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Masters Program in Public Health, Universitas Sebelas Maret

Meta-Analysis

The Efficacy of Aquatic Therapy for Pain in Knee Osteoarthritis: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Osteoarthritis (OA) is a joint disease that affects adults to the elderly in which the incidence and prevalence of OA will increase with age. One of the interventions to reduce pain for improving the quality of life in patients with knee osteoarthritis is by providing aquatic therapy. This study aims to determine the effectiveness of aquatic therapy for pain in patients with knee osteoarthritis.
Subjects and Method: It was a meta-analysis study using PICO. P: patients with knee osteoarthritis. I: aquatic therapy. C: non-aquatic therapy. O: reduced pain. The articles used in this study were obtained from several databases namely Google Scholar, PubMed, NCBI, Science Direct, and Springer Link. The keywords used were "osteoarthritis knee" OR "OA knee" AND "aquatic" OR "aquatic physiotherapy" OR "aquatic therapy" OR "aquatic exercise" OR "hydrotherapy" AND "quality of life" OR "QOL" AND "pain" and "RCT" or "randomized control trial". The article included in this study was a full-text article with a Randomized Controlled Trial study design. The Review Manager 5.3 application was used to analyze articles. Results from the meta-analysis were reported using the PRISMA flow diagram.
Results: A total of 9 articles that had been analyzed were from Spain, Thailand, Brazil, Australia, New Zealand, Korea, and Italy. Studies show that elderly with knee osteoarthritis who obtained aquatic therapy experienced lower pain by 0.62 units than those who did not obtain aquatic therapy thus improving the quality of life, and this effect was claimed to be statistically significant (SMD = -0.62; CI 95% -1.13 to -0.11; p <0.001).
Conclusion: Aquatic therapy reduces pain and has an impact on improving quality of life.

Keywords: aquatic therapy, knee osteoarthritis, pain, quality of life.

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BACKGROUND

Ailments such as the occurrence of pain in the joints are often incorrectly perceived by society. In fact, pain in the joints can occur as a result of various other diseases, one of which is osteoarthritis (OA). Osteoarthritis (OA) is a joint disease that can affect adults to the elderly in which the incidence and prevalence of OA will increase with age. OA usually persists and develops into a chronic disease and causes the sufferer to feel overtaxed of not getting better.

According to the Clinical Practice Management Guidelines of Osteoarthritis 2013,

OA is defined as a degenerative joint disease that is progressive due to failure in the repair of joint damage. It may arise as a result of the occurrence of biomechanical, biochemical, or genetic factors whose process may involve one or more joints (Kamaruzaman., 2013).

Degenerative processes in OA cause inflammation characterized by changes in articular cartilage, the occurrence of fibrillation areas, fractures, and the thickening of the subchondral bone. It is clinically associated with pain, stiffness, deformity, and loss of functional capacity. In Indonesia, the prevalence of osteoarthritis is 5% in individuals aged <40 years, 30% in individuals aged 40-60 years, and 65% in individuals aged >61 years. The prevalence of OA knee is relatively high, namely 15.5% in men and 12.7% in women (Siddik and Darjanti., 2020). About 10% of the population above 60 years of age is affected by OA; 80% of this population has limitations in movement, and another 25% have functional limitations that compromise the performance of daily activities. One of the things that interfere with daily activities is very intense pain and they do not know how to deal with the pain (Alcalde et al., 2017).

Pain is an unpleasant sensory and emotional experience resulting as the result tissue damage, it can be directly, as it is described by the term injury, or indirectly (Wijianto et al., 2021). Pain becomes the most significant symptom that can be observed in people with OA knee. This is usually due to changes in the compression strength of the knee joint and the effect can be seen in functional mobility (walking and ambulation) and quality of life (physical, social, psychological, and environmental impacts) (Khruakhrom et al., 2021). As a reaction to joint pain that generally occurs during daily functional activities, it tends to cause a person with OA to be reluctant to overuse their knees and become physically inactive. Avoiding such activities can pose other problems in the functioning and structure of the body such as changes in cardiovascular function, muscle weakness, and reduced knee range of motion, while also causing more common health problems such as a higher risk of comorbidities and early death. Thus, they will reduce the quality of life in OA patients (Rewald et al., 2016).

According to the World Health Organization, "Quality of life" is described as an individual's perception of one's life position in the context of the culture and value system in which they live and in relation to their goals, expectations, standards, and concerns. Thus, people with OA knee suffer a progressive increase that impacts their daily life activities, which leads to losses in work relationships, leisure, social life, and sleep quality, which also generates an important decrease in their quality of life. Thus, the need to know in patients with knee Osteoarthritis is the quality of life of these people (Kawano et al., 2015). Currently, there is no drug to cure OA, however, there are many treatments and approaches to manage the long-term symptoms of this disease (Kali, 2018). Since it is an incurable disease, the focus of OA management is to relieve pain, improve physical functioning, and reduce its symptoms (Munukka et al., 2020). A conservative method widely used by physiotherapy to reduce pain, slow down muscle weakness, and joint stiffness, prevent muscle atrophy and reduce knee joint limitations in chronic knee osteoarthritis patients is aquatic therapy (Jamaludin and Widodo., 2021).

Aquatic therapy is a physiotherapeutic intervention that can be given in knee osteoarthritis conditions. Aquatic provides natural endurance, which is used to strengthen muscles. This exercise can reduce pain and improve physical functioning as well as the

quality of life in patients with knee OA (Times, 2018). Aquatic therapy has a good reputation among patients with OA knee because doing exercises in the water feels easier and reduces the risk of feeling pain. Buoyancy force in water is a very important element because it causes joint decompression to help the patient to be more freely moving and not feel heavy while moving. In addition, water with a warm temperature can relax the muscles allowing a reduction in pain and the perception of joint stiffness (Rewald et al., 2016).

Based on the background described, a comprehensive study is needed from various primary studies on the effectiveness of aquatic therapy for pain and quality of life in people with knee osteoarthritis.

SUBJECTS AND METHOD

1. Study Design

This study is a systematic review and meta-analysis. The articles used in the study were obtained from several databases, including Google Scholar, PubMed, NCBI, Science Direct, and Springer Link. The keywords for searching for articles are: "osteoarthritis knee" OR "OA knee" AND "aquatic" OR "aquatic physiotherapy" OR "aquatic therapy" OR "aquatic exercise" OR "hydrotherapy" AND "quality of life" OR "QOL" AND "pain" and "RCT" or "randomized control trial".

2. Steps of Meta-Analysis

Meta analysis was carried out in 5 steps as follows:

1) Formulate research questions in PICO format (Population, Intervention, Comparison, Outcome).
2) Look for primary study articles from various electronic and non-electronic databases such as PubMed, ScienceDirect, Google Scholar, Scopus.
3) Perform screening to determine inclusion and exclusion criteria and carry out a critical assessment
4) Extract primary study data and synthesize effect estimates using the RevMan 5.3 application.
5) Interpret the results and draw conclusions.

3. Inclusion Criteria

The article included in this study was a full-text article using a Randomized Controlled Trial (RCT) study design. The subject of the study was a person with knee osteoarthritis. Selected articles provide therapeutic interventions for pain and quality of life in people with knee osteoarthritis. The age range of the respondents was 45-70 years.

4. Exclusion Criteria

Exclusion Criteria i.e. articles that were not included in this study were non-English articles, non-RCT study designs, and non-full-text articles, published before 2005.

5. Operational Definition of Variables

The article search was conducted by taking into account the relevant criteria specified using the PICO model. The population in the study was patients with knee osteoarthritis, intervention in the form of aquatic therapy, and outcomes in the form of pain reduction.

Aquatic therapy is an activity that involves all activities carried out in the water to assist in rehabilitation and recovery. Instruments: aquatic therapy with categorical measurement scales.

Pain is a defense mechanism that can be triggered by the stimulation of nociceptors who perceive a threat, which raises awareness when tissue damage occurs. Instruments: aquatic therapy with categorical measurement scales.

Quality of life is an individual's perception of one's life position in the context of the culture and value system in which they live and in relation to their goals, expectations, standards, and concerns. Instrument: a questionnaire with a categorical measurement scale, and staff data collection records re-

lated to the diagnosis of Diabetes Mellitus. The measurement scale is categorical.

6. Study Instruments

Each identified study report was assessed based on eligibility criteria. The quality and design of the study analyzed in the meta-analysis is very important because it affects the results. The quality assessment used in this study was critical appraisal tools randomized controlled trial (RCT) published by CEBM University of Oxford 2014.

7. Data Analysis

The data were processed using Review Manager (RevMan 5.3) to conduct a systematic review of the quality of life. Subsequently, the mean difference in the WOMAC pain score was calculated in determining a combined study model that would form the final result of the meta-analysis.

RESULTS

The process of searching for articles is carried out through several journal databases which include including Google Scholar, PubMed, NCBI, Science Direct, and Springer Link. The review process for related articles can be seen in the PRISMA flow diagram in figure 1. There were 800 articles identified from the databases, After the removal process of duplicated data, 505 articles were obtained, 28 of which met the study requirements, hence 9 articles were included in the synthesis and meta-analysis.

It can be seen in Figure 2 that research articles come from 4 continents, America, Europe, Australia, and Asia. 2 studies were from America, 2 studies were from Europe, 2 studies were from Australia, and 3 studies were from Asia.

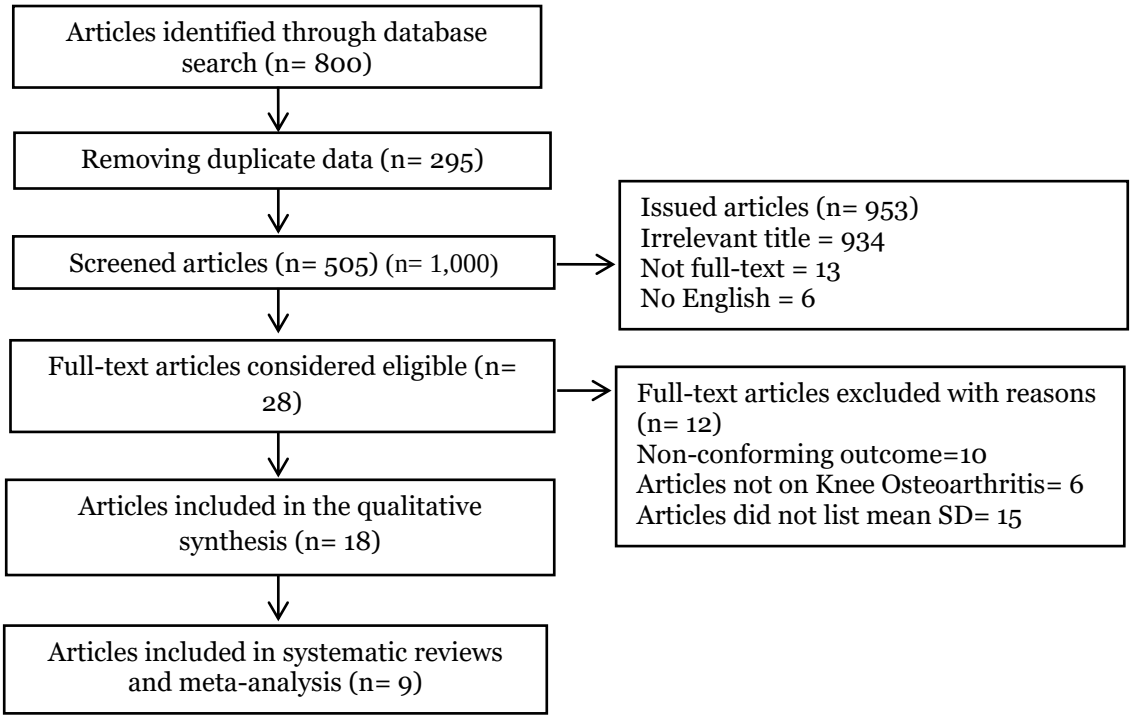

Figure 1. Results of Prisma Flow Diagrams

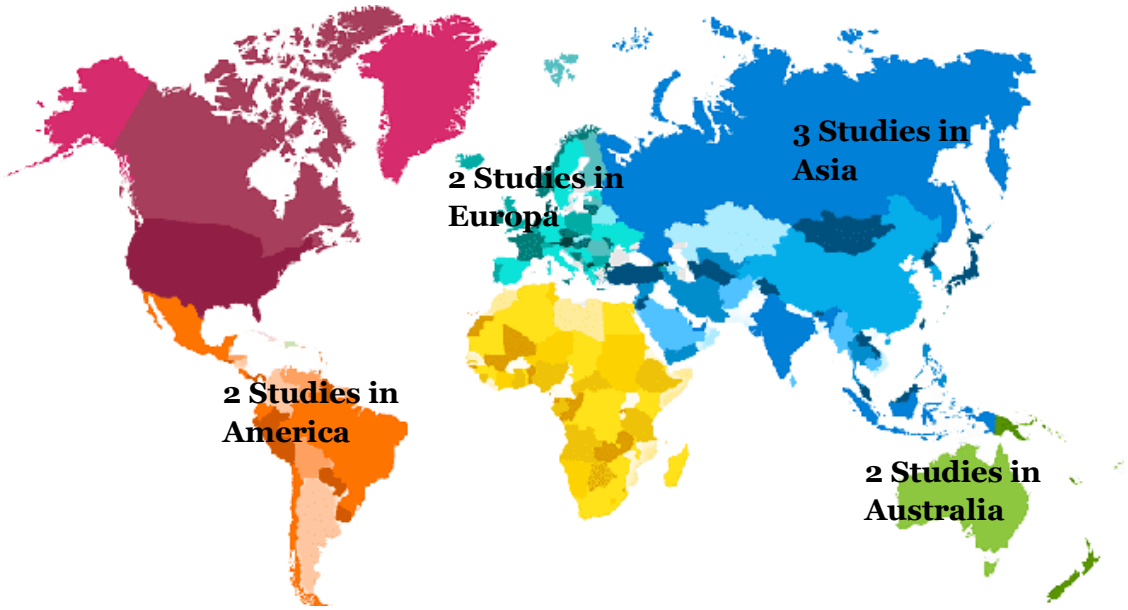

Figure 2. Resarch Distribution Map

Table 1. Critical Appraisal Checklist using CEBM

Primary Study	Criteria												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
(Casilda et al., 2017)	1	1	1	1	1	1	1	1	0	1	0	1	10
(Yennan et al., 2010)	1	1	1	1	1	0	1	1	1	1	0	1	10
(Dias et al., 2017)	1	1	1	1	1	1	1	1	0	1	0	1	10
(Fransen et al., 2007)	1	1	1	1	1	1	1	1	1	1	0	1	11
(Hale et al., 2012)	1	1	1	1	1	1	1	1	1	1	0	1	11
(Silva et al., 2008)	1	1	1	1	1	0	1	1	1	1	0	1	10
(Khruakhorn et al., 2021)	1	1	1	1	1	1	1	1	0	1	0	1	10
(Lim et al., 2010)	1	1	1	0	1	0	1	1	1	1	0	1	9
Taglietti et al., 2018)	1	1	1	1	1	1	1	1	1	1	0	1	11

Description of the question criteria:

1 = Does the study clearly address the focused statements/issues?
2 = Is the Randomized Controlled Trial study method appropriate to answer research questions?
3 = Are there enough subjects in the study to establish that the findings do not occur coincidently?
4 = Are subjects randomly allocated to the experiment and control groups? If not, can this lead to bias?
5 = Are inclusion/exclusion criteria used?
6 = Were the two groups comparable at the beginning of the study?
7 = Are objective and unbiased outcome criteria used?
8 = Is an objective and validated measurement method used in measuring the results? If not, are the results assessed by someone unaware of the group task (i.e. is the assessment blinded)?
9 = Is effect size practically relevant?
10 = How precise are the effect estimates? Is there a confidence interval?
11 = Could there be a confounding factor that has not been taken into account?
12 = Can the results be applied to your study?

Answer score description:

0 = No
1 = Can't tell
2 = Yes

Tabel 2. Summary of primary RCT study with PICO (N=581)

Author (Year)	Country	Sample	P	I	C	O
(Casilda-López et al., 2017)	Spanyol	34	Obese women with knee OA	dance-based aquatic exercise Intervention	Global aquatic exercise	reduced pain
(Yennan et al., 2010)	Thailand	50	Women elderly with knee OA	aquatic exercise Intervention	land-based exercise intervention	reduced pain
(Dias et al., 2017)	Brazil	73	Women aged 65 and over with knee OA	Hydrotherapy program	Educational program	reduced pain
(Fransen et al., 2007)	Australia	152	Elderly with symptomatic chronic OA knee	Hydrotherapy program	No intervention	reduced pain
(Hale et al., 2012)	New Zealand	39	Women with mild to moderate knee OA	Water-based program	a time-matched computer training program	reduced pain
(Silva et al., 2008)	Brazil	64	Patients with knee OA	Hydrotherapy program	Conventional Land-Based Exercise	reduced pain
(Khruakhorn et al.,2021)	Thailand	34	Patients with knee OA	Hydrotherapy	Land-based	reduced pain
(Lim et al., 2010)	Korea	75	Obese patients with knee OA	Aquatic exercise	land-based exercise	reduced pain
(Taglietti et al., 2018)	Italy	60	Patients aged 60-85 years with knee OA	Aquatic exercise	Educational Program	reduced pain

After assessing the quality of the study, a total of 9 articles were obtained with Randomized Control Trial study design that will be used as a source of meta-analysis of the efficacy of aquatic therapy for pain in knee osteoarthritis. The source of the article comes from 4 continent, namely America, Asia, Australia, and Europe, the articles were then extracted and summarized according to the PICO study.

Tabel 3. Effect estimates (Mean SD) of all primary studies performed in the meta-analysis (N=581)

Authors (year)	Aquatic		Non Aquatic	
	Mean	SD	Mean	SD
(Casilda-López et al., 2017)	5.80	4.81	8.02	3.05
(Yennan et al., 2010)	13.48	13.84	14.64	15.28
(Dias et al., 2017)	37.7	16.5	48.6	22.1
(Fransen et al., 2007)	27.3	18.7	40.0	16.2
(Hale et al., 2012)	7.80	9.52	7.10	8.07
(Silva et al., 2008)	15.56	12.55	22.68	18.34
(Khruakhorn et al.,2021)	7.47	6.85	7.94	9.22
(Lim et al., 2010)	20.9	9.90	23.6	12.28
(Taglietti et al., 2018)	4.20	0.70	8.10	1.50

1. Forest Plot

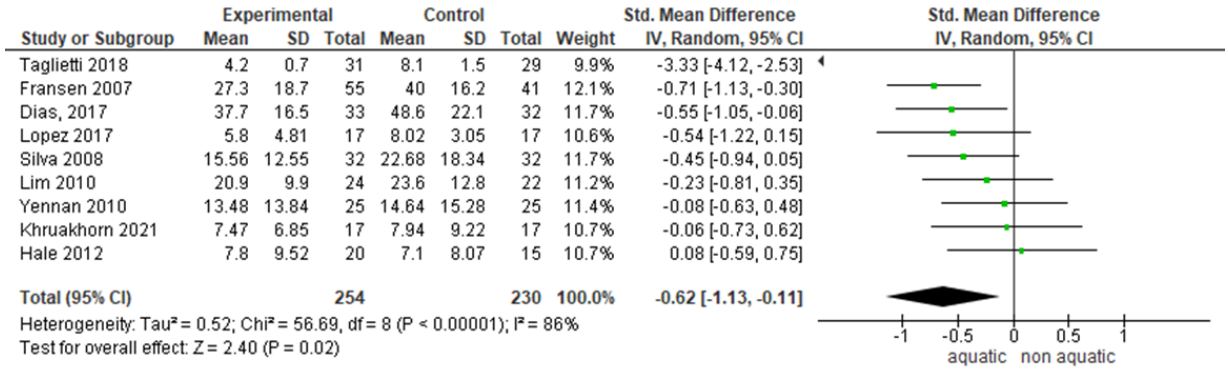

Figure 3. Forest Plot of the effectiveness of aquatic therapy for pain in patients with knee osteoarthritis.

Based on the results of the forest plot (figure 3) aquatic therapy could reduce pain in people with knee OA. Elderly with knee osteoarthritis who obtained aquatic therapy experienced lower pain by 0.62 units than those who obtained non-aquatic therapy thus improving the quality of life, and this effect was statistically significant (SMD= -0.62; 95% CI= -1.13 to -0.11; p <0.001). The estimated heterogeneity across studies in this meta-analysis was high at I^2= 86%. Therefore, the synthesis of the overall effect estimates of the main study was carried out using a random effect model approach.

2. Funnel Plot

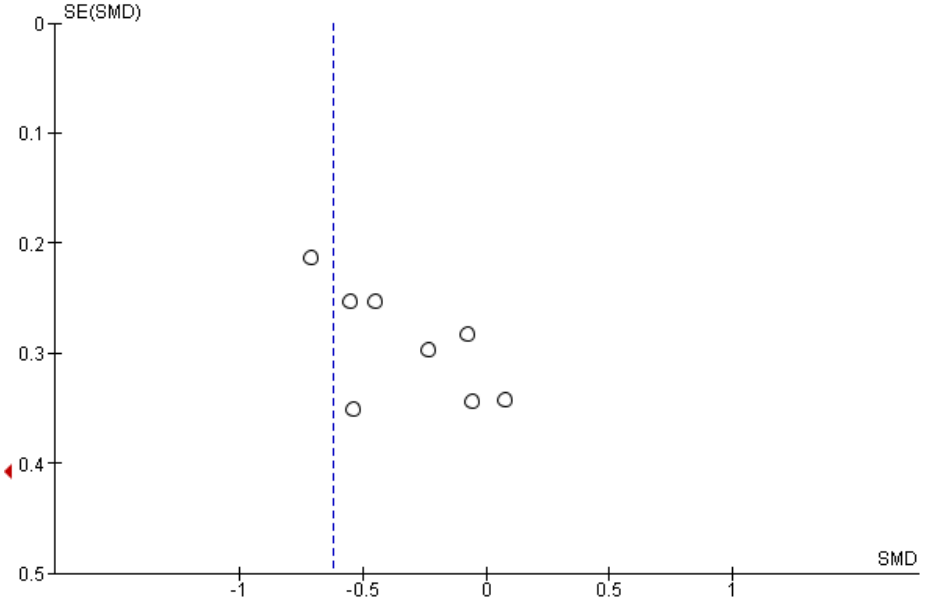

Figure 4. Funnel plot of the effectiveness of aquatic therapy for pain in patients with knee osteoarthritis.

The plot funnel (Figure 4) shows that the distributions of effect estimates were more on the right than on the left of the estimates central vertical line. Therefore, the plot Funnel shows publication bias. Publication bias reduced the actual effect because the direction of the bias is to the right of the zero vertical line, as opposed to the average

diamond in the effect estimate, which is to the left of the zero vertical line (under-estimate).

DISCUSSION

The systematic and meta-analysis study discussed the theme of the effectiveness of aquatic therapy for pain reduction and improvement of quality of life in people with knee osteoarthritis. A study on aquatic therapeutic interventions for pain reduction and quality of life improvement in people with osteoarthritis knee is considered important because the problem occurs in almost all countries, both developed and developing countries.

Aquatic-based interventions for pain reduction and quality of life improvement in patients with knee osteoarthritis were processed using RevMan 5.3 with the Continous method, this method was used to analyze the effect size or standardized mean difference in bivariate data of two groups with its confounding factors controlled by randomization.

The forest results showed that the elderly who obtained aquatic therapy experienced lower pain by 0.62 units than those who obtained non-aquatic (SMD = -0.62; CI 95% -1.13 to -0.11; p <0.001). The heterogeneity of the study data showed I^2=86% thus the distributions were claimed to be heterogeneous (random effect model).

According to Casilda-López et al. (2017) the 8-week aquatic dance-based program shows significant differences between the group in WOMAC pain and the post-intervention aggregate scores (P1/4 0.002 and P 1/4 0.048, respectively). The results of the ANOVA test on one of the indexes on the functional activity scale indicate that it can reduce pain in obese women with knee osteoarthritis with a post-intervention WOMAC score (Mean= 28.50; SD= 14.03 vs Mean= 29.25; SD= 10.04; P = 0.730).

A study by Yennan et al. (2010), reveals a significant reduction of knee pain with a post-intervention WOMAC score (Mean= 13.48; SD= 13.84 vs Mean= 14.64; SD= 15.28; p= 0.607). Both exercises reduce knee pain, but in an experiment conducted by Yennan et al. (2010)knee pain in the aquatic group is decreased more than in the land-based group. This may be due to buoyancy and floating forces that reduce shocks to the knees during exercise and whirlpools that help stimulate muscle work to reduce pain.

According to a study by Dias et al. (2017) results of the covariance analysis shows that the participants from the intervention group experience a significant reduction in knee pain (adjusted mean difference= 11, 95% CI= 3-18). A structured six-week hydrotherapy program along with an educational program provided a greater improvement in short-term pain reduction with a post-intervention WOMAC score (Mean= 37.7; SD= 16.5 vs Mean= 48.6; SD= 22.1; p = 0.003) compared to the provision of only educational programs to women with knee osteoarthritis conditions.

According to (Fransen et al., 2007), there was a significant improvement in pain for both the hydrotherapy group and Tai Chi group given to the elderly with knee OA conditions with a WOMAC score (Mean= 27.3; SD= 18.7 and mean= 30.7; SD= 18.9) compared to the control group. Only the hydrotherapy class generates a significant improvement in pain scores, with a small medication effect (SRM= 0.43; 95% CI= 0.30 to 0.56) compared to the control group, the post-intervention WOMAC scores are (Mean= 27.3; SD= 18.7 vs Mean= 40.0; SD= 16.2).

According to a study by Hale et al. (2012) after administering water-based

exercise interventions for 12 weeks, no statistical significance of differences between groups was found for the main results or any of the secondary outcomes measured by WOMAC scores (Mean= 7.8; SD= 6.09 vs Mean= 7.1; SD= 6.22). There was a selection bias by recruiting people who are clearly willing to do exercises in the water. Older adults with knee osteoarthritis who did not want to do exercises inside would not volunteer, potentially generating bias to the study sample to more active people with knee osteoarthritis and therefore reducing the size of the effects used in our strength calculations.

According to (Silva et al., 2008), participants in both groups experience a significant reduction in pain in the previous week over time with a WOMAC score (Mean= 15.56; SD= 12.55 vs Mean=22.68; SD= 18.34). The water-based exercise group experiences a significant improvement in the reduction of pain compared to the land-based exercise group. This improvement is seen in the ninth week in both groups. The reduction of pain discovered in both groups is a very important benefit for patients with knee osteoarthritis conditions.

A study by (Khruakhorn and Chiwarakranon., 2021) used a 22-items modified Thai WOMAC version for comparison in groups after 6 weeks, there is a significant improvement of WOMAC scores in patients with knee osteoarthritis in both groups (Mean= 7.47; SD= 6.85 vs Mean=7.94; SD= 9.22).

According to a study by (Lim et al., 2010) pain and WOMAC significantly differ across groups. The intensity of pain in the aquatic exercise group (AQE) decreases from (Mean= 4. 41; SD= 1. 43) to (Mean= 3. 27; SD= 1. 93) after exercise, and in the land-based exercise group (LBE), reduces from (Mean= 4. 02; SD= 1. 45) to (Mean= 3. 46; SD= 1. 30) compared with a slight increase in the control group, from (Mean= 4. 13; SD= 2. 08) to (Mean= 4. 55; SD= 1. 88). The pain score decreased from (Mean= 25. 8; SD= 15. 1) to (Mean= 17. 3; SD= 11. 1) and from (Mean= 20. 5; SD= 12. 2) to (Mean= 16. 6; 10.8) in aquatic exercise and land-based exercise groups. WOMAC decreases during the program in both the aquatic exercise and land-based exercise groups and also decreases in the control group (Mean= 20.9; SD= 9.9) vs (Mean= 23.6; SD= 12.8). The results show that a significant reduction in pain after aquatic exercise has several implycations for improving exercise interventions. In addition, the pain intensity of the land-based exercise group is no different from that of the control group, which showed the limitations of land-based exercise.

A study by (Taglietti et al., 2018) reveals the pain domain assessment from the WOMAC questionnaire shows statistical changes found within and among the groups, particularly the aquatic exercise group. In this group, pain decreases at the end (SMD= −3.3; 95% CI= −6.56 to −0.1; p= 0.031) and in the follow-up period (SMD= −3.1; 95% CI= −6.3 to −0.03; p=0.046). At the end of the intervention, a significant decrease is recorded in favor of the aquatic exercise group when compared to the Educational Program group (SMD= −3. 8; 95% CI= -8. 7 to −1; p=0. 021). Assessment with the WOMAC questionnaire (pain domain), with changes observed over time for the aquatic exercise group and at the end of the intervention between groups, also supports the aquatic exercise group. It is generally accepted that the WOMAC questionnaire has greater specificity due to a better response for people with osteoarthritis when compared to the Visual Analog Scale. Only with WOMAC questionnaire (Mean= 4.2; SD= 0.7 vs Mean= 8.1; SD= 1.5) is sufficiently explaining the improvement.

AUTHOR CONTRIBUTION

Ananta was the main researcher who selected topics, searched, and collected study data. Wahyuni was responsible for analyzing data and reviewing research documents.

FUNDING AND SPONSORSHIP

The study used personal funding from the main researcher.

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CONFLICT OF INTEREST

There was no conflict of interest.

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