Chulalongkorn Medical Journal

Volume 68 | Issue 4 Article 1

October 2024

EFFECT OF AQUATIC EXERCISES ON PATELLOFEMORAL JOINT DYSFUNCTION IN MIDDLE AGE OBESE WOMEN

Akshaya Joshi
Intern, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Deemed to be University, Karad, Maharashtra, India., akshayajoshi577@gmail.com

Sandeep Shinde
Professor, Head of Department, Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Deemed to be University, Karad, Maharashtra, India., drsandeepshinde24@gmail.com

Sawani Aphale
First year Masters Of Physiotherapy, Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Deemed to be University, Karad, Maharashtra, India., sawani.aphale@gmail.com

Recommended Citation

Joshi, Akshaya; Shinde, Sandeep; and Aphale, Sawani (2024) "EFFECT OF AQUATIC EXERCISES ON PATELLOFEMORAL JOINT DYSFUNCTION IN MIDDLE AGE OBESE WOMEN," *Chulalongkorn Medical Journal*: Vol. 68: Iss. 4, Article 1.
DOI: https://doi.org/10.56808/2673-060X.5415
Available at: https://digital.car.chula.ac.th/clmjournal/vol68/iss4/1

EFFECT OF AQUATIC EXERCISES ON PATELLOFEMORAL JOINT DYSFUNCTION IN MIDDLE AGE OBESE WOMEN

Abstract

Background: The patellofemoral joint, known for its incongruence, is susceptible to dysfunction due to abnormal pathomechanics, especially with increased body mass causing excessive stress on knee cartilage, leading to degeneration and dysfunction. Dysfunction results in pain, limited range of motion, and diminished quality of life.

Objectives: To determine the effect of aquatic exercises on patellofemoral joint dysfunction in middle-aged obese women and to compare the effect of aquatic exercises with land-based exercises on patellofemoral joint dysfunction in middle-aged obese women.

Methods: In this experimental study, 100 subjects with patellofemoral joint dysfunction were separated into group A (Land-based exercises) and group B (Aquatic exercises). Pre-test and post-test evaluations were conducted over an 6-weeks treatment period using paired t test.

Results: Statistical analysis revealed an extremely significant improvement in both group A and group B, indicating the effectiveness of both exercise interventions. Paired t test was used for interpretation of results. There was statistically significant difference in pre and post values in both the groups , having more improvement in group B than group A in the terms of pain, range of motion, and patellofemoral joint evaluation scale.

Conclusion: The study concludes that subjects engaging in aquatic exercises demonstrated significant improvements, highlighting the efficacy of this intervention.

Keywords

Pain, Patellofemoral Joint Evaluation Scale, Aquatic exercises, Range of motion

Cover Page Footnote

I would like to express my sincere gratitude to the management of Krishna Vishwa Vidyapeeth, Karad for allowing me to perform this research by supplying me with the necessary materials. We acknowledge the guidance from Dr. G.Varadharajulu (Dean, Krishna College Of Physiotherapy, KVVDU, Karad) and Dr. Kakade S.V. for statistical help. My deepest gratitude to all the staff members who guided me through my research. I would like to take this time to thank everyone who helped me to conduct this study run.

Chula Med J Vol. 68 No. 4 October - December 2024 ; 229 - 237 DOI : 10.56808/2673-060X.5415

Original article

Effect of aquatic exercises on patellofemoral joint dysfunction in middle-aged women with obesity

Akshaya Vinayak Joshi, Sawani Aphale, Sandeep Shinde*

Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth,Deemed to be University, Karad, Maharashtra, India

Abstract

Background: The patellofemoral joint, known for its incongruence, is susceptible to dysfunction caused by abnormal pathomechanics, particularly with increased body mass causing excessive stress on knee cartilage, leading to degeneration and dysfunction. Dysfunction results in pain, limited range of motion, and diminished quality of life.

Objectives: This study aimed to determine the effect of aquatic exercises on patellofemoral joint dysfunction in middle-aged women with obesity and compare the effect of aquatic exercises with land-based exercises on patellofemoral joint dysfunction in middle-aged women with obesity.

Methods: In this experimental study, 100 patients with patellofemoral joint dysfunction were divided into groups (land-based exercises) and group (aquatic exercises) B. Pre- and post-test evaluations were conducted in a 6-week treatment period using the paired *t*-test.

Results: Statistical analysis revealed an extremely significant improvement in both groups, indicating the effectiveness of both exercise interventions. Significant differences in pre- and post-test values were found in both groups, having more improvements in pain, range of motion, and patellofemoral joint evaluation scale in group B than in group A.

Conclusion: Participants engaging in aquatic exercises demonstrated significant improvements, highlighting the efficacy of this intervention.

Keywords: Aquatic exercises, pain, patellofemoral joint evaluation scale, range of motion.

Aquatic exercises utilize water as a medium for therapeutic purposes, demonstrating advantages across various rehabilitation contexts. Facilitated by water, aquatic exercises, including joint mobilization, strengthening, stretching, balance and gait training, and endurance training. These exercises aim to enhance the effectiveness of manual techniques, initiate resistance training, facilitate range-of-motion (ROM) exercises, afford patients three-dimensional accessibility, etc. Furthermore, aquatic exercises contribute to reducing the risk of injury or reinjury during rehabilitation. In addition, they contribute to patient relaxation.[1]

***Correspondence to: Sandeep Shinde,** Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth , Deemed to be University, Karad, Maharashtra, India.
E-mail: drsandeepshinde24@gmail.com
Received: Febuary 9, 2023
Revised: July 30, 2024
Accepted: August 17, 2024

The distinctive characteristics of water and immersion significantly influence the administration of therapeutic exercise. In an aquatic setting, surface tension, buoyancy, hydrostatic pressure, and viscosity directly affect the body. The counterforce to gravity, known as buoyancy, reduces the gravitational force on the body, providing a sense of weightlessness and relieving joints from loading. This makes it easier for individuals to engage in active movements. When an individual moves a limb against the buoyancy force, resistance is felt, which contributes to muscle strengthening.[1]

Hydrostatic pressure refers to the force exerted by water on a submerged object, and it is directly proportional to the water depth. Patients find it easier to participate in exercises when they are in proximity to the water's surface because of the connection between pressure and depth. Viscosity is the resistance to flow in liquids caused by intermolecular friction; as the velocity of movement increases, so does resistance. Water flow also increases resistance

in a larger surface area. Surface tension is another water property, where an extremity experiences less function when submerged than when moving through the water's surface. Water has a higher heat conductivity than air, and velocity enhances heat transfer. Moving through water results in quicker cooling than being submerged at rest.[1]

The patellofemoral joint is incongruent. It is formed by the articulation of the posterior patella and distal femur. Enhancing the extensor torque by 30.0% at the extremity of the ROM is crucial in the functioning of the knees, particularly considering that patellofemoral joint may experience forces equivalent to two or three times the body weight during daily activities.[2] Increased femoral anteversion, increased external tibial torsion, and enhanced genu valgus lead to increases in the Q angle, which results in the alteration of the knee biomechanics and therefore in the patellofemoral joint.[3] Many factors, such as obesity, menopause, hormonal imbalances, comorbidities, unhealthy lifestyle, and irregular diet, can contribute to dysfunction. Patellofemoral joint dysfunction has been linked to several physiological, psychological, and physical factors. Specifically, this condition compromises muscle strength and ROM. Furthermore, a higher body mass index (BMI) is a clinical sign of patellofemoral joint dysfunction.[2,4]

Obesity is a chronic and multifactorial condition defined by excess calories in the body. [5] Recently, the proportion of women who are overweight, particularly in developing nations, is increasing, posing an increased risk of patellofemoral dysfunction. This heightened risk is attributed to the potential effect of high body mass and related metabolic factors, which may amplify the mechanical requirements and impose excessive stress on the articular cartilage of the knee. Consequently, this can lead to degenerative alterations and additional dysfunction. [2,4] Obesity is the second most common cause of osteoarthritis (OA), degenerative joint disease, disability, and dysfunction.[2, 4, 6]

Pain in the retropatellar area, along the patellar tendon, or at the subpatellar fat pads is among impairments that may be linked to patellofemoral joint dysfunction. Patellar crepitus, knee swelling, or locking occurs. Altered alignment of the lower extremities, more specifically increased internal rotation, hip adduction, and dynamic knee valgus during weight-bearing activities such as squatting, jumping, and climbing stairs, and weakness of the external rotator, extensor, and hip abductor muscles are also reported.

The musculoskeletal health of women is becoming a threat to their health at the midline and beyond. A decline in bone mineral density, resulting from decreased bone mass, is referred to as osteoporosis, a condition that is widespread among postmenopausal women. Another condition is sarcopenia, which is the age-related loss of muscle mass and function. Sarcopenia is prevalent in women aged 50 years. OA is a joint inflammation that develops slowly and can be brought on by cartilage deterioration. Current data present that estrogen deficiency during menopause can lead to the deterioration of cartilage. Cartilage degeneration, synovial inflammation, and capsule thickening result in joint deformity and stiffness.[7,8]

Only a few studies have focused on middle-aged women with obesity and patellofemoral joint dysfunction. Most studies have focused on younger or older populations. In addition, no standardized aquatic exercise programs have been established for individuals with patellofemoral joint dysfunction. Studies may differ by the type, intensity, duration, and frequency of aquatic exercises. Thus, more studies may be needed to understand the underlying mechanisms of how aquatic exercises affect the patellofemoral joint in this population. This study aimed to determine the effect of aquatic exercises on patellofemoral joint dysfunction in middle-aged women with obesity and compare the effect of aquatic exercises with land-based exercises on patellofemoral joint dysfunction in this population.

Materials and methods

A randomized controlled trial was conducted at Krishna College of Physiotherapy, Karad, involving 100 participants randomly assigned into two groups. The randomization was designed by a computerized numerical randomization using SPSS version 26.0. Then, participants were divided into group A undergoing land-based exercises and group B engaging in aquatic exercises **(Figure 1).** Participants were randomly chosen according to the inclusion and exclusion criteria, and they provided written informed consent after a detailed explanation of the entire procedure.

During screening, participants underwent detailed musculoskeletal evaluation. Female patients with clinically diagnosed patellofemoral joint dysfunction aged 40–55 years who were obese

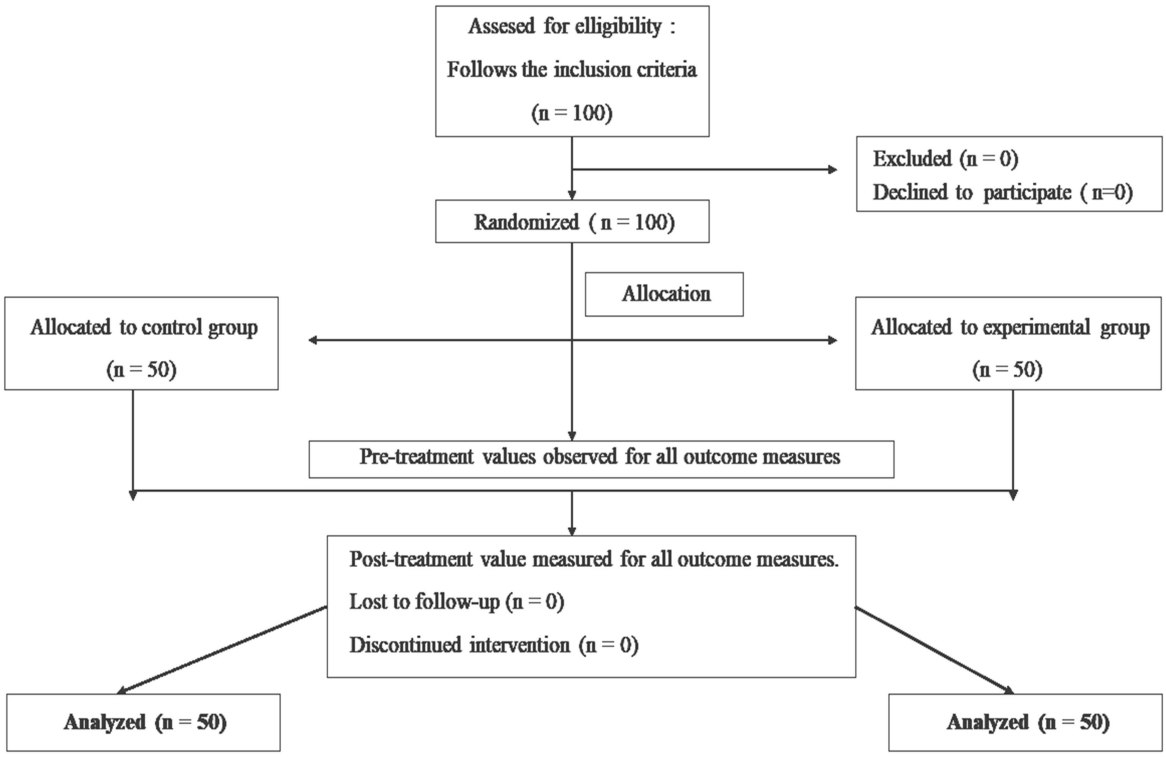

Figure 1. Consort flowchart.

(BMI 30–40 kg/m^2) and experienced anterior or posterior knee pain, reduced ROM, increased Q angle, or deformities were included. Conversely, women aged <40 years, with a BMI <30 kg/m^2, recent fractures, skin infections, hydrophobia, neurological or respiratory disorders, and ataxia were excluded.

The study was approved by the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth (KVVDU, no. 057/2023-2024).

Outcome measures

The numerical pain rating scale (NPRS) was employed to evaluate pain intensity (PI), requiring patients to choose a number on a scale of 0–10 to indicate the severity of their pain. According to Alghadir AH, *et al*., the test–retest reliability of the NPRS was high, with an intraclass correlation coefficient of 0.991.[9] The hip, knee, and ankle joint ROMs were assessed using a universal goniometer. The initial position involved women lying in a relaxed supine position on the plinth. Hip movements such as flexion, extension, abduction, adduction, and medial and lateral rotation, as well as knee movements including flexion and extension, were assessed. Ankle movements, encompassing dorsiflexion, plantarflexion, inversion, and eversion, were also examined.

The patellofemoral joint evaluation scale was used to assess the functional status of the participants. The questionnaire involves multiple-choice questions related to knee pain during activities such as stair climbing, swelling, sensations of giving way, crepitation, and utilization of assistive devices. Higher scores on the scale indicate favorable outcomes and lower levels of pain. The scores ranged from 0 to 100; 90–100 points indicated excellent results; 80–89 points, good outcomes; 60–79 points, fair results; and <60 points, poor results.[10]

Treatment protocol

The methodology and purpose of the study were explained to all participants before they consented to the study. In this study, 100 middle-aged women who were obese received the treatment for 6 weeks with three sessions per week. One session took 30 min. The participants were divided into two groups having 50 participants each. Group A executed land-based

exercises, whereas group B performed aquatic exercises. The temperature of the hydrotherapy pool ranged from 26°C to 36°C, and the depth of the hydrotherapy pool was up to the hip joint level**.** The hydrotherapy pool was 123 long, 53 wide, and 63 deep. Exercises were done under the guidance of an aquatic exercise therapist **(Table 1).**

Table 1. Treatment protocol for patellofemoral joint dysfunction.

Exercises	**Repetitions/ holds × sets (week 1 and 2)**	**Repetitions/ holds × sets (week 3 and 4)**	**Repetitions/ holds × sets (week 5 and 6)**
Warm-up hip rotations, twisting knee circling forward, backward, sideway walking jog in place	10 × 1	10 × 1	10 × 1
Hip, knee, and ankle joint free range of motion exercises	10 × 1 (Done underwater)	10 × 1 (Performed on the water's surface)	10 × 1 (Performed on the water's surface)
Hamstring, quadriceps, VMO, adductors, and abductors strengthening using theraband/ weightcuff	10 × 1	10 × 2	10 × 3
Minisquats at 30º - 40º	3-sec hold × 10 times	3-sec hold × 10 times (hold the ball between knees)	5-sec hold × 10 times (hold the ball between knees)
Lunges	10 × 1	10 × 2	10 × 3
Toe raise	10 × 1	10 × 2	10 × 3
Heel raise	10 × 1	10 × 2	10 × 3
Step up and step down	10 × 1	10 × 2	10 × 3
Hamstring curls	10 × 1	10 × 2	10 × 3
Cool down Stretching (Quadriceps and Hamstring muscle static stretching were given.) Breathing exercises			

Table 2. Pain assessment.

	Pre - intervention	**Post - intervention**	***P* - value**
Rest			
Group A	6.0 ± 0.8	1.8 ± 1.0	< 0.0001
Group B	6.1 ± 0.8	1.2 ± 0.8	< 0.0001
Activity			
Group A	7.8 ± 0.9	3.0 ± 0.9	< 0.0001
Group B	7.7 ± 0.9	2.4 ± 0.8	< 0.0001

Statistical analysis

Manual analysis and software analysis by SPSS version 26.0 were performed. Numerical data are presented as means ± standard deviations, and the paired *t*-test was used to analyze pre- and post-intervention data within the group. Continuous variables were tested for normality. The repeated-measure analysis was performed for both scores to evaluate significant changes occurring over time. A significance level of $P < 0.0001$ was chosen for all analyses.

Results

Regarding demographic data, 20.0% of the women were 40–45 years, 50.0% were 46–50 years, and 30.0% were 51–55 years. The participants were further divided based on obesity grades, in which 40.0%, 50.0%, and 10.0% had grade 1, 2, and 3 obesity, respectively. In addition, comorbidities were considered, including hypertension (32.0%), diabetes (33.0%), and both hypertension and diabetes (10.0%), and 25.0% had no morbidities. In terms of quadriceps angles, 35.0% of the women exhibited angles >18°, whereas the remaining 58.0% had quadriceps angles < 18° and 7.0% had normal quadriceps angle.

Interpretation

For the within-group analysis, a paired *t*-test was employed to assess the significance of the intragroup comparison. The results indicated an extremely significant difference for both groups A and B, presenting notable changes within each group. This observation indicates a significant reduction in pain after the intervention **(Table 2).**

Interpretation

A paired *t*-test was used for the statistical assessment of intragroup comparisons, indicating an extremely significant difference in hip flexion, extension, abduction, adduction, medial rotation, lateral rotation, knee flexion, extension, and ankle dorsiflexion, plantarflexion, inversion, and eversion for groups A and B **(Table 3)**. This finding indicates that after the intervention, the joint ROM increased.

Interpretation

In **Table 4**, groups A and B initially exhibited poor results on the patellofemoral joint evaluation scale before the intervention. After the intervention, group A displayed good results, were group B demonstrated excellent results. The intragroup comparison, assessed through a paired *t*-test, revealed an extremely significant difference between groups A and B. This means that both groups had enhanced scores in the patellofemoral joint evaluation scale after the intervention.

Discussion

Primarily, this study aimed to explore the effect of aquatic exercises on patellofemoral joint dysfunction in middle-aged women with obesity and compare this effect with those of land-based exercises. A total of 100 middle-aged women, meeting the study criteria, were enlisted for the research. After participant selection, they received detailed information about the study and provided written consent. The participants were then divided into group A, who executed land-based exercises, and group B, who were engaged in aquatic exercises. Pre- and post-test assessments were conducted, and the treatment spanned 6 weeks. The evaluation focused on pain levels, ROM, and patellofemoral joint evaluation scale.

In 2013, Gao HL, *et al.* examined 743 women aged 35–64 years who experienced regular knee discomfort. The study showed a notable rise in the incidence of joint stiffness and knee discomfort as age progressed. Furthermore, the authors identified a positive correlation between a higher BMI and increased incidence of joint stiffness and knee discomfort. The study concluded the significance of age, BMI, and menopause.[11]

Patellofemoral joint dysfunction can be caused by biomechanical factors or physiological factors such as obesity. Obesity is a recognized factor contributing to increased stress on the patellofemoral joint, leading to wear and tear of the articular cartilage. According to a widely accepted theory, the etiology of patellofemoral joint dysfunction is associated with joint pain. People experiencing patellofemoral joint problems often endure pain in the course of their daily activities. Some studies have also demonstrated an association between patellofemoral joint dysfunction and pain in the region behind the kneecap. Individuals with patellofemoral problems may experience pain when engaging in activities such as ascending or descending stairs, stepping up and down, prolonged sitting, squatting, and rising from a chair.

Table 3. Range of motion.

	Pre-intervention	Post-intervention	*P* - value
Hip flexion			
Group A	65.0 ± 21.6	95.7 ± 19.3	< 0.0001
Group B	67.6 ± 16.2	109.6 ± 13.1	< 0.0001
Hip extension			
Group A	13.2 ± 2.5	19.9 ± 2.3	< 0.0001
Group B	12.3 ± 2.2	22.0 ± 1.6	< 0.0001
Hip abduction			
Group A	32.8 ± 4.8	42.7 ± 4.9	< 0.0001
Group B	32.2 ± 4.2	47.3 ± 2.8	< 0.0001
Hip adduction			
Group A	18.4 ± 2.1	21.6 ± 1.6	< 0.0001
Group B	17.4 ± 2.2	23.3 ± 0.8	< 0.0001
Hip medial rotation			
Group A	28.6 ± 2.8	36.4 ± 3.6	< 0.0001
Group B	28.0 ± 2.7	38.8 ± 1.8	< 0.0001
Hip lateral rotation			
Group A	29.0 ± 3.2	38.0 ± 2.6	< 0.0001
Group B	28.4 ± 2.6	41.4 ± 2.0	< 0.0001
Knee flexion			
Group A	121.7 ± 3.5	131.1 ± 2.7	< 0.0001
Group B	123.2 ± 2.8	132.6 ± 2.5	< 0.0001
Knee extension			
Group A	6.0 ± 2.9	1.8 ± 1.3	< 0.0001
Group B	5.6 ± 2.4	0.4 ± 0.8	< 0.0001
Ankle dorsiflexion			
Group A	11.5 ± 1.4	14.7 ± 0.9	< 0.0001
Group B	10.9 ± 1.3	16.3 ± 1.1	< 0.0001
Ankle plantarflexion			
Group A	40.9 ± 4.2	47.2 ± 3.9	< 0.0001
Group B	41.5 ± 2.1	49.0 ± 2.0	< 0.0001
Ankle inversion			
Group A	25.3 ± 3.8	30.4 ± 1.2	< 0.0001
Group B	25.4 ± 3.0	31.8 ± 0.9	< 0.0001
Ankle eversion			
Group A	11.0 ± 1.4	15.1 ± 0.9	< 0.0001
Group B	11.2 ± 1.5	15.1 ± 1.5	< 0.0001

Table 4. Patellofemoral joint evaluation scale.

	Pre-intervention	Post-intervention	*P* - value
Group A	56.0 ± 7.7	87.2 ± 3.5	< 0.0001
Group B	58.1 ± 12.8	91.6 ± 5.1	< 0.0001

According to Smith BE, *et al*. patellofemoral pain (PFP) is a prevalent form of knee pain. Knee pain stands as the second most frequently encountered condition. PFP is characterized as a nontraumatic pain, manifesting as a general discomfort in the front of the knee during activities that put a load on the joint, such as running, squatting, and going up or down stairs.[12]

Şahin M, *et al.* reported that exercises targeting hip and knee strengthening prove more effective in alleviating pain and enhancing functional status. The research included 55 young female patients who were diagnosed with PFP syndrome. The patients underwent a total of 30 supervised clinic sessions over 6 weeks, during which they were randomly assigned to either knee-only or hip-and-knee exercise programs. Evaluations were conducted before therapy, after 6 weeks of supervised exercises, and following 6 weeks of at-home exercises. Outcome measures included subjective and objective function, pain levels, and muscle strength. The study recommended the integration of supplementary hip-strengthening exercises for individuals with PFP syndrome as an effective approach to reduce pain and improve functional status.[13]

Da Silva Boitrago MV, *et al.* examined the effect of properioceptive exercises and strengthening on pain and functionality in women with PFP syndrome. The study analyzed two experimental groups: the exercise group performed various lower limb activities with proprioceptive exercises in addition and the guidance group attended a 60-min session on the information and knowledge regarding PFPS. The study stated that compared with the guidance group, the exercise group resulted in better effects on patients with PFPS and was more effective. [14]

Adegoke Bo, *et al.* examinedy 29 patients diagnosed with knee OA, who were randomly allocated to either the open kinetic chain exercises or closed kinetic chain exercises. PI, functional score (FS), active ROM (AROM), and knee passive ROM (PROM) were assessed using the visual analog scale, functional index questionnaire, and a half-circle universal goniometer at baseline and at weeks 4 and 8. The results indicated the lack of significant differences between the two groups at any stage of the study for any of the four outcomes. However, a significant time effect was observed for all measures: PI consistently decreased over time, whereas the FS, AROM, and PROM significantly increased. [15]

In the study by Dias JM, *et al*. 73 women aged ≥ 65 years were randomly divided into hydrotherapy and control groups for 6 weeks. The hydrotherapy group demonstrated improvements in pain management and strengths of the knee flexor and extensor.[16] Maddocks S, *et al*. aimed to assess the effect of a 4-week hydrotherapy program on pain evaluation. This study involved 18 individuals with persistent knee pain, which was noticeably reduced after the 4-week hydrotherapy program.[17]

Bhore P and Shinde S examined the effect of multicomponent exercise program on pain-related gait adaptations among individuals with knee joint OA. The control group received electrotherapy modalities and AROM exercises. The experimental group received warmup, conditioning, cool-down session, and gait training with various types of exercises. In addition, the experimental group showed significant improvement in patients with knee OA.[18]

In one study that was performed on running performance in marathon runners, the experimental group performed aquatic training, whereas the control group performed swimming with no special exercises. They found that aquatic therapy was found to be effective in reducing pain and increasing ROM. The experimental group showed significant improvement in reducing pain and improving speed in marathon runners.[19]

Janhavi S, Shinde S examined the effect of the lower limb proximal to distal muscle imbalance correction on functional pes planus deformity in young adults. In relation to the patellofemoral joint dysfunction, malalignment in the spine or foot complex can increase patellofemoral joint reaction forces, which ultimately increase the load on the joint. Hydrotherapy involves both the proximal and distal joints, which will help reduce the load on the joint and help to reduce pain.[20]

This study observed a notable reduction in pain after the intervention, as assessed using a NPRS. The results suggested that as strength levels increased and pain levels decreased, the ROM is simultaneously enhanced. According to the patellofemoral joint evaluation scale, before treatment, both groups had poor scale scores, with group A achieving a good score post-intervention, whereas group B attained an excellent score. In conclusion, the results indicate a significant enhancement in participants who engaged in aquatic exercises.

The study presents its clinical effect as the treatment protocol is given with the help of aquatic therapy. In routine practice, patients performed land-based exercises. The use of aquatic therapy may help patients recover at a faster rate than usual. This study involves only women because of one most important factor, which is menopause. Obesity is prevalent among postmenopausal women. In addition, one research study mentioned that patellofemoral joint dysfunction is observed more in women than in men.

This study has limitations, such as the relatively small sample size and limited geographic scope, which could affect the generalizability of the results. Thus, subsequent research should consider these factors when interpreting and applying the findings. Further academic exploration of this study is necessary, and opportunities exist for expanding the population under investigation. Both male and elderly populations must be considered, utilizing diverse outcome measures, and incorporating additional geographical regions for more comprehensive investigations.

Conclusion

The comparative analysis between aquatic and land-based exercises indicates that they both resulted in significant improvements; however, aquatic exercises demonstrated superior effects. These findings confirmed the incorporation of aquatic exercises as a valuable therapeutic strategy, contributing to holistic improvements in musculoskeletal well-being. It underscores the capacity of aquatic interventions to enhance the overall quality of life of individuals with patellofemoral joint dysfunction.

Acknowledgements

I would like to express my sincere gratitude to the management of Krishna Vishwa Vidyapeeth, Karad for allowing me to perform this research by supplying me with the necessary materials. We acknowledge the guidance from Dean, Krishna College Of Physiotherapy, KVVDU, Karad, and Kakade SV for statistical help. My deepest gratitude to all the staff members who guided me through my research. I would like to take this time to thank everyone who helped me to conduct this study run.

Conflicts of interest statement

All authors have completed and submitted the International Committee of Medical Journal Editors Uniform Disclosure Form for Potential Conflicts of Interest None of the authors disclose any conflict of interest.

Data sharing statement

All data generated or analyzed during the present study are included in this published article and the citations herein. Further details, opinions, and interpretation are available from the corresponding author on reasonable request.

References

1. Kisner C, Colby LA, Borstad J. Therapeutic exercise: foundations and techniques. Philadelphia: F.A. Davis; 2018.
2. Arrebola LS, Carvalho RT, Lima VC, Percivale KA, Oliveira VG, Pinfildi CE. Influence of body mass index on patellofemoral pain. Fisioter Mov 2020;33:e003309.
3. Codorean II, Codorean IB. Clinical-MRI correlations of anterior knee pain: Common and uncommon causes. Cham: Springer Nature; 2023.
4. Ferreira AS, Mentiplay BF, Taborda B, Pazzinatto MF, de Azevedo FM, de Oliveira Silva D. Overweight and obesity in young adults with patellofemoral pain: impact on functional capacity and strength. J Sport Health Sci 2023;12:202-11.
5. Mohajan D, Mohajan HK. Obesity and its related diseases: a new escalating alarming in global health. J Innov Med Res 2023;2:12-23.
6. Barber Foss KD, Hornsby M, Edwards NM, Myer GD, Hewett TE. Is body composition associated with an increased risk of developing anterior knee pain in adolescent female athletes? Phys Sportsmed 2012;40:13-9.
7. Cunha-Henriques S, Costa-Paiva L, Pinto-Neto AM, Fonsechi-Carvesan G, Nanni L, Morais SS. Postmenopausal women with osteoporosis and musculoskeletal status: a comparative cross-sectional study. J Clin Med Res 2011;3:168-76.
8. Lou C, Xiang G, Weng Q, Chen Z, Chen D, Wang Q, et al. Menopause is associated with articular cartilage degeneration: a clinical study of knee joint in 860 women. Menopause 2016;23:1239-46.
9. Alghadir AH, Anwer S, Iqbal A, Iqbal ZA. Test–retest reliability, validity, and minimum detectable change of visual analog, numerical rating, and verbal rating scales for measurement of osteoarthritic knee pain. J Pain Res 2018:11:851-6.

10. Manske RC, Magee DJ. Orthopedic physical assessment. 7th ed. St. Louis, Missouri: Elsevier; 2021.
11. Gao HL, Lin SQ, Wei Y, Chen Y, Wu ZL. The effect of age and menopausal status on musculoskeletal symptoms in Chinese women aged 35-64 years. Climacteric 2013;16:639-45.
12. Smith BE, Selfe J, Thacker D, Hendrick P, Bateman M, Moffatt F, Rathleff MS, Smith TO, Logan P. Incidence and prevalence of patellofemoral pain: a systematic review and meta-analysis. PloS One 2018;13:e0190892.
13. Şahin M, Ayhan FF, Borman P, Atasoy H. The effect of hip and knee exercises on pain, function, and strength in patients with patellofemoral pain syndrome: a randomized controlled trial. Turkish J Med Sci 2016;46:265-77.
14. da Silva Boitrago MV, de Mello NN, Barin FR, Júnior PL, de Souza Borges JH, Oliveira M. Effects of proprioceptive exercises and strengthening on pain and functionality for patellofemoral pain syndrome in women: a randomized controlled trial. J Clin Orthop Trauma 2021;18:94-9.
15. Adegoke BO, Sanya AO, Ogunlade SO, Olagbegi OM. The effectiveness of open versus closed kinetic chain exercises on pain, function, and range of motion in patients with knee osteoarthritis. Balt J Health Phys Act 2019:11;39-52.
16. Dias JM, Cisneros L, Dias R, Fritsch C, Gomes W, Pereira L, et al. Hydrotherapy improves pain and function in older women with knee osteoarthritis: a randomized controlled trial. Braz J Phy Ther 2017;21: 449-56.
17. Maddocks S, Sekome K. The short-term effects of hydrotherapy on pain and self- perceived functional status in individuals living with osteoarthritis of the knee joint. S Afr J Physiother 2019;751-6.
18. Bhore P, Shinde S. Effect of multi-component exercises program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint. J Edu Health Promot 2023;12:138.
19. Manjrekar M, Dhane S, Shinde S. Effect of pre-participation aquatic training program on running performance in marathon runners. Inter J Disabil Sports Health Sci 2024;7:94-102.
20. Sawant Janhavi M, Shinde S. Effect of lower limb proximal to distal muscle imbalance correction on functional pes planus deformity in young adults. JMPAS 2021;10:3469-73.