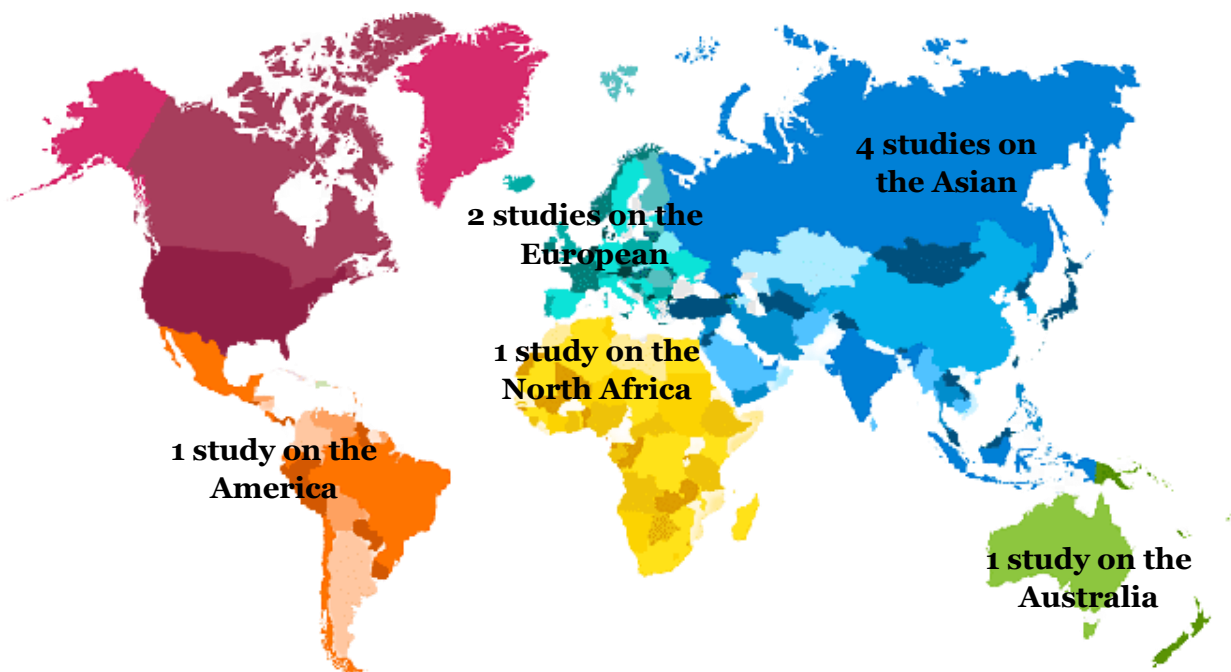


Figure 2. Study Map Area Effect of Aquatic Therapy on Functional Ability in Patients with Knee Osteoarthritis

Table 4. Description of Primary Studies included in Meta-analysis

Author (year)	Country	Design Studies	Number of Samples		Population	Intervention	Comparison	Outcome
			Aquatic Therapy	Non-aquatic Therapy				
Fazaa et al. (2014)	Tunisia	RCT	116	117	Male and Female COA patients, grade 2-3, age <75 years	Water temperature 36°C with 5 types of therapy: Underwater showers 15 minutes, massage jets showers 10 minutes, hydromassage 20 minutes, pool rehabilitation 20 minutes, application heat peloid 15 minutes, for 21 days.	Classical rehabilitation programs such as 30-minute pain relief electrotherapy and strengthening exercises.	Womac index results: p=0.001 significantly increased functional ability on day 21
Kruakhorn et al. (2021)	Thailand	RCT	17	17	Individuals with KOA male and female, age 45-75 years, grade 2-3	Hydrotherapy: pool temperature 32-33°C, 45-60 minutes, 3x/ week, 6 weeks, stretching, strengthening, cycling.	Land-based exercise: exercise on the mat 45-60 minutes, 3x/week, 6 weeks, stretching, strengthening, cycling.	Womac index results: p<0.01 significantly improve functional ability
Taglietti et al. (2018)	Brazil	RCT	31	29	COA patients grade 1-4, aged 60-85 years	Aquatic program 60 minutes, 2x/week, for 8 weeks, temperature 32°C, depth 1.2 m, warm up 5 minutes (walking, patellar mob, stretching, leg muscle). Knee and hip isometric, and 15 minutes of dynamic exercise. Aerobic exercise 20 minutes, Step training and proprioceptive exercise 10 minutes, cooling down 10 minutes.	Educational group program	Womac index: p=0.04 significantly improved functional ability

Cont.

Author (year)	Country	Design Studies	Number of Samples		Population	Intervention	Comparison	Outcome
			Aquatic Therapy	Non-aquatic Therapy				
Hale et al. (2012)	Australia	RCT	20	15	Male and female COA patients, age 65 years or >55 years	Water-based exercise: depth of 1.3 meters, temperature 28°C 2x/week, 12 weeks 20-60 minutes. warm up (stretching, walk exercise, calf and toe raises) Balance exercises Cool down (Walking and stretching)	SeniorNet, a computer-based training program	Womac index: there is no significant difference
Naik et al. (2020)	India	RCT	15	15	Female, 45-55 years old, KOA	Underwater treadmill 10 minutes for 2 weeks	Closed chain exercise on land	Womac index: p<0.0001 significantly improve functional ability
Benkar et al. (2020)	India	RCT	42	42	COA patient	MWM under water, 10 moves, 3 sets	MWM in land, 10 moves, 3 sets	Womac index: p=0.94 not significant
Cardoso et al. (2017)	Brazil	RCT	17	17	KOA female, grade 1-2	CKC Pool: 2 months, 3x/week Warm-up Mini squattingo - 300 degrees, Front step up and down, Lateral step up and down, Leg press, Float walking, Proprioceptive board, Frontal walking training, Lateral walking training, Backwards walking training	CKC ground: 2 months, 3x/week Warm-up Mini squattingo - 300 degrees, Front step up and down, Lateral step up and down, Leg press, Float walking, Proprioceptive board, Frontal walking training, Lateral walking training, Backwards walking training	Womac index: p<0.05 in pool group

Author (year)	Country	Design Studies	Number of Samples		Population	Intervention	Comparison	Outcome
			Aquatic Therapy	Non-aquatic Therapy				
Ha et al. (2018)	Korea	RCT	9	8	Middle-aged woman with KOA	Aquatic exercise program 12 weeks, 3x/week 60 minutes. Preparation exercise 10 minutes (jumping, walking, stretching) Exercise underwater 40 minutes (swimming, walking, squat, lifting), Healing exercise	No therapy	Womac index: p<0.01 significantly improve functional ability
Kim et al. (2021)	USA	RCT	20	23	Primary COA patients, age >50 years	Aquatic Exercise Intervention: water temperature 32°C Warm up 10 minutes. Joint ROM and strength 20 minutes. Low intensity endurance 20 minutes. cool down 10 minutes.	Brochure about nutrition before surgery	Womac index: p<0.0001 significantly improve functional ability

Table 2. Assessment of research quality of Aquatic Therapy on Functional Ability in Patients with Knee Osteoarthritis

No	Questions	Cardoso et al 2012	Fazaa et al 2014	Khruak horn et al 2021	Taglietti et al (2018)	Hale et al (2012)	Ha et al. (2017)	Kim et al. (2021)	Rise etr al. (2021)	Benkar et al. (2019)
1	Does the experiment clearly address the clinical problem?	1	1	1	1	1	1	1	1	1
2	Was the intervention given to the patient randomized?	1	1	1	1	1	1	1	1	1
3	Were all patients included in the study properly accounted for in the conclusions?	1	1	1	1	1	0	1	1	1
4	Are patients, health workers, and researchers blinded?	1	1	1	1	1	1	1	1	1
5	Were the study groups similar at the start of the study?	1	1	1	1	1	1	1	1	1
6	Outside of the intervention studied, were the study groups treated equally?	1	1	1	1	1	1	1	1	1
7	Is the effect of the intervention large enough?	0	1	0	1	0	1	1	1	1
8	How precise is the estimation of the effect of the intervention?	1	0	1	1	1	1	1	1	1
9	Do the benefits provided by the intervention outweigh the costs and disadvantages?	1	1	1	1	1	1	1	1	1
10	Are the results applicable to the context of practice or local populations?	1	1	1	1	1	1	1	1	1
11	Are all other clinically important outcomes considered in this article?	1	1	1	1	1	1	1	1	1
Total score		10	10	10	11	10	10	11	11	11

Answer: 1=Yes, 0=No.

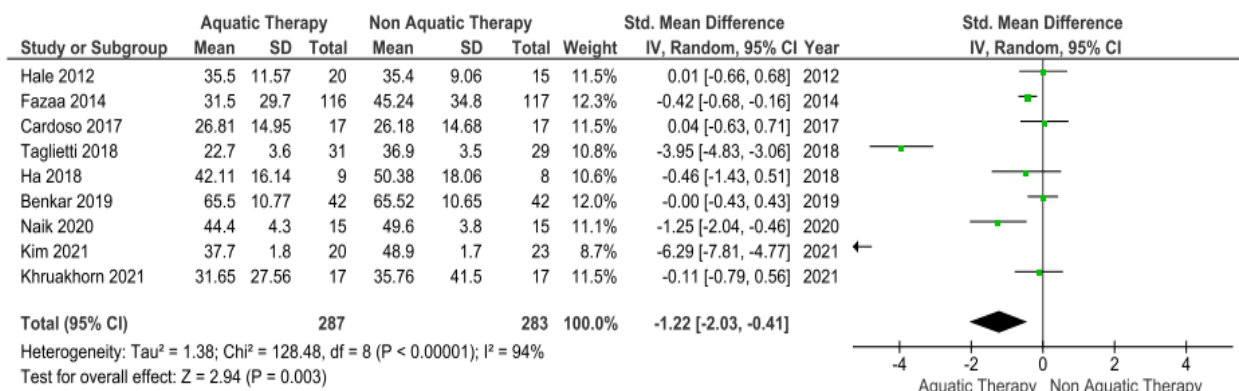


Figure 2. Forest Plot

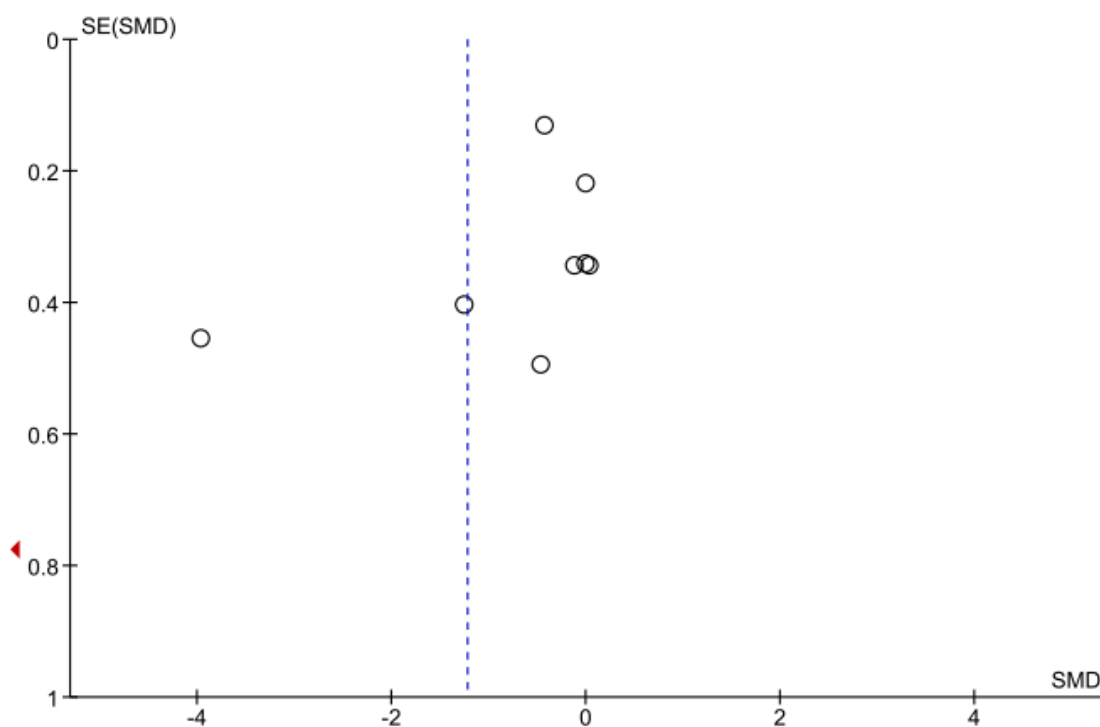


Figure 3. Funnel plot

a. Forest Plot

Forest plot shows that there is an effect of aquatic therapy on functional ability in knee osteoarthritis patients. Knee OA patients receiving aquatic therapy had a mean WOMAC score of 1.22 units lower than those without aquatic therapy, and the effect was statistically significant (SMD = -1.22; 95% CI -2.03 to -0.41; p = 0.003). In other words,

aquatic therapy is effective in improving functional ability in knee OA patients (Figure 2).

The forest plot also shows the heterogeneity of the estimated effect between studies in this meta-analysis (I² = 94%; p < 0.001). Thus, the calculation of the average estimated effect of aquatic therapy from all

studies in this meta-analysis uses the random effects model (REM approach).

b. Funnel plot

The funnel plot in Figure 2 shows the asymmetric distribution of the effect estimates to the right and left of the mean vertical line of the effect estimates. The estimated effect is more visible to the right of the vertical line than to the left. So the funnel plot indicates that there is publication bias. Due to the tendency of the distribution of effect estimates to the right of the estimated mean vertical line in the opposite direction to the effect estimation average diamond to the left of the null hypothesis vertical line on the funnel plot, the publication's bias indicates a tendency to underestimate the effect of aquatic therapy.

DISCUSSION

These results are in accordance with the meta-analysis of Waller et al., (2014) showing that Therapeutic Aquatic Exercise is effective in managing symptoms associated with lower extremity OA. Another study stated that there was an effect of hydrotherapy exercise on pain intensity and functional ability in knee OA patients (Amelia et al., 2020).

Aquatic therapy interventions such as treadmill exercise in water, swimming, and other exercises have been reported in men to increase cardiovascular endurance, increase muscle strength, reduce leg swelling, increase joint range of motion, reduce mechanical stress on the extremities. King et al., (2012). The increased resistance and buoyancy inherent in aquatic exercise improve joint stability and reduce stress on muscles and joints. Immersion of the lower extremities, causes circumferential compression, which increases in proportion to the depth of the water. Increased extravascular hydrostatic pressure improves circulation and reduces edema.

Hydrotherapy can also help reduce pain through the effects of temperature. Immersion in warm water causes vasodilation, increased circulation and decreased muscle spasm, whereas cold water reduces inflammation by restricting blood flow and reducing the accumulation of inflammatory mediators. Aquatic therapy is a versatile treatment modality capable of producing a wide range of therapeutic effects and is therefore considered an effective method for the rehabilitation of individuals with OA (King et al., 2012).

Another study showing that aquatic therapy has an effect on improving function is according to Dias et al, (2017) where a structured six-week hydrotherapy program led to greater improvements in pain and function in the short term compared to an educational program alone in women with knee OA. Water exercise is usually recommended in the treatment of knee OA because of the nature of water, especially its buoyancy, which has the potential to reduce joint stress. Water pressure and temperature can also lead to increased sensory input and further relief in pain relief.

Aquatic exercise has shown a beneficial effect on joint function in patients with osteoarthritis as demonstrated in a meta-analysis. Exercise, regardless of setting, can increase joint strength and range of motion leading to improved joint function. However, the incidence of osteoarthritis is high in overweight patients, and the buoyancy of water supports body weight, thereby reducing the impact on joints, this helps reduce pain and facilitates movement (Song and Oh, 2022).

This meta-analysis shows that aquatic therapy has an effect on improving functional ability in knee osteoarthritis patients. Knee osteoarthritis patients who received aquatic therapy intervention experienced a decrease in the womac scale (function

limitation scale) thereby increasing functional ability.

AUTHORS CONTRIBUTION

Wita Hana Puspita is the main researcher who selects the topic, searches for, and collects research data. Didik Tamtomo and Hanung Prasetya played a role in analyzing and analyzing research data.

FUNDING AND SPONSORSHIP

This research was independently funded.

ACKNOWLEDGEMENT

We thank all those who have helped in the preparation of this article and thank the database providers Google Scholar, PubMed, Science Direct.

CONFLICT OF INTEREST

The study was conducted without any commercial or financial relationship that could be construed as a potential conflict of interest.

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