THE EFFECTIVENESS OF AQUATIC NEUROMUSCULAR TRAINING ON PAIN AMONG INDIVIDUAL WITH ACHILLES TENDINOPATHY.

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Abstract: Achilles tendinopathy is a chronic musculoskeletal disorder characterized by pain, localized swelling, and reduced tendon function, commonly caused by repetitive mechanical overload exceeding the tendon's capacity to adapt. It is more prevalent in individuals with increased body weight due to greater stress on the tendon. This randomized controlled study included 15 women aged 22–30 diagnosed with chronic Achilles tendinopathy who underwent aquatic neuromuscular training three times per week for four weeks. Results showed a highly significant improvement in pain levels measured by the Visual Analog Scale (VAS) and functional performance assessed using the Heel Raise Endurance Test (HRET) ($p \leq 0.001$). Participants demonstrated reduced pain and enhanced functional capacity following the intervention. The findings indicate that aquatic neuromuscular training is an effective physiotherapy approach for managing Achilles tendinopathy, promoting pain reduction and improved functional recovery, and can be recommended as a beneficial rehabilitation strategy.

KEYWORDS: Achilles tendinopathy, aquatic neuromuscular training, eccentric exercise, concentric isotonic exercises, Heavy-slow resistance.

INTRODUCTION:

The calcaneal tendon, also known as the Achilles tendon, is the largest and strongest tendon in the human body. It is situated at the back of the lower limb and connects the gastrocnemius and soleus muscles—together called the calf muscles—to the calcaneal tuberosity of the heel. These muscles play an important role in walking, with the soleus mainly responsible for stabilizing the leg over the foot. The tendon receives its nerve supply primarily from the sural and posterior tibial nerves. Its main function is to transmit and regulate muscular forces, helping to protect the tendon from injury. Increased body mass index (BMI) places greater mechanical load on the tendon, which can contribute to the development of pain[1].Tendons are specially structured to tolerate very high forces during joint movement, sometimes experiencing loads greater than 9 kN. However, repeated exposure to high-intensity loading can lead to tendinopathy, a painful and function-limiting tendon condition that may last for months or even years. The Achilles tendon, despite being one of the largest and strongest tendons in the human body, is commonly affected by this condition. Tendon injuries account for approximately 30–50% of all sports-related injuries, occur in about 50% of elite endurance runners, and affect around 6% of sedentary individuals. Among disorders involving the Achilles tendon, tendinopathy represents roughly 55–65% of all clinical diagnoses[2] Achilles Tendinopathy are common overuse injuries seen in athletes. Eccentric muscle training has traditionally been the primary conservative treatment approach for these conditions; however, as many as 45% of patients may not respond adequately to this method. Alternative loading strategies, such as eccentric–concentric exercises progressing to eccentric loading (Silbernagel combined protocol) and eccentric–concentric isotonic training using heavy-slow resistance (HSR), have also been explored. For clinicians to make well-informed treatment decisions,

it is essential to understand the different loading options and the evidence comparing their effectiveness. Additionally, clarifying the mechanisms underlying various loading approaches can help tailor treatment to individual patient deficits and improve the design of future rehabilitation programs[3].The Achilles tendon is formed by the fusion is the soleus muscle with the two heads of the gastrocnemius and inserts distally and to the calcaneus. A normal tendon appears as a white, elastic, fibrillar, and typically rounded structure with relatively limited vascularity. The remaining 5-10% consists mainly of chondrocytes located at the enthesis and a small number of synovial cells with in the tendon sheath. The extra cellular matrix surrounding collagen fibers and tenocytes contains glycosaminoglycans, glycoproteins, and proteoglycans, whose strong affinity for water contributes to tendon elasticity. Type 1 collagen is the predominant form roughly 95% of the total collagen. Blood reaches the tendon from 3 main sources: the muscle-tendon junction, bone-tendon junction, and vessels along the tendon's length, with the surrounding paratenon providing an important contribution to the midportion. The insertional region generally has richest blood supply but over 30years individuals' origin tendon tends to more vascular. The Achilles tendon is approximately origin 2-6cm above the calcaneal insertion is least vascularized in all ages, the healing capacity will be reduced in the area of stress or injury[4].The main clinical features of Achilles tendinopathy are pain and impaired function. Athletes report early symptoms of morning stiffness or stiffness after prolonged sitting, pain during activity like (running, jumping), tenderness on palpation. Some athletes notice pain decline at first during the performance like slow running speed or reduced jumping ability. If we ignored the early symptoms the condition will get progress and lead to pain occur during both before and after the activity along with further performance reduction[5].

AQUATIC THERAPY:

Aquatic therapy provides low impact setting that reduces tendon loading while promoting neuromuscular activation. It creates buoyancy effect in water that reduces mechanical stress on Achilles tendon, enabling safe and gradual activation of calf muscle. At the same time water provide the natural resistance to support and improvements in proprioception, strength, and joint mobility. The neuromuscular exercise program conducted in water integrate balance, proprioception exercise, dynamic joint stabilization, functional strengthening activity[6].

NEED OF THE STUDY:

The effectiveness of aquatic neuromuscular exercise. Determine its on pain reduction, assess improvement in ankle dorsiflexion range of motion, provide evidence for a safer and more effective rehabilitation approach for this specific population, evaluate enhancement in functional performance.

AIM OF THE STUDY:

The effectiveness of aquatic neuromuscular training in reducing pain among individuals with Achilles tendinopathy.

OBJECTIVES OF THE STUDY:

- To evaluate the effect of aquatic neuromuscular training on pain in individuals with Achilles tendinopathy.
- To assess functional improvement following interventions.
- To identify the effective intervention for clinical management of Achilles tendinopathy.

BACKGROUND OF THE STUDY:

Achilles tendinopathy is a chronic musculoskeletal condition characterized by persistent pain, localized swelling, and reduced functional performance of the affected tendon. It commonly develops as a result of repetitive mechanical overload that exceeds the tendon's capacity for adaptation and repair. Middle-aged individuals, particularly overweight women, appear to have a higher prevalence of this condition. Increased body weight contributes to greater mechanical stress on the Achilles tendon during daily and physical activities, thereby accelerating degenerative changes. In addition, age-related reductions in tendon elasticity and healing capacity further increase susceptibility to injury. Hormonal variations, especially those associated with midlife physiological changes, may also influence tendon structure and metabolism, predisposing this population to tendon degeneration. These combined biomechanical and physiological factors often result in prolonged symptoms, including pain, stiffness, and decreased functional mobility, ultimately affecting quality of life and participation in physical activities.

HYPOTHESIS:

NULL HYPOTHESIS:

There is no difference in effectiveness in aquatic neuromuscular training in reducing pain among individuals with Achilles tendinopathy.

ALTERNATIVE HYPOTHESIS:

There is significant difference of effectiveness in aquatic neuromuscular training in reducing pain among individuals with Achilles tendinopathy.

METHODOLOGY:

STUDY DESIGN: Exprimental study

STUDY SETTING: Shri Isari Velan Mission Hospital, Thazhambur.

SAMPLE SIZE: 15 Patients.

SAMPLE TECHINIQUE: Random

STUDY DURATION: 4Week

INCLUSION CRITERIA:

- Inclusion criteria, which involved a sudden onset of pain in the lower posterior leg, approximately 2 to 4cm above the heel, beginning within the past 6 months.
- The discomfort typically develops after a recent increase in physical activity, such as prolonged standing or walking
- The pain was described as sharp during activity and tended to subside with rest; however, there was noticeable stiffness and soreness during the first few steps in the morning.
- Participants clinically diagnose with Achilles tendinopathy, aged between 22-30 years, and having a BMI of 25 to29.9 km/m^2 were included.

EXCLUSION CRITERIA:

- Individuals were excluded if they had a known history of OA of the hip, knee, or ankle;
- diabetes mellitus;
- peripheral neuropathy; prior lower limb trauma; foot disorders;
- peripheral arterial disease
- DVT;
- if they had undergone surgical intervention involving the hip, knee, ankle within the past 10 years

OUTCOME MEASURE:

- VAS-Visual Analog Scale -to measure the pain
- Heel rise endurance test- for muscle strength (HRET)

PROCEDURE:

In this exprimental study 30 Achilles tendinopathy patients who filled the inclusion and exclusion criteria were selected for the study. Aquatic neuromuscular training for 3 session a week, for 4 weeks

(AQUATIC NEUROMUSCULAR TRAINING)

The subject was asked to perform Aquatic neuromuscular training for 3 session a week, for 4 weeks.

The exercise given as follows;

WEEK 1:

WARM UP PHASE:

Deep breathing exercise Thoracic expansion exercise

Pursed lip breathing (Duration 3 minute)

EXERCISE TRAINING PHASE

- Aquatic lunges
- Aquatic toe and heel raise
- Heel walking in water
- Single leg standing

COOL DOWN PHASE:

- Tendo-Achilles stretching
- Relaxation regime

WEEK 2:

WARM UP PHASE:

Deep breathing exercise Thoracic expansion exercise

Pursed lip breathing (Duration 3 minute)

EXERCISE TRAINING PHASE

- ❖ Aquatic heel raise
- ❖ Aquatic eccentric heel drop
- ❖ Side stepping in water
- ❖ Toe walking forward in water
- ❖ Heel walking backward in water

COOL DOWN PHASE:

- ➢ Tendo-Achilles stretching
- ➢ Relaxation regim

WEEK 3:

WARM UP PHASE:

Deep breathing exercise Thoracic expansion exercise

Pursed lip breathing (Duration 3 minute)

EXERCISE TRAINING PHASE

- ❖ Step-ups on submerged pool stairs
- ❖ Side stepping in water
- ❖ Toe walking
- ❖ Heel walking
- ❖ Weight shifts

COOL DOWN PHASE:

- ➢ Tendo-Achilles stretching
- ➢ Relaxation regime

WEEK 4:

WARM UP PHASE:

Deep breathing exercise Thoracic expansion exercise

Pursed lip breathing (Duration 3 minute)

EXERCISE TRAINING PHASE

❖ Lateral hops

❖ Toe waking forward

❖ Aquatic eccentric heel drop

❖ Side stepping in water

COOL DOWN PHASE:

➢ Tendo-Achilles stretching

➢ Relaxation

AQUATIC NEUROMUSCULAR TRAINING

WEEK1:

WARMUP PHASE:

1. DEEP BREATHING EXERCISE:

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose.

✓ Then the patient is asked to hold their breath and exhale out the air finally.

2. THORACIC EXPANSION EXERCISE:

✓ The patient is placed in a supporting chair with good neutral posture

✓ Then the patient hand is placed on the lower ribcage to feel expansion

✓ Now the patient slowly deep breath through the nose while concentrating on moving the ribs into the hands.

✓ Hold the breath for 2-3 seconds at the end of inspiration

✓ Breath out gentle and slowly

3. PURSED LIP BREATHING:

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose (4-7SECONDS)

✓ Then the patient is asked to hold their breath (2-3 SECONDS)

✓ Then the patients are instructed to exhale out the air through lips (4-8 SECONDS)

EXERCISE TRAINING PHASE:

AQUATIC LUNGES:

✓ Stand in the water at least waist deep preferably chest deep with your hip-width apart.

✓ Then maintain aright posture and lunge forward or backward while keeping the front knee forward at approximately 90 degrees

✓ Ensure your front knee does not extend past toe

✓ Then push of the front toe to return to the normal upright posture

✓ Repeat the exercise for 10 times,3 set with 10 second hold.

✓ As given in the figure:7

AQUATIC TOE AND HEEL RAISES:

✓ Stand in water at chest deep

✓ Phase the pool wall with feet shoulder width apart.

✓ Slowly raise on to the ball of your feet

✓ Hold this position and squeezing the calf muscle

✓ Now lower the heels back to the pool floor

✓ Walk back on the heels and lift your toes

✓ Place the feet on the floor in front of the knee

✓ Repeat the exercise for 10 times,3 set with 10 second hold.

✓ As given in the figure 8,9

AQUATIC HEEL WALKING IN WATER:

✓ Stand in water at the level of your waist

✓ Keep the core engage

✓ Then pull our toes towards the shine and walk forward by striking only with your heels

✓ Maintain the posture and walk straight

✓ Repeat the exercise for 10 times,3 set with 10 second hold.

✓ As given in the figure :8

AQUATIC SINGLE LEGSTANDS:

✓ Stand in the water waist-to-chest level

✓ Keep the spine in neutral and maintain upright posture

✓ Now lift one leg and keep the knee of the supporting leg slightly bent

✓ Repeat the exercise for 10 times,3 set with 10 second hold.

✓ As given in the figure:10,11

COOL DOWN PHASE:

1. TENDO-ACHILLES STRETCHING:

✓ Stand facing the wall

✓ Place the hand at eye level

✓ Place the foot of the leg behind you (stretching leg)

✓ Bent the knee which is in front and lean towards the wall

✓ Hold for 30 seconds

✓ Repeat for 3 times and 2 sets

2. RELAXATION REGIME:

NECK STRETCH:

✓ Uplift your neck and look towards the sky

✓ Loose your hand and place it on the chin

✓ Now hold the chin for 30 seconds

✓ Repeat for 3 times and 2 sets BREATH:

✓ Relax for few second and follow the thoraco abdominal breathing WALKING:

✓ Walk for 1 to 2 minutes

WEEK 2:

WARMUP PHASE

1. DEEP BREATHING EXERCISE:

Using diaphragm exercise is done;

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose.

✓ Then the patient is asked to hold their breath and exhale out the air finally.

2. THORACIC EXPANSION EXERCISE:

✓ The patient is placed in a supporting chair with good neutral posture

✓ Then the patient hand is placed on the lower ribcage to feel expansion

✓ Now the patient slowly deep breath through the nose while concentrating on moving the ribs into the hands.

✓ Hold the breath for 2-3 seconds at the end of inspiration

✓ Breath out gentle and slowly

3.PURSED LIP BREATHING:

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose (4-7SECONDS)

✓ Then the patient is asked to hold their breath (2-3 SECONDS)

Then the patients are instructed to exhale out the air through lips (4-8SECONDS)

EXERCISE TRAINING PHASE:

AQUATIC HEEL RAISE:

✓ Stand in water at chest level with feet shoulder width apart

✓ Place the hands on the edge of the pool and stabilize your body

✓ Now raise your toes as I as possible against the resistance

✓ Slowly lower the heels back to the floor

✓ Repeat the exercise for 20 times and 2 sets

✓ As shown in the figure :8

AQUATIC ECCENTRIC HEEL DROP:

✓ Stand in the pool position yourself on the edge of the pool with the ball of your feet

✓ Let the heels hang over the edge

✓ Use both the legs to rise on the toes

✓ Slowly lower the legs the level of stepover the count for 3 to 5 seconds

✓ Repeat the exercise for 20 times and 2 sets

✓ As demonstrate in the figure:16

SIDE STEPPING IN WATER:

✓ Stand in the water and place your feet together

✓ Keep an upright posture

✓ Take a step to the right with the right foot then bring your left foot to meet it

✓ Repeat it with another side

✓ Repeat the exercise for 20 times and 2 sets

✓ As given in the figure :12

TOEWALKING FORWARD:

✓ Stand in the water

✓ Maintain upright position and keep the back straight

✓ Lift the heel of the floor

✓ Move forward slowly by placing one foot in front the other one

✓ Repeat the exercise for 20 times and 2 sets

2. AQUATIC HEEL WALKING BACKING:

✓ Stand in the water

✓ Maintain upright position and keep the back straight

✓ Lift the heel of the floor

✓ Move backward slowly by placing one foot behind

✓ Take a step backward and land on the heels first

✓ Maintain arm swing balance

✓ Repeat the exercise for 20 times and 2 sets

COOL DOWN PHASE:

1. TENDO-ACHILLES STRETCHING:

✓ Stand facing the wall

✓ Place the hand at eye level

✓ Place the foot of the leg behind you (stretching leg)

✓ Bent the knee which is in front and lean towards the wall

✓ Hold for 30 seconds

✓ Repeat for 3 times and 2 sets

2.RELAXATION REGIME:

BREATH:

✓ Relax for few second and follow the thoraco abdominal breathing WALKING:

✓ Walk for 1 to 2 minutes

WEEL 3:

WARMUP PHASE

1. DEEP BREATHING EXERCISE:

Using diaphragm exercise is done;

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose.

✓ Then the patient is asked to hold their breath and exhale out the air finally.

2. THORACIC EXPANSION EXERCISE:

✓ The patient is placed in a supporting chair with good neutral posture

✓ Then the patient hand is placed on the lower ribcage to feel expansion

✓ Now the patient slowly deep breath through the nose while concentrating on moving the ribs into the hands.

✓ Hold the breath for 2-3 seconds at the end of inspiration

✓ Breath out gentle and slowly

3. PURSED LIP BREATHING:

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose (4-7SECONDS)

✓ Then the patient is asked to hold their breath (2-3 SECONDS)

Then the patients are instructed to exhale out the air through lips (4-8SECONDS)

EXERCISE TRAINING PHASE:

STAND IN SUBMERGED STAIRS;

✓ Stand in the water

✓ Stand straight and maintain posture

✓ Slowly lift one leg and place on the stairs

✓ Now lift the whole body

✓ Now place the other foot on the same stair

SIDE STEPPING IN WATER:

✓ Stand in the water and place your feet together

✓ Keep an upright posture

✓ Take a step to the right with the right foot then bring your left foot to meet it

✓ Repeat it with another side

✓ Repeat the exercise for 20 times and 2 sets

✓ As demonstrate in given figure :12

TOE WALKING:

✓ Stand in the water

✓ Maintain upright position and keep the back straight

✓ Lift the heel of the floor

✓ Walk to and fro

✓ Repeat the exercise for 20 times and 2 sets

✓ As shown in the figure :14

COOL DOWN PHASE:

TENDO-ACHILLES STRETCHING:

✓ Stand facing the wall

✓ Place the hand at eye level

✓ Place the foot of the leg behind you (stretching leg)

✓ Bent the knee which is in front and lean towards the wall

✓ Hold for 30 seconds

✓ Repeat for 3 times and 2 sets 2.RELAXATION REGIME:

NECK STRETCH:

✓ Uplift your neck and look towards the sky

✓ Loose your hand and place it on the chin

✓ Now hold the chin for 30 seconds

✓ Repeat for 3 times and 2 sets BREATH:

✓ Relax for few second and follow the thoraco abdominal breathing WALKING:

✓ Walk for 1 to 2 minutes

WEEK4:

WARMUP PHASE

1. DEEP BREATHING EXERCISE:

Using diaphragm exercise is done;

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose.

✓ Then the patient is asked to hold their breath and exhale out the air finally.

2. THORACIC EXPANSION EXERCISE:

✓ The patient is placed in a supporting chair with good neutral posture

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✓ Hold the breath for 2-3 seconds at the end of inspiration

✓ Breath out gentle and slowly

3. PURSED LIP BREATHING:

✓ The patient is asked is to sit erect with calmness when the patient is asked to inhale slowly through the nose (4-7SECONDS)

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Then the patients are instructed to exhale out the air through lips (4-8SECONDS)

EXERCISE TRAINING PHASE

LATERAL HOPS:

✓ Stand with feet shoulder width apart

✓ Bent your knees slightly into a mini squat position and keep a straight posture

✓ Engage core

✓ Explosively jump to the right and land on the feet

✓ Now repeat the same with another side

✓ Repeat the exercise for 20 times 2sets

✓ As demonstrate in the figure :15

TOE WALKING FORWARD:

✓ Stand in the water

✓ Maintain upright position and keep the back straight

✓ Lift the heel of the floor

✓ Move forward slowly by placing one foot in front the other one

✓ Repeat the exercise for 20 times and 2 sets

✓ As shown in the figure :14

AQUATIC ECCENTRIC HEEL DROP:

✓ Stand in the pool position yourself on the edge of the pool with the ball of your feet

✓ Let the heels hang over the edge

✓ Use both the legs to rise on the toes

✓ Slowly lower the legs the level of stepover the count for 3 to 5 seconds

✓ Repeat the exercise for 20 times and 2 sets

✓ As demonstrate in figure:8

SIDE STEPPING IN WATER:

✓ Stand in the water and place your feet together

✓ Keep an upright posture

✓ Take a step to the right with the right foot then bring your left foot to meet it

✓ Repeat it with another side

✓ Repeat the exercise for 20 times and 2 sets

✓ Shown in figure:12

COOL DOWN PHASE:

TENDO-ACHILLES STRETCHING:

✓ Stand facing the wall

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✓ Place the foot of the leg behind you (stretching leg)

✓ Bent the knee which is in front and lean towards the wall

✓ Hold for 30 seconds

✓ Repeat for 3 times and 2 sets 2.RELAXATION REGIME:

NECK STRETCH:

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✓ Now hold the chin for 30 seconds

✓ Repeat for 3 times and 2 sets BREATH:

✓ Relax for few second and follow the thoraco abdominal breathing WALKING:

✓ Walk for 1 to 2 minutes

DATA ANALYSIS:

The parameters were assessed in (AQUATIC NEUROMUSCULAR TRAINING) having 15 Subjects (n=15). The pre-test and post-test assessments were taken subjects of the groups. The samples were assessed initially and then again at the end of the 4th week. The data obtained are analyzed using paired t-test.

TABLE 1: REPRESENTS THE PRE AND POST MEAN VALUE OF (VAS)

VAS SCALE	MEAN		STANDARD DEVIATION SD		t- VALUE	SIGNIFICANCE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
	7.27	2.40	0.88	0.51	36.5000	0.0001

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre- test and post-test within (VAS)

There is a statistically highly significant difference between the pre- test and post- test values of VAS scale within (VAS)

GRAPH 1: REPRESENTS THE PRE AND POST MEAN VALUE OF (VAS)

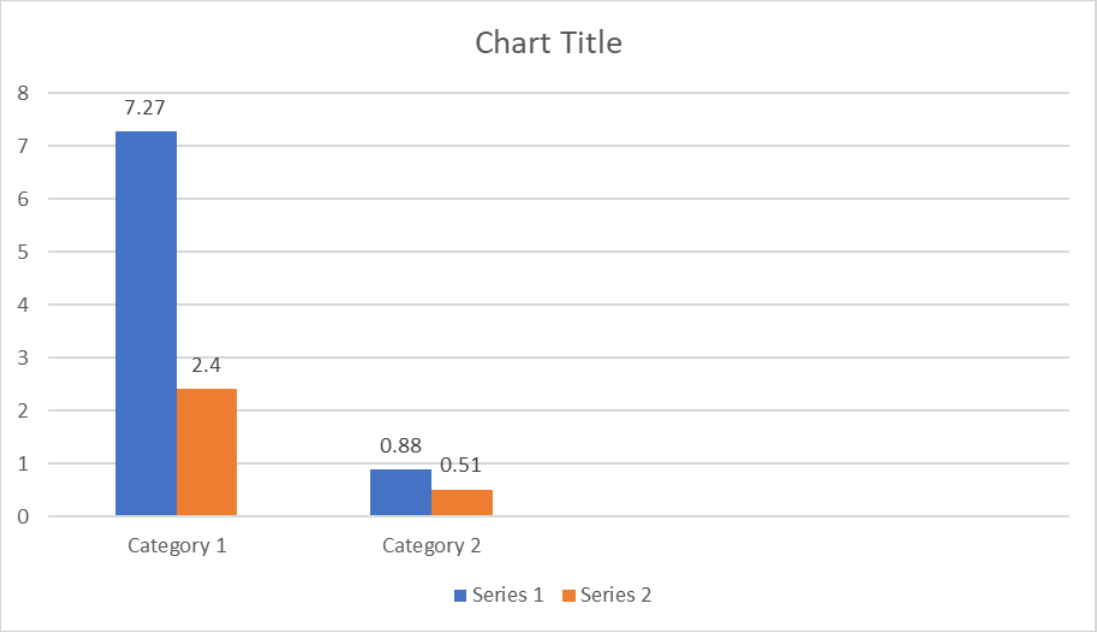


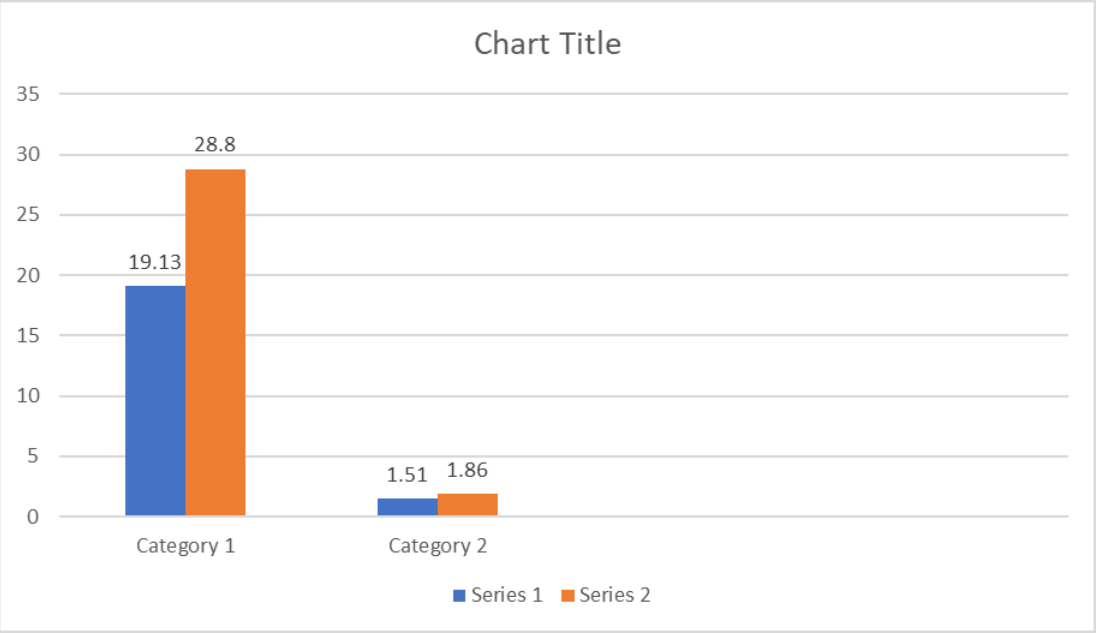
TABLE 2: REPRESENTS THE PRE AND POST MEAN VALUES OF (HRET – HEEL RAISE ENDURANCE TEST)

HEEL RAISE ENDURANCE TEST	MEAN		STANDARD DEVIATION SD		t- VALUE	SIGNIFICANCE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
	19.13	28.80	1.51	1.86	76.7268	0.0001

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre- test and post-test within . (HRET)

There is a statistically highly significant difference between the pre- test and post- test values of within (HRET)

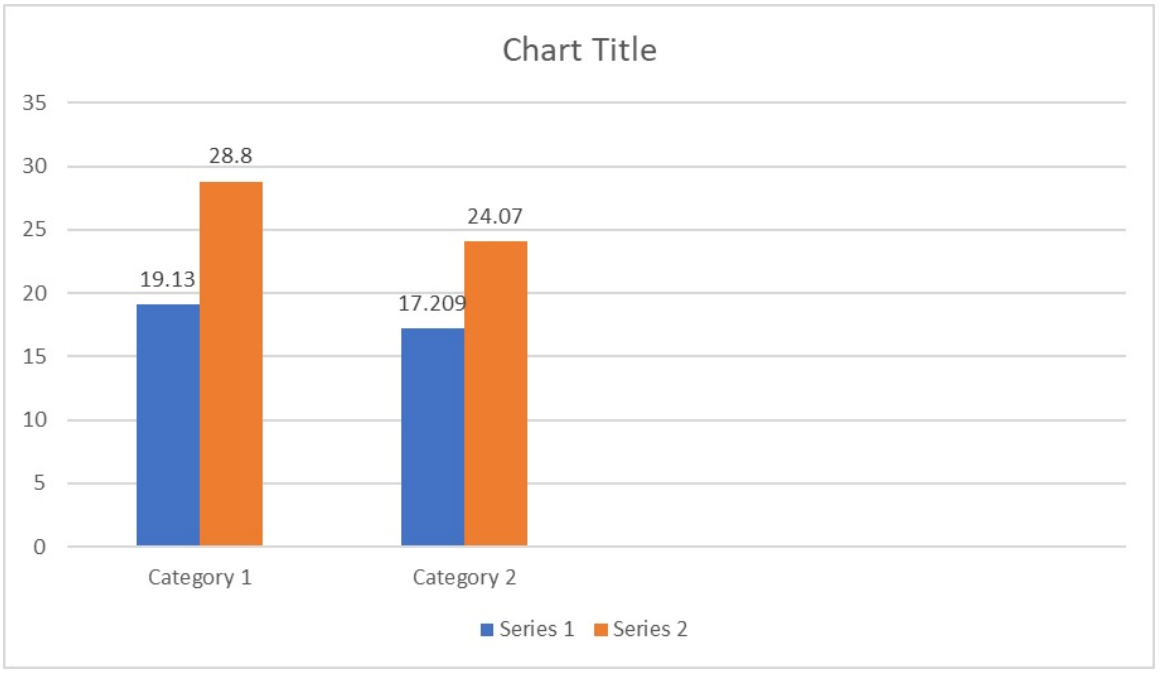
GRAPH 2: REPRESENTS THE PRE AND POST MEAN VALUES OF (HRET – HEEL RAISE ENDURANCE TEST)



GRAPH 3: REPRESENTS THE PRE AND POST TEST MEAN VALUES OF (HRET – HEEL RAISE ENDURANCE TEST)

HRET	MEAN		STANDARD DEVIATION SD		t- VALUE	SIGNIFICANCE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
	19.13	28.80	1.51	1.86	76.7268	0.0001
	17.20	24.07	0.94	1.16	75.5813	0.0001

This table shows that there is no significant difference in pre- test values of the HRET This table shows that there is a significant difference in post- test values of the HRET



RESULT:

1. VAS (VISUAL ANALOG SCALE)

The mean pre-test VAS score was 7.27 ± 0.88, which reduced to 2.40 ± 0.51 in the post-test. The calculated t-value was 36.5000 with a p-value of 0.0001.

This indicates a highly statistically significant reduction in pain following the intervention.

2. HRET (Heel Raise Endurance Test)

The mean pre-test value was 19.13 ± 1.51, which increased to 28.80 ± 1.86 in the post-test. The t-value was 76.7268 with a p-value of 0.0001.

DISCUSSION:

The present study aimed the effectiveness of aquatic neuromuscular training in reducing pain among individuals with Achilles tendinopathy. The findings of this study indicate that both interventions were effective in reducing pain;

The reduction in pain observed can be attributed to the principle of mechanical loading and tendon adaptation. Tendinopathy is now understood as a failed healing response rather than an inflammatory condition, where appropriate loading stimulates collagen remodeling and improves tendon structure. which involves slow, controlled concentric and eccentric loading, enhances tendon stiffness and promotes structural adaptation. Previous research has shown that with high patient satisfaction. This supports the pain reduction observed of the present study

CONCLUSION:

The results of the study demonstrated that showed statistically significant improvements in pain reduction (VAS scale) and functional performance (Heel Raise Endurance Test) following the 4-week intervention program. However, when comparing the post-test values.

SpecificallY, showed a greater reduction in pain scores and a higher increase in heel raise endurance . The difference in post-test values was found to be statistically significant, indicating superior effectiveness of aquatic neuromuscular training.

The improved outcomes in may be attributed to the buoyancy and resistance properties of water, which reduce mechanical stress on the Achilles tendon while enhancing neuromuscular control, strength, and proprioception in a safe and supportive environment.

Therefore, it can be concluded that aquatic neuromuscular training is more effective in reducing pain and improving functional performance in individuals with Achilles tendinopathy.

LIMITATION :

- Small sample size (n=15).
- Short study duration (4 weeks).
- Only female participants included.
- Narrow age group (22–30 years).
- Limited outcome measures (VAS & HRET only).
- No long-term follow-up.
- Variation in patient compliance.

RECOMMENDATIONS:

- Increase sample size.
- Extend study duration.
- Include both genders.
- Include wider age groups.
- Use additional outcome measures.
- Conduct follow-up studies.
- Monitor patient adherence strictly.

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