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Case Study

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Rehabilitation of A Patient Diagnosed with Polymyositis Following COVID-19 Vaccination: A Case Report

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Abstract

Polymyositis (PM) is one of four types of rare inflammatory myopathies. The occurrence of myositis induced by COVID-19 vaccination is an uncommon phenomenon, and there is uncertainty whether such cases would respond to conventional physical therapy treatments typically administered to patients with polymyositis. This study is a single case report that aims to outline the physical therapy plan of care for a patient diagnosed with PM following COVID-19 vaccination. A woman in her 30s was admitted to home health physical therapy more than a year after being diagnosed with PM. She complained of 4/10 dull-aching pain in the lumbo-pelvic area, and functional deficits included inability to rise to standing from a sitting position, roll in bed, reach overhead, walk without assistance and negotiate a flight of stairs. The patient was assessed with the SF-36 questionnaire, TUG, 2MWT, standing balance and muscle strength testing. She participated in physical therapy treatment for 10 weeks. The patient demonstrated improvement of overall functional mobility. TUG improved from 29 to 23 seconds, and 2MWT increased from 50 to 96 meters. Pain decreased from 4/10 to 2-3/10. This case report provides one example of physical therapy interventions for the rehabilitation of Covid vaccine induced PM. Results suggest physical therapy interventions may improve functional mobility, even in this condition.

Keywords: Covid-19, myositis, TUG

Introduction

Idiopathic inflammatory myopathies are rare, systemic and acquired diseases that are classified into 4 sub-types: dermatomyositis, polymyositis, immune-mediated necrotizing myopathies, and sporadic inclusion body myositis[1]. PM is more prevalent in women than in men[2]. It rarely presents in childhood and usually affects people above the age of 20 years. The exact cause of polymyositis is unknown[3]. PM resembles an autoimmune disorder where the body attacks its own tissues. Associated conditions include Raynaud's disease, connective tissue disorders such as lupus, rheumatoid arthritis, scleroderma, and Sjogren's syndrome. Cardiovascular diseases such as myocarditis, congestive heart failure, arrhythmias, and lung diseases such as fibrosis are also commonly related.It is thought to be triggered by environmental factors in genetically predisposed individuals. Other suspected triggers include long term use of drugs such as hydralazine, procainamide, viral infections such as human immune-deficiency virus, Coxsackievirus and Hepatitis C virus; and malignancies. Vaccines, which elicit an immune response in individuals have also been considered as potential triggers for autoimmune conditions[4].

The main characteristic of PM is weakness in the proximal muscles of the hips, thighs, trunk, shoulders, and neck, along with joint stiffness and

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myalgia. It may progress to affect the respiratory, speech, and swallowing muscles, causing dysphagia, breathing difficulties, or pneumonia[5]. Common medications used to treat PM include corticosteroids like prednisone, corticosteroid-sparing agents such as azathioprine and methotrexate, intravenous immunoglobulins, and Rituximab[6].

The Covid-19 pandemic, caused by the novel coronavirus SARS-CoV-2 has had a profound impact on global public health. In 2020, vaccines developed by Pfizer-BioNTech, Moderna, and AstraZeneca were distributed globally to combat the infection. Auto-immune diseases post vaccination can be overlooked as potential contributors to the clinical manifestation of myositis[7]. Covid-19 vaccine-induced myositis represents an uncommon phenomenon[8]. It is uncertain whether it would respond to traditional physical therapy care in a manner provided to patients with polymyositis.

The primary objectives in managing PM are to reduce inflammation, restore muscle function, and prevent the progression of chronic muscle disease to enhance quality of life. Physical therapy intervention has been shown to improve muscle strength and quality of life in patients with PM[9]. A study conducted by H. Alexanderson et al[10] showed that resistance training improved muscle performance and aerobic capacity in adult patients with active PM. Varjú et al[11] examined the effects of physical exercise in patients with acute and chronic PM and showed improved muscle strength and respiratory function in both groups.

The purpose of this case report is to describe the physical therapy plan of care for a patient diagnosed with PM after receiving the Covid-19 vaccination.

Materials and Methodology

A female patient in her 30s was admitted to home health physical therapy more than a year after being diagnosed with PM. It is unknown why she did not receive physiotherapy care soon after experiencing the symptoms. Her symptoms started as generalized muscle pain and stiffness during the early morning hours, a few weeks after having received the dose of Covid-19 vaccine. The myalgias increased in duration and frequency and within a few months she was experiencing exhaustion requiring extensive help in all the activities of daily living. She complained of 4/10 dull-aching pain on the numerical rating scale in the lumbo-pelvic area, was unable to rise to standing from a low-sitting position, roll in bed, reach overhead, walk without the use of assistive device, and negotiate a flight of stairs. She was prescribed corticosteroids and medications for pain relief.The patient had an unremarkable medical history and no family history of autoimmune disorders. Prior to this, the patient was active and employed full-time. Laboratory tests and a muscle biopsy confirmed the diagnosis of PM. The development of symptoms post-vaccination and the confirming tests suggested Covid-19 induced polymyositis.

At the time of evaluation, her vitals were, blood pressure 134/76, pulse 81, temperature 97.9°F and oxygen saturation 100%. There was no peripheral joint swelling or nodules within the upper and lower extremity muscles and joints upon palpation. A visual inspection of the skin revealed no discoloration, rashes or lesions. Sensations for light touch and pressure were intact in bilateral upper and lower extremities. Proprioception was intact in bilateral hip, knee, ankle, inter-phalangeal joints of great toe, shoulder, elbow and wrist joints. She experienced mild dysphagia at times but denied coughing, wheezing or trouble breathing. Active range of motion was moderately limited in all shoulder motions, elbow flexion and extension and severely limited in all hip motions, knee flexion and extension and ankle dorsiflexion.

The patient required contact guard assist for sit to stand transfers and minimum assist of one for bed mobility transfers. She was able to ambulate for 65 feet on a level surface with a rolling walker with stand-by assistance before needing to sit due to muscle fatigue. The patient ambulated with a backward trunk lean and a waddling gait. She displayed poor cadence and increased double support time. She displayed a slightly stooped posture in sitting. In standing, she presented with sway-back posture and an anterior pelvic tilt. Muscle strength was assessed using MMT for musculature. The patient's strength limitations are noted in Table 1.

Table 1. Manual Muscle Test grades for upper and lower extremity musculature

Muscle group	Right Initial Evaluation	Left initial Evaluation	Right final Evaluation	Left final Evaluation
Hip Flexion	2+/5	3-/5	3/5	3+/5
Hip Extension	2+/5	3/5	3/5	3+/5
Hip adduction	3-/5	3/5	3/5	3+/5
Hip abduction	2/5	3-/5	3/5	3+/5
Knee flexion	3/5	3+/5	3+/5	4/5
Knee extension	3-/5	3+/5	3+/5	4/5
Ankle plantarflexion	3+/5	4-/5	4-/5	4/5
Ankle dorsiflexion	3-/5	3+/5	3/5	4/5
Shoulder flexion	3-/5	3-/5	3+/5	3+/5
Shoulder extension	2+/5	2/5	3-/5	3/5
Shoulder abduction	2+/5	2+/5	3+/5	4-/5
Elbow flexion	3+/5	3+/5	4/5	4/5
Elbow extension	3+/5	3/5	4-/5	4/5
Forearm supination	3/5	3/5	3+/5	3+/5
Forearm pronation	3+/5	3+/5	4/5	4-/5

Active range of motion was moderately limited in all shoulder motions, elbow flexion and extension and severely limited in all hip motions, knee flexion and extension and ankle dorsiflexion. PROM was grossly within functional limits.

The SF-36 questionnaire (SF-36) is a measure of quality of life. It is self- reported and consists of 36 questions that cover 8 domains of health[12]The International Myositis Assessment and Clinical Studies Group has recommended the use of the SF-36 to assess health related quality of life[13]. The patient scored on physical functioning 10/100, on role limitations due to physical health 0/100, on role limitations due to emotional problems 0/100, on fatigue 15/100, on emotional well-being 36/100, on social functioning 25/100, on pain 55/100, on general health 30/100. The mean score is 50 for each domain. Scores higher than the mean indicate better health and functioning while lower scores indicate poor health.

The Timed Up and Go test (TUG) was used to measure functional mobility[14]. This test was adapted by Podsiadlo and Richardson from Mathias et al[15]and is used to test basic mobility and fall risk in community dwelling adults between 60-90 years of age. The patient scored 29 seconds.

The two-minute walk test (2-MWT) was used to assess endurance and walking ability. It was used over the standard 6-minute walk test due to the cardiopulmonary demands to ambulate for the duration of the test. The patient ambulated for 50 meters in 2 minutes using a rolling walker.

Standing static balance was evaluated using the 4-stage balance test. The patient exhibited difficulty maintaining her position in tandem stance for a duration of 10 seconds, and was unable to stand on a single leg. Static sitting balance was good. The patient was able to sit with an upright posture without loss of balance against moderate resistance. Dynamic sitting balance, although not specifically tested with perturbations, appeared diminished. The patient exhibited impaired weight shifting bilaterally during movement and required upper extremity support to cross midline.

The patient presented with exam findings of proximal muscle weakness, trunk weakness, deconditioning, impaired static and dynamic balance and impaired active range of motion due to vaccine induced PM, resulting in difficulty with ADLs and grooming, difficulty with ambulation and transfers and impaired tolerance to activity due to fatigue. These limitations were limiting the patient to participate in community and leisure activities, function independently in her home and return to her work duties due to her impaired strength and endurance.

Intervention

The patient received physical therapy treatment twice per week for 10 weeks for 60-minute sessions. Two additional sessions were conducted which consisted of the initial evaluation and a discharge visit. PT interventions consisted of therapeutic exercise to improve strength and mobility, gait and balance training, and endurance exercises. A written home exercise program was established in each visit for the patient to continue exercises on non-therapy days. Strength-resistance training targeting both upper and lower extremity musculature was performed. 10-repetition maximum rule was utilized for progression to increase weights. Strengthening exercises for the core and back musculature were also incorporated to address impaired posture and add stability during functional mobility (Table 3).

Table 3. Strengthening exercises for upper and lower extremity musculature. BW=body weight, TB=TheraBand, AAROM=active assisted range of motion, AROM=active range of motion

Exercise	Weight/resistance	Progression	
		Initial resistance level	Final resistance level at discharge
Seated long-arc quad	BW/ 1lb, 2lbs ankle weights	1lb ankle weight	2 lbs. ankle weights
Seated hip flexion	BW/ 1lb, 2lbs, 2.5lbs ankle weights	1lb ankle weight	2.5 lbs. ankle weights
Seated hip abduction	BW/ 1lb, 2lbs, 2.5lbs ankle weights	1lb ankle weight	2.5 lbs. ankle weights
Standing hip flexion, extension, abduction	BW/ 1lb, 2lbs, 2.5lbs ankle weights	1lb ankle weight	2.5 lbs. ankle weights
Supine hip abduction, adduction	BW/1lb, 1.5lbs ankle weights	1lb ankle weight	1.5 lbs. ankle weights
Supine hip flexion	BW/ 1lb ankle weight	Minimal assistance by therapist to complete the activity	1lb ankle weight
Seated hamstring curls	Orange/green/blue TB	Orange TB	Blue TB
Seated ankle plantar/ dorsi-flexion	Yellow/orange/green TB	Yellow TB	Green TB
Supine heel slides	BW/ Yellow/ Orange/ green TB	Yellow TB	Green TB
Seated bicep curls	2lbs, 4lbs dumbbells	2lbs dumbbells	4lbs dumbbells
Seated shoulder flexion, abduction	1lb, 2lbs dumbbells	1lbs dumbbells	2lbs dumbbells
Chest press	Orange/green/blue TB	Orange TB	Blue TB
Chest pulls	Yellow/orange/green TB	Yellow TB	Green TB

Continue....

Upright row	Yellow/orange/green TB	Yellow TB	Green TB
Overhead press	Yellow/orange/green TB	Yellow TB	Green TB
Core and Back strengthening			
Sitting back extension	Manual resistance	Minimal resistance	Moderate-Maximum resistance
Supine isometric abdominals	BW	5-sec hold time	20-sec hold time
Bridging	BW	AAROM	Bridging with pillow in between, single leg bridging
Half-abdominal crunch	BW	Neck off/upper scapula off surface	Scapula off the surface
Trunk rotation	BW	AAROM	AROM
Pelvic tilts	BW	10 reps/set, 1 set	10 reps/set, 3sets
Pelvic tilts with knee fall-outs	BW	AAROM	AROM with isometric control
Mini-squats/ Squats	BW	10 reps/set, 1 set	15 reps/set, 3 sets

Ambulation was performed using a front wheeled walker and stand-by assistance from the therapist. Gait training doubled as a functional endurance exercise. Depending on the patient's tolerance, ambulation distance was gradually increased in each visit and obstacle negotiation was implemented.

Therapeutic activity, focusing on functional balance training, was introduced in the third week of the plan of care. Therapeutic activities included stepping exercises to the side, and backwards, standing on 1 to 3" foam pads and on a 6- inch step while incorporating reaching in all directions. The patient required the support of a front wheeled walker as well as assistance of her spouse and the therapist for these functional activities.

Result

Throughout the plan of care, the patient showed gains in her strength and endurance. She demonstrated improvement in bed mobility and was able to roll independently in bed. However, she still required minimal to contact guard assistance for supine to sit transfers in bed. She was able to rise from a chair and perform bed to chair transfers using the rolling walker independently. Although she ambulated with a slow gait and increased double support time, the patient showed improvement in her endurance and ability to ambulate up to 180 ft before needing to sit down to rest. The patient continued to have episodes of loss of balance while ambulating therefore it was decided that she would continue to use her rolling walker for ambulation. She was able to negotiate a flight of 12 steps using 1 handrail independently.

The TUG which was originally validated in older adults has a sensitivity of 80% to predict falls with a cut-off score of greater than 13.5 seconds and specificity of 100%[16]. Although it is not tested in 30-year-old patients or in PM, it is a valuable tool for mobility assessment and to predict risk for falls. The patient's score of 29 seconds was above the normative value of 8.56 seconds in 30-year-old individuals indicating reduced physical capacity[17]. Upon discharge, the patient had a moderate improvement with a score of 23 seconds. Additionally, the patient showed greater improvement in the 2-MWT. She was able to ambulate for 96meters at the time of discharge. Despite not being directly addressed using modalities, the patient showed a reduction in her self-reported pain score.

For the SF-36 questionnaire, upon final evaluation the patient showed gains in all the domains; on physical functioning 55/100, on role limitations due to physical health 75/100, on role limitations due to emotional problems 100/100, on fatigue 55/100, on emotional well-being 84/100, on social functioning 75/100, on pain 90/100, on general health 50/100.

Additional details of patient's outcomes are listed in Table 2.

Table 2. Outcomes measures

Outcome	Initial evaluation	Discharge
TUG	29 seconds	23 seconds
2-MWT	50 meters	96 meters
Single leg stance	Unable to maintain position	Unable to maintain position
Pain	4/10	2-3/10

Discussion

The goal of this study was to describe physical therapy management of an otherwise healthy patient diagnosed with polymyositis after vaccination. The therapeutic approach yielded notable improvements in the patient's functional capacity and quality of life. The patient demonstrated improvement in lower extremity strength and endurance. Additionally, the patient's upper extremity function improved as well. The patient was able to engage more independently in the activities of daily living (ADLs), such as grooming, dressing and other self-care abilities. She reported an improved tolerance for community mobility with assistance from her husband. These outcomes are consistent with physical therapy's role in the treatment of PM, as it is recognized as a crucial intervention for restoring muscle strength and function.[18]. With increased independence, she had an improved perception of emotional well-being as seen on the SF-36 scores. It can be concluded that physical therapy management is safe and effective in a case such as this.

There were limitations to this case report, mainly the patient had marginal increase in the 2-MWT and the TUG. The patient ambulated for 96 m using the rolling walker for 2-MWT which was greater than the distance ambulated during initial evaluation. It was however, still below the mean distance of 183m calculated for women in the same age group[19]. The difference was still slightly greater than 33.4 meters which is the minimal detectable change required for clinical improvement. The patient continued to have balance impairments as evidenced on the balance test. 4-stage balance test has a specificity of 76% and the patient was unable to maintain single-leg stance for a duration of 5 seconds indicative of increased risk for falls[20]. The patient did improve by a marginal score of 6 seconds in the TUG test. It is considered a valid tool for predicting risk for falls when combined with other balance measures. Results of the TUG and 4-stage balance test put the patient at risk for falls.

Interventions consisting of targeted strength and balance exercises and incorporating pain management strategies could have been used to improve the outcome. Additionally, stressing the importance of adherence to the exercise program in a home-health setting would have been beneficial. Another limitation was the lack of inter-disciplinary approach to the care of the patient. She could have benefitted from respiratory therapy management to improve the function of respiratory musculature as these are commonly affected with PM. Additionally, referral for dietician interventions could have assisted the patient with improving her general well-being.

Several studies have shown the importance of early diagnosis and management of PM. A study done by Malik, et al[1] focused on a tailored clinical approach with the use of corticosteroids and immunotherapy for disease control. In terms of rehabilitation, a systematic review done by Corrado, et al[9] stressed the importance of supervised physiotherapy to improve functional mobility in patients with PM. This was also supported by a study done by Alexanderson, et al[10] in which home based exercise programs improved functional ability in patients with PM.

Vaccines are a boon to humanity with some of them being able to eradicate diseases completely but they have also been identified as a potential trigger for autoimmune and inflammatory responses,

including myositis. Orbach and Tanay[4] noted that vaccines, particularly the flu vaccine, have been associated with the onset of myositis in susceptible individuals. Covid-19 vaccination has seen a moderate increase in number of inflammatory myopathies[21.] More recently, Jara et al.[7] reviewed autoimmune syndromes following COVID-19 vaccination, with some cases reporting inflammatory myopathies, such as polymyositis. This aligns with the observations in the present study, which found a temporal link between COVID-19 vaccination and the onset of myositis in a subset of patients. A study byVojdani and Kharrazian[22] mentioned the possibility of an auto-immune reaction due to the similar structural properties between spike protein in a vaccine and the host protein. It is important for clinicians to take that into consideration when encountering a patient with clinical symptoms of polymyositis post vaccination for a viral disease.

Conclusion

This case report highlights the value of appropriately directed physical therapy care for a patient with vaccine induced PM. It is important for all patients to have a plan of care that's unique to them and their functional needs and goals. This case report also emphasizes the importance of additional research for physical therapy protocols for vaccine induced polymyositis. Future investigations should also aim to evaluate the long-term effects of physical therapy interventions in this patient population.

Conflict of Interest: None

Source of Funding: Self

Ethical Clearance. This case report was reviewed under the MedStar Health Research Institute (MHRI) guidelines and was determined not to constitute human subject's research. According to the August 1, 2017 memo from the MHRI Office of Research Integrity, case reports involving fewer than three patients do not meet the Department of Health and Human Services (DHHS) or Food and Drug Administration (FDA) definitions of research and are therefore exempt from Institutional Review Board (IRB) review and approval. The report was prepared in compliance with HIPAA guidelines. No identifiable patient information is included, and IRB exemption applies per MedStar policy.

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Case Study

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Delayed Post-Traumatic Lymphedema Following Misdiagnosed Navicular Fracture in a Diabetic Patient: A Case Report

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Abstract

Background: Isolated fractures of the tarsal navicular bone are rare and often overlooked due to their subtle presentation. While typically resulting from high-energy trauma, these fractures can be misdiagnosed as soft tissue injuries, leading to delayed treatment and potential long-term complications. One such complication, post-traumatic lymphatic obstruction, is extremely uncommon and poorly understood. This case highlights a unique presentation characterized by a delayed onset of secondary lymphedema occurring approximately four years after the initial injuryin a patient with diabetes mellitus. Unlike most reported cases, this patient developed lymphatic dysfunction without prior surgery, high-energy trauma, or acute post-injury edema.

Methods: A 35-year-old female with a history of diabetes mellitus presented with progressive swelling, warmth, and erythema in the left lower limb, five years after sustaining a foot injury initially diagnosed as an ankle sprain. Clinical examination and imaging were performed to evaluate the cause of persistent edema. Doppler ultrasound excluded deep vein thrombosis, while magnetic resonance imaging revealed navicular bone fragmentation, surrounding edema, and Achilles tendinopathy. Lymphoscintigraphy was used to assess lymphatic function and demonstrated obstructed lymphatic drainage in the affected limb. Based on these findings, a diagnosis of secondary lymphedema secondary to post-traumatic lymphatic dysfunction was established.

Conclusion: This case underscores the importance of considering lymphatic disruption as a differential diagnosis in patients with unresolved lower extremity swelling following trauma, particularly when other common causes have been ruled out. Chronic inflammation, delayed diagnosis, and underlying comorbidities such as diabetes may contribute to lymphatic dysfunction. Early identification and multidisciplinary management,including physical therapy, compression therapy, and surgical consultation, when necessary,are essential to prevent chronic lymphedema and functional impairment. Clinicians should maintain a high index of suspicion for secondary lymphedema in similar cases to improve long-term outcomes.

Keywords: Navicular fracture, Post-traumatic lymphedema, Secondary lymphatic obstruction, Chronic lower limb swelling, Diabetes mellitus.

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Introduction

Isolated navicular fractures, often resulting from significant impact, can be associated with other injuries due to the severity and mechanism of the injury[1]. These fractures are rare and typically result from high-energy trauma[2]. Because of their subtle clinical presentation, navicular fractures are frequently misdiagnosed as mid-foot sprains, leading to delays in appropriate treatment[3]. A forceful twisting motion of the foot and ankle, specifically involving plantar flexion with excessive inversion or eversion, is the mechanism of injury, similar to that of ankle sprains[3]. Chronic edema frequently develops following mechanical injury to the soft tissues and bones of the lower extremity, affecting both the site of trauma and distal areas[4]. Post-traumatic edema can result from lymphatic obstruction, deep venous thrombosis (DVT), or increased activity of growth factors and cytokines at the site of injury[4]. Compromised venous and lymphatic drainage, often associated with limb edema, predisposes to infections[5]. Secondary lymphedema, a specific form of lymphatic dysfunction, develops due to damage or impairment of the normally functioning lymphatic system[6]. Lymphatic obstruction following an isolated navicular fracture is an uncommon and underrecognized complication. Particularly in the absence of contributory factors such as DVT, its occurrence remains rarely documented in the clinical literature. This paucity of documented evidence highlights a significant gap in current understanding regarding post-traumatic lymphatic complications. We report the case of a working woman who developed lymphatic obstruction subsequent to an isolated tarsal navicular fracture. This case draws attention to the need for clinicians to consider lymphatic dysfunction in the differential diagnosis of persistent lower extremity swelling after trauma, especially when conventional causes have been ruled out.

Case Presentation

A 35-year-old female presented to the clinic with a chief complaint of right ankle pain, swelling, and redness. Her medical history is significant for diabetes mellitus managed with oral medication. No other relevant medical conditions were identified. Her family history is unknown. Her body weight at presentation was 68 kg.

She reported a right ankle injury sustained 5 years prior at work when she twisted her right ankle after stepping on an uneven surface while wearing a normal work shoe. She was initially treated conservatively for a presumed mild ankle sprain, consisting of rest from activity, an ankle brace, analgesics, and topical ointments.

Approximately one year before this presentation (4 years after the initial ankle injury), in March 2024, she began experiencing severe swelling, warmth (hot to the touch), and red discoloration at the distal right leg and dorsal aspect of the right foot, accompanied by tenderness in the right calf muscle. The tenderness was located in the lower right calf and was rated 5 out of 10 in intensity. It was described as a dull ache, elicited only with palpation.

She also reported pain with weight-bearing, with the swelling noted to increase with activity, such as walking and standing. She also reported difficulty standing on the affected leg. No specific contributing factors were identified at this time.

Clinical Findings

A physical examination revealed tenderness at the midportion of the Achilles tendon, and a positive Arc Sign test suggested Achilles tendinopathy. There was moderate (++) non-pitting edema at the medial malleolus, dorsum of the foot, and distal leg, extending approximately 10 cm proximal to the malleolus. The edema was firm to palpation. The affected area was warm to the touch and diffuse erythematous (red), with no evidence of skin breakdown or ulceration. Capillary refill was normal. Active dorsiflexion of the right ankle was reduced to 20 degrees, while plantarflexion, inversion, and eversion were within normal limits, although some discomfort was noted with forced plantarflexion. The skin was dry, and no lymphadenopathy was noted. Manual muscle testing using the Oxford scale revealed the following muscle strength: right

ankle dorsi flexors and plantar flexors 4/5, left ankle dorsiflexors and plantar flexors 5/5. She had difficulty performing a single leg hop on the affected leg and demonstrated an antalgic gait, favoring the right leg. Neurovascular examination of the right lower extremity was unremarkable, with palpable pulses and intact sensation.

Diagnostic Assessment

A Doppler ultrasound of the right lower limb, performed on 06 March 2024, ruled out deep vein thrombosis (DVT). MRI of the right ankle, conducted on 24 November 2024, confirmed bony fragmentation of the dorsal aspect of the tarsal navicular bone, a sequela of the previous injury. Severe subcutaneous edema was noted in the distal leg and dorsum of the foot, along with Kager's fat pad edema and minimal distal Achilles tendinopathy, also related to the previous injury. All surrounding ligaments were well-preserved Figure 1. Lymphoscintigraphy, performed on 30 December 2024, demonstrated obstructed lymphatic drainage in the right lower limb, without evidence of radionuclide migration through discrete lymphatic vessels Figure 2. The full chronological timeline of the injury, symptom progression, and diagnostic assessments is summarized in Table 1.

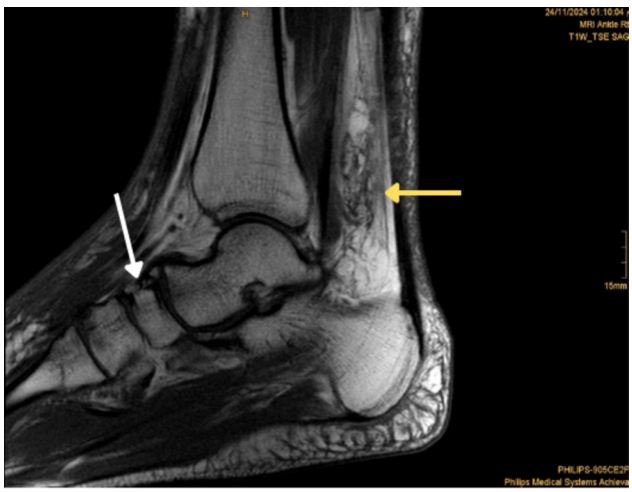

Figure 1: MRI of the right ankle showing bony fragmentation of the dorsal aspect of the tarsal navicular bone (white arrow), with associated subcutaneous edema and Kager's fat pad involvement (yellow arrow).

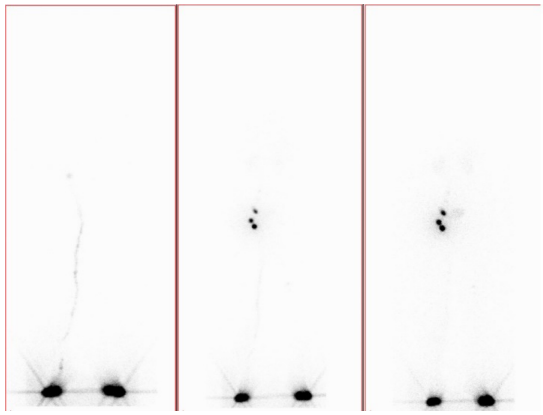

Figure 2: Lymphoscintigraphy image of the right lower limb demonstrating obstructed lymphatic drainage. No discrete lymphatic channels or proximal radionuclide migration is visible, indicating lymphatic dysfunction.

Table 1. Chronological Timeline of Injury, Symptom Onset, and Diagnostic Procedures.

Date	Event
23/01/2020	Right ankle injury sustained at work (5 years prior to presentation)
24/01/2020	Initial treatment: Rest and crepe bandage for 3 weeks
March 2024	Onset of severe swelling, warmth, red discoloration, and calf tenderness
06 /03/ 2024	Doppler ultrasound of right lower limb (ruled out DVT)
24 Nov 2024	MRI of right ankle confirmed bony fragmentation, edema, tendinopathy
30 Dec 2024	Lymphoscintigraphy (demonstrated obstructed lymphatic drainage)
23/01/2025	Presentation to the clinic with a chief complaint of ankle pain, swelling, redness

Discussion

This case highlights a rare and unique presentation of post-traumatic lymphatic obstruction following an isolated navicular fracture. What

distinguishes this case from previously reported ones is the notably delayed onset of lymphatic dysfunction, occurring several years after the initial injury, rather than an immediate or early post-traumatic complication. While fractures of the tarsal navicular bone are uncommon and typically result from high-energy trauma, their subtle presentation often leads to misdiagnosis, resulting in prolonged complications[7]. In this patient, the initial misdiagnosis of an ankle sprain delayed appropriate intervention, potentially contributing to the subsequent development of chronic lymphatic dysfunction.

Post-traumatic edema following lower limb injuries is well documented and is usually attributed to venous insufficiency, inflammatory responses, or direct damage to the lymphatic system[8, 9]. In this case, DVT was ruled out via Doppler ultrasound, suggesting an alternative mechanism of fluid accumulation. Lymphoscintigraphy, a nuclear medicine imaging technique that involves injecting a radioactive tracer to visualize lymphatic vessel function and drainage patterns, confirmed obstructed lymphatic drainage in the affected limb. This method allows for the assessment of lymphatic flow and identification of blockages or dysfunction. A key aspect of this case is the delayed onset of significant swelling, warmth, and erythema emerging years after the initial injury specifically, approximately four years post-injury. This delayed presentation suggests a progressive disruption of lymphatic function rather than an immediate post-traumatic response. Chronic inflammation and tissue remodeling likely played a role in exacerbating lymphatic dysfunction over time. Additionally, the presence of Achilles tendinopathy and Kager's fat pad edema on MRI suggests ongoing mechanical stress and localized inflammation, further complicating the clinical picture.

The potential role of diabetes mellitus as a contributing factor cannot be overlooked. Diabetes is associated with microvascular dysfunction, impaired wound healing, and increased susceptibility to chronic inflammation[10–12], all of which may predispose patients to lymphatic complications[10–13]. Although the patient's diabetes was managed with oral medication, its influence on lymphatic drainage remains a possibility that warrants further investigation.

The clinical implications of lymphatic obstruction following lower limb fractures extend beyond localized swelling, potentially leading to chronic lymphedema, delayed wound healing, increased risk of infection, and long-term functional impairment[14]. Early identification and management are crucial to improving patient outcomes[15]. This case underscores the importance of considering secondary lymphedema in patients with persistent post-traumatic swelling, particularly when standard causes such as DVT have been excluded.

Treatment strategies for post-traumatic lymphedema focus on symptom management and functional rehabilitation[16]. Compression therapy, manual lymphatic drainage, and structured exercise programs can help reduce swelling and prevent complications[16]. Physiotherapy plays a critical role by providing tailored exercise regimens to improve lymphatic flow, restore limb function, and prevent joint stiffness and muscle weakness. Occupational therapy complements this by assisting patients in adapting daily activities to accommodate swelling and pain, promoting limb protection, and enhancing quality of life through ergonomic interventions and self-management education. These multidisciplinary rehabilitation approaches are essential to optimize recovery and prevent long-term disability.

In cases where conservative management is insufficient, surgical options such as lymphatic bypass procedures or vascularized lymph node transfers may be considered[17,18].

Conclusion

This case report presents a rare instance of post-traumatic lymphatic obstruction following an isolated navicular fracturean underrecognized complication with significant clinical implications. The delayed onset of lymphatic dysfunction, confirmed via lymphoscintigraphy, suggests a progressive, rather than immediate, disruption of lymphatic drainage mechanisms likely

exacerbated by chronic inflammation, localized tissue remodeling, and comorbid factors such as diabetes mellitus.

The novelty of this report lies in its documentation of lymphatic impairment in the absence of more commonly associated factors like deep vein thrombosis or prior surgery, drawing attention to subtle and delayed sequelae of seemingly minor trauma. The findings highlight the importance of considering lymphatic dysfunction in the differential diagnosis of persistent lower extremity swelling, particularly when conventional causes have been excluded.

Although this report is limited by its single-patient focus and lack of long-term follow-up, it underscores the need for heightened clinical awareness and early diagnostic imaging in similar cases. Further research is warranted to establish the incidence of post-traumatic lymphatic complications following midfoot fractures and to evaluate the influence of factors such as sex, age, and metabolic conditions on lymphatic recovery. This case also raises considerations for interdisciplinary management protocols, integrating lymphatic rehabilitation strategies early in post-injury care.

By linking persistent edema to lymphatic obstruction in the context of a seemingly isolated fracture, this report bridges a critical gap in trauma-related lymphatic research and emphasizes the value of holistic patient assessment beyond initial orthopaedic recovery.

This case underscores the critical need for early imaging and consideration of lymphatic injury in patients with unresolved lower limb swelling following trauma, even when initial symptoms appear minor.

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Case Study

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Home-based Physical Therapy Following Tricuspid Valve Repair (TriClip): A Case Study

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Abstract

Background and Purpose: This case study describes the home-based physical therapy rehabilitation of a patient following a novel, less invasive tricuspid valve repair surgery using a TriClip system.

Case Description: The patient is an 82 years old female presenting with heart failure secondary to tricuspid regurgitation and underwent successful TriClip implantation. She was discharged home 2 days after surgery with a home health physical therapy referral.

Intervention: A comprehensive home health physical therapy program consisting of progressive exercises, patient education, strength, balance, and endurance training was implemented.

Outcomes: Improvement was noted in patient outcome measures including 2 min walk test, Timed Up and Go (TUG), 2 min step test on discharge as compared to the initial assessment. It demonstrated the positive impact of home-based physical therapy on a patient's participation in activities of daily living following TriClip implantation.

Discussion: With a reduction in the number of days in the hospital and the popularization of less invasive surgeries, early intervention with home-based health physical therapy is crucial for optimizing functional outcomes and patient recovery. This case study suggests the importance of tailored rehabilitation in this patient population.

Keywords: Physical therapy, TriClip, Heart Failure, Home health therapy, Rehabilitation, Case study.

Background/Purpose

Tricuspid valve disease, primarily Tricuspid Regurgitation(TR), is a widespread condition that has a complex pathophysiology. It has been one of the leading causes of heart failure (HF) and mortality in recent years [1]. In this case the patient's TR was likely secondary to cardiomyopathy and chronic atrial fibrillation. TR can have a significant impact in a patient's life as it can lead to mild to severe HF [2]. Severe TR can lead to right ventricular dysfunction by exacerbating HF symptoms, creating a vicious cycle [3]. Current clinical practical guidelines (CPGs) for HF lack specific recommendations for managing patients with significant TR, representing a clinical gap in clinical practice.

New minimally invasive techniques have been developed and studied over the last decade. Transcatheter Tricuspid Valve Intervention (TTVI)

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using coaptation devices, such as TriClip, MitraClip and PASCAL have gained popularity in the recent years [2]. A 2024 systematic review conducted on these three devices showed Triclip to be superior in treating patients suffering from severe TR [4].

Studies conducted by Kitamura et al, showed improvement in quality of life and functional capacity post TTVI. In this study a 36 item short form health survey (SF-36) and Minnesota Living with heart failure questionnaire (MLHFQ) were evaluated at baseline and 1 month follow up visits. It concluded correlation with reduction in TR with improvement in MLHFQ and SF-36 scores [5]. There are limited studies to evaluate the impact of structured physical therapy rehabilitation protocols, especially in home settings. This study aims to address this gap by exploring if a structured home-based physical therapy program improves recovery after a TriClip procedure in patients with severe TR.

Patient Profile

Patient is 82 y.o. overweight female (BMI: 26) residing in a two-level private home with her husband. She has been using a front wheel walker for her mobility due to weakness and fatigue since the past 2 years. While no steps are required for home entry, the patient requires stairs to reach the bedroom. Patient had been suffering from severe HF symptoms for the past 2 years and her symptoms had progressively worsened over the last few months. Her symptoms included shortness of breath when performing ADLS like walking, stair climbing, dressing and showering. She also had increased swelling in bilateral ankle and feet along with weakness.

Patient was referred for home health physical therapy following correction of tricuspid regurgitation using TTVI procedure using TRiclip coalition.

Past Medical History: Atrial fibrillation, type 2 diabetes, cardiomyopathy, valvular heart disease (severe TR).

This patient was further considered unstable, as evidenced by the knowledge deficit related to medications, safety, infection, and wound care. Physical therapy was required for gait training, endurance training, and muscle strengthening.

Prior Level of Function: Patient had increased swelling in her feet and reduced endurance. She had difficulty going up the stairs to her bedroom and had been sleeping in the living room for 3 months.

Patient Goals

1. Patient wants to be able to climb stairs independently to be able to sleep in her bedroom.
2. Patient wants to get back to walking longer distances without any assistive devices.
3. Patient wants to get back to participating in all her Activities of Daily LIving (ADL) independently without fatiguing.

Timelines of significant events are depicted in the table below.

Table 1. Significant events

Day	Events
0	TTVI using TriCLip for TR.
3	Discharged home with PT referral
4	PT evaluation
16	PT reevaluation
30	Home health PT discharge, referred to cardiac rehabilitation.

Clinical Findings

The patient underwent home health physical therapy assessment on day 3 post-surgery. As per the physical therapy assessment, the patient appeared to require assistance for most of her ADLs. She required help performing tasks like dressing, showering, and getting on and off the toilet. Patient was able to walk 120 ft using a walker and required a rest break after that. She had an antalgic gait pattern due to slight pain around the surgical site.

Vitals within normal limits (WNL) pre physical therapy evaluation: BP 126/78 mmHg, HR 72 bpm, RR 14 breaths/min, SpO2 98% on room air. Patient

has reduced strength in bilateral lower and upper extremity muscles of 4-/5.

She reported a 2/10 pain in her groin area along the surgical site while walking. She required minimal assistance (minA) to get up from her recliner because of soreness at the surgical site.

The patient required Contact Guard Assistance (CGA) and a walker for ambulation with cues to lift the legs higher while walking and standing straight.

She had a Timed Up and Go (TUG) score of 48 seconds (Normal value < 13.5sec) using a front-wheeled walker (FWW), putting her at a high risk of falls [6]. The patient was able to walk for 2 min inside the house using a walker covering a distance of 120 feet, with a modified Rate of Perceived Exertion (mRPE) score of 6/10 (hard) [7].

Vitals WNL post physical therapy evaluation: BP 132/82 mmHg, HR 82 bpm, RR 16 breaths/min, SpO2 99% on room air.

Objective measurements during initial assessment and patient centric goals are depicted in Table 2.

Table 2. Objective measurements and goals.

Objective Measurement	Impairment	Clinical Reasoning	Goals
2min walk test	Patient was able to tolerate walking for 120ft in 2 mins using a walker and CGA, mRPE 6/10, SpO2>90%	To assess for exercise capacity and functional endurance when performing ADLs[6].	Patient will be able to walk for 300ft in 2 mins with or without an AD with mRPE<2/10 to be able to walk to the car without getting tired.
Transfers	Patient required minA for her transfer from the recliner	Required assistance due to slight pain in the surgical site.	Patient will be able to perform transfers Independently in 1-2 weeks
TUG test	28 seconds	Indicated patient being at risk of falls based on her age[7].	Patient will be able to perform a TUG test in <14 seconds in 4 weeks.
Stairs	Unable to perform during Initial assessment	To be able to maneuver 12 stairs and get to her bedroom.	Patient will be able to walk up 12 steps Independently with mRPE<4/10 at the end of 4 weeks.
2 min step test	Tested on Week 2 (reassessment) 46 reps, mRPE:5/10	To assess for aerobic capacity [8].	Patient will be able to perform >60 reps with mRPE <4/10 to show improved aerobic capacity based on her age

Keywords: CGA, contact guard assistance; mRPE, modified rate of perceived exertion; AD: Assistive device; TUG: Timed up-and-go.

Physical Therapy Intervention

Patient received home health physical therapy 2 times a week for 4 weeks to address the above mentioned deficits following a TTVI surgery.

After the initial assessment, the patient and the PT worked collectively to set goals, focusing on the following:

1. Improving strength and mobility allowing her to partake in her ADLs.
2. Increase walking distance and walking without any assistive device.
3. Improving balance and endurance so that she could climb stairs and sleep in her bedroom.

All therapy sessions monitored the signs and symptoms of HF, as shown in Table 3 [3.] Vitals, pain and mRPE were checked pre, mid and post exercises each session.

Table 3. Definitions of Zone Colors Associated With Clinical Manifestations and Physical Therapist Recommendations.

Zone Color	Signs and Symptoms	Physical Therapist Recommendations
Green zone	• No shortness of breath • No swelling • No weight gain • No chest pain • No decrease in your ability to maintain your activity level	Continue activity and therapy as tolerated.
Yellow zone	• Weight gain of 2–3 lbs in 24 hrs • Increased cough • Peripheral edema: increased distal extremity swelling • Increase in shortness of breath with activity • Orthopnea: increase in the number of pillows needed	Symptoms may indicate an adjustment in medications and therefore warrants communication with the physician
Red zone	• Shortness of breath at rest • Unrelieved chest pain • Wheezing or chest tightness at rest • Paroxysmal nocturnal dyspnea: requiring to sit in chair to sleep • Weight gain or loss of more than 5 lbs in 3 days • Confusion	Symptoms indicate overt decompensation and an immediate visit to the emergency department or physician office.

Adapted from Shoemaker, M. J., Dias, K. J., Lefebvre, K. M., Heick, J. D., Collins, S. M. (2020). Physical therapist's clinical practice guidelines for the management of individuals with heart failure. *Physical therapy*, *100*(1), 14-43 [3.]

Strengthening

Gentle ROM exercises progressed to isotonic exercises, followed by progressive resistance exercises as tolerated. Exercises were initiated with 10 reps and 3 sets and progressed as tolerated up to 20 reps x 3 sets using resistance bands or weight bearing exercises. Exercises included:

In sitting position: ankle pumps, hip abduction, long arc quadriceps, sit to stands.

Standing position: heel raises, marching, hip abduction, hip extension, mini squats. All standing exercises were performed at the kitchen sink for safety. A Home Exercises Program (HEP) was given in the first session, and was updated each session.

Patient was advised to perform all exercises 3 times a day as tolerated.

Gait Training

Patient was able to walk using a walker for the first 2 weeks, and then slowly progressed to walking with the cane for a week followed by walking without any assistive device safely and independently. Gait training involved working on pre-gait activities like static standing balance, weight shifts, standing marching. Patient required cues to lift legs higher and to be closer to the walker while walking to improve gait pattern. The patient was able to participate in stair climbing progressively from 2 to 12 steps. She was able to meet her goal of sleeping upstairs in her bedroom by the end of three weeks. This was a facilitator in further motivating the patient and boosting her confidence to meet the remaining goals established in the plan of care.

Endurance

Exercises in sitting and standing progressed slowly, as tolerated, with increasing repetitions and time. Exercises progressed from seated marching x 1 min to standing marching x 2 mins on discharge. Initial two weeks of therapy focused on improving exercise tolerance. On the 2nd week reassessment, she was able to participate in 2 min step test after demonstration and cuing with a score of 46 reps and mRPE of 6/10 (N>or=60)[8].

The walking time was increased progressively from 2 to 10 min at discharge. All exercises were performed according to HF guidelines monitoring the mRPE scale.

Patient was educated regarding activity pacing and was advised to participate in all exercises and activities accordingly.

Follow up and Patient Outcomes

Patient showed steady improvement towards all her goals with Physical Therapy interventions. No complications were noted, and the patient was able to participate regularly in all her home exercises.

A detailed description of the outcome measures at the initial assessment, reassessment, and discharge is depicted in Table 4.

Table 4. Summary of outcome measures at different stages of rehabilitation.

Objective tests	Initial Assessment	Re-Assessment (2 weeks)	Discharge (4 weeks)
2min walk test	120ft	220ft	300ft
TUG test	28 seconds	18 seconds	12 seconds
Transfers	min A	SBA	Independent
Gait	CGA with FWW	SBA with Cane	Independent w/o AD
2 min step test	Not tested	46reps mRPE:6/10	62 reps,mRPE:5/10

Keywords: TUG, timed up and go; minA, minimum assistance; SBA, standby assistance; CGA, contact guard assistance; FWW, front wheel walker; AD, assistive device; mRPE, modified rate of perceived exertion.

Functional tests like transfers and gait were assessed at all three periods which showed progressive improvement. Patient required minA to get up from her recliner initially and was able to stand up from all surfaces independently. She was independent with all ADLs and was able to walk without any AD. Objective measures like 2 min walk test which was done to assess for functional capacity showed progressive improvement over each session with her being able to walk for 300 ft from 120 ft during the initial assessment showing improvement in functional capacity [9].

Patient was able to complete her TUG test in less than 12 seconds by discharge putting her at low risk of falls [10].

She was able to participate in a 2 min step test only after 2 weeks during the reassessment where she could perform 46 reps with a mRPE score of 6/10. By the time of the discharge the patient had improved endurance and could perform 62 reps and a mRPE of 5/10. This test score shows improvement in her aerobic capacity [11].

The patient mentioned feeling "her best self" since the past 3 years on discharge and updated her goals to get back to hiking. She was advised to have a follow-up visit with her cardiologist and to continue her rehabilitation with a cardiac rehabilitation program.

Discussion

The case study highlights improvement in her functional activity participation and overall quality of life after home health PT following TTIV with TriCLiP. The patient's improvement in ambulation, stair climbing and ADL independence signifies the importance of early PT intervention. The significant functional improvement aligns with previous studies which have shown improvement in quality of life of patients after TTIV surgery [5].

This case study contributes to the literature by demonstrating the effectiveness and feasibility of a structured home-based physical therapy program.

The length of hospital stay has reduced considerably over the past decade [12]. With new interventions and less invasive surgeries, the FWWlength of hospital stay is bound to be reduced even further. Early home based therapy as demonstrated in this case study is becoming crucial for optimal recovery.

Home health physical therapy is a unique branch of PT in which care is provided in the patient's own environment. Postsurgical education, care, environmental modifications, and rehabilitation are some of the most important factors to consider in improving overall patient outcomes. Studies have shown that patients have fewer instances of rehospitalizations and improved overall results after receiving physical rehabilitation after hospitalization for heart failure [13].

Future research to develop standardized rehabilitation protocol for patients undergoing Triclip procedure and to evaluate for long-term impact of home health PT on quality of life and functional outcomes is warranted.

Conclusion

This study contributes valuable evidence supporting the efficiency of early home based rehabilitation following TTIV with TRiClip procedure. It shows how a structured home based physical therapy program has a positive impact on a patients quality of life and functional recovery. Future research to develop standardized rehabilitation protocols for patients undergoing Triclip procedure is warranted.

Declaration of Patient Consent

The authors certify that they obtained all appropriate patient consent forms. In this form, the patient provided consent for her clinical information to be reported in the journal. The patient understands that her name and initials will not be published, and due efforts will be made to conceal her identity; however, anonymity cannot be guaranteed.

Conflict of Interest: There is no conflict of interest.

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Review Article

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A Systematic Review and Meta-Analysis to Study the Effectiveness of Hand-Arm Bimanual Intensive Therapy Including Lower Extremities in Children with Cerebral Palsy

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Abstract

Background: Cerebral palsy (CP) is the most common pediatric motor disorder caused by atypical brain development, especially affecting pathways controlling skilled movements. Motor impairments in CP significantly impact daily activities due to reduced manual abilities and gross motor function, affecting quality of life and participation. Hand-arm bimanual intensive therapy with lower extremity (HABIT-ILE) is an intensive intervention designed for children with unilateral CP. It integrates bimanual training with postural control and lower-extremity function, based on motor learning principles to induce practice-driven brain changes.

Objectives: To evaluate the effectiveness of HABIT-ILE in improving upper and lower extremity motor functions in children with CP.

Methods: A systematic review and meta-analysis were conducted following PRISMA-2020 guidelines. Four databases were searched for studies involving children aged 1-18 years. Risk of bias was assessed using Cochrane tools. Effect sizes were analyzed using forest plots, with heterogeneity assessed by tau-squared, chi-square, and I-squared statistics.

Results: Six studies (3 RCTs, 3 non-randomized) met criteria. Meta-analysis revealed significant heterogeneity. Overall effect sizes favored conventional treatments over HABIT-ILE for both upper and lower extremities. Subgroup analyses showed consistent results.

Conclusion: Despite heterogeneity, findings favor conventional treatments. Further research is needed to explore heterogeneity and validate HABIT-ILE's effectiveness.

Keywords: "HABIT-ILE", "Cerebral palsy", "Bimanual intensive therapy" "Upper Extremity Function", "Lower Extremity Function".

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Introduction

Cerebral palsy (CP) is a group of conditions characterized by motor dysfunction due to non-progressive brain damage caused in early childhood years. CP is non-progressive in nature, inferring that the underlying damage or lesion does not worsen over time, but the symptoms can change over the individual's lifespan. It is mainly caused due to damage in the parts of brain that control movement, balance, and posture hence resulting in the development of symptoms such as stiff muscles (spasticity), poor coordination, tremors, and difficulty with balance and walking.[1]

CP is characterized by a range of deficits in sensory, motor and postural control, and muscular action coordination. These impairments are usually categorized based on the type and distribution of motor impairment. Other conditions linked to cerebral palsy (CP) include placental abruption, feto maternal hemorrhage, placental infarction, developmental brain abnormalities, cerebrovascular accident (CVA) and maternal exposure to environmental toxins.[1]

HABIT-ILE is a bimanual training approach that consistently integrates postural control and lower-extremity function. Based on the HABIT framework, HABIT-ILE was presented as a comprehensive training block that leverages motor learning principles (such as practice specificity, learning context, feedback, speed-accuracy trade-off, and learning transfer). The goal is to induce practice-induced brain changes that result from repetition, enhancing movement complexity, motivation, and reward.[2]

In HABIT-ILE, motor skill learning concepts are applied to intense training; different activities with progressively increasing difficulty must be performed continuously for several hours each day over a two-week period to stimulate both UE and LE as well as postural control. Improvements have been seen in all three domains of the International Classification of Functioning, Disability and Health, with particular emphasis on neuroplastic changes and motor function of the UE and LE.[3]

However, there remains limited consolidated evidence evaluating the overall effectiveness of HABIT-ILE in children with cerebral palsy, particularly its impact on both upper and lower extremity motor functions. Therefore, this systematic review and meta-analysis aims to synthesize available research to better understand the clinical utility of HABIT-ILE and its potential to enhance functional outcomes in children with CP.

Methods

Search Strategy

A comprehensive and systematic up to date search was conducted for articles about the effectiveness of HABIT-ILE on upper extremity and lower extremity function in children with CP.

Four databases including PubMed, Google Scholar, OT Seeker and BMC (BioMed Central) were searched. Search strategies included the title, abstract, and content of articles using the keywords "HABIT-ILE", "Cerebral palsy", "Bimanual intensive therapy", "Upper extremity function" and "Lower extremity function". Titles were screened for relevance, followed by an abstract screening where abstracts of potentially relevant studies were reviewed to determine their eligibility. When abstracts did not provide sufficient information, full texts were retrieved and examined in detail. The screening process was conducted independently by the authors, with discrepancies resolved through discussion.

Inclusion and Exclusion Criteria

Articles were included if they satisfied the following inclusion criteria: 1) Experimental studies such as Randomized controlled trials/clinical trials (RCTs), quasi-experimental studies, Retrospective studies, observational studies, qualitative studies in interest. 2) Participants needed to be diagnosed with CP and aged between 1 and 18 years old; and 3) Articles were published in English between 2014-2024. 4) Full text freely available articles. Articles were excluded if they did not assess outcomes related to upper and/or lower extremities, were Meta-analysis or systematic reviews, original

research or were in the initial stages (e.g., study protocols, commentary).

Methodological Quality Assessment

The Cochrane risk of bias assessment tools – Risk of bias assessment tool (RoB 2.0).[4] A revised tool to assess risk of bias in randomized trials and ROBINS-I[5] tool (Risk Of Bias In Non-randomized Studies - of Interventions) were used to assess risk of bias in non- randomized trials. Summary plots were generated using the ROBVIS tool developed by McGuinness and Higgins.[6] The five domains for individually randomized trials (including cross-over trials) in RoB 2.0 were: 1) Bias arising from the randomization process; 2) Bias due to deviations from intended interventions; 3) Bias due to missing outcome data 4) Bias in measurement of the outcome; 5) Bias in selection of the reported result. The possible risk-of-bias judgements as per RoB 2.0 guideline were: 1) Low risk of bias; 2) Some concerns; and 3) High risk of bias.

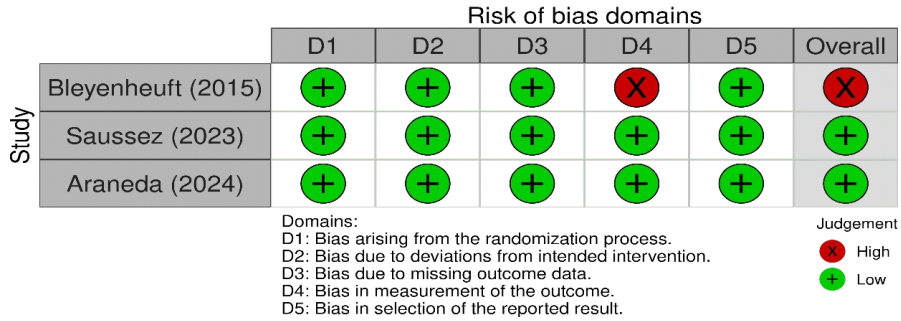


Figure 1: Risk of bias summary using RoB 2: review authors' judgements on each methodological quality item for each included RCTs (n=3) Bleyenheuft et al.[7,] Saussez et al.[11,] Araneda et al.[12]

ROBINS-I assessed quality of quasi-experimental or non- randomized trials across 7 domains:- 1) Bias due to confounding 2) Bias in selection of participants into the study 3) Bias in classification of interventions 4) Bias due to deviations from intended interventions 5) Bias due to missing data 6) Bias in measurement of outcomes 7) Bias in selection of the reported result. The response options for each domain-level RoB judgement were: Low risk of bias (the study is comparable to a well-performed randomized trial with regard to this domain); Moderate risk of bias (the study is methodologically acceptable for a non-randomized design within this domain however it cannot be equated with the rigor of a well-executed randomized controlled trial); Serious risk of bias (the study has several critical issues in this domain); Critical risk of bias (the study is too problematic in this domain to provide any useful evidence on the effects of intervention); and No information (on which to base a judgement about risk of bias for this domain). Assessment of study quality for each included study was done by two reviewers independently, and disagreements regarding study quality were resolved through discussion among the two reviewers until consensus was achieved.

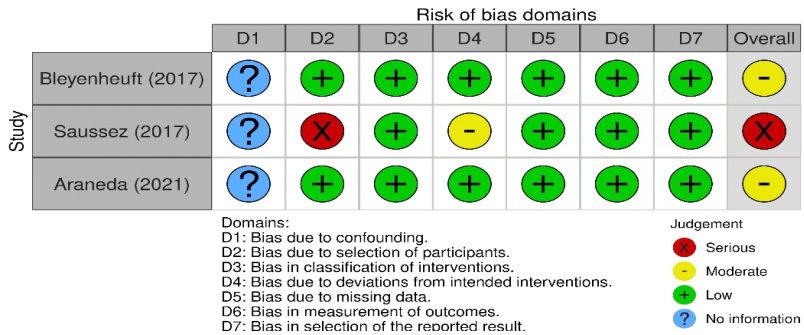


Figure 2: Risk of bias summary using ROBINS-I: review authors judgements on each methodological quality item for each included non-RCTs (n=3) Bleyenheuft et al.[8,] Saussez et al.[9,] Araneda et al.[10]

Computation of Effect Size Measures and Synthesis Method

The key effect size measures employed in this study are Hedge's g, Cohen's d, and Glass's delta, all measured with a 95% confidence interval (CI). These measures serve as essential tools in quantifying the standardized mean difference (SMD) between groups, thereby facilitating a nuanced interpretation of our study outcomes. We used multiple effect size measures as utilizing multiple effect size measures allows for a more comprehensive understanding of the magnitude and direction of effects in the study, enabling a deeper and more refined analysis of the research findings.

Small effect size: around 0.2 for Cohen's d, 0.5 for hedges' and 0.2 for glass delta. Medium effect size: around 0.5 for Cohen's d, 0.8 for hedge's g, and 0.5 for glass delta. Large effect size: around 0.8 for Cohen's d, 1.2 for hedge's g, and 0.8 for glass delta. A meta-analysis was conducted for continuous data type. The inverse- variance method and implemented a random effects model to account for heterogeneity reported comprehensively in the result section of this document. The analysis was conducted separately for two outcome domains: Upper extremity and lower extremity. Given the diverse outcome measures across included studies, 95% Confidence Intervals were calculated for each domain to provide robust estimates of effect sizes. Data were extracted from studies meeting inclusion criteria focusing on outcome measures related to upper extremity which were: AHA, ABILHAND-kids, JTTHF, BBT, PEDI, MA2, and for lower extremity were: 6MWT, ABILOCO-kids, ACTIVLIM-CP, GMFM-66. All the possible outcome measures that were common across the included studies were selected for the analysis. For analysis of upper extremity and lower extremity domains data from two outcome measures each for upper extremity and lower extremity was extracted from each study.

Heterogeneity Assessment

Heterogeneity was assessed using the following: 1) Chi-square (χ^2) Statistic. The Chi-square statistic tests the null hypothesis that there is no heterogeneity among the effect sizes of the included studies. A significant Chi-square value indicates the presence of heterogeneity. In our meta-analysis, the Chi-square value was calculated indicating heterogeneity among the studies along with p-value and degrees of freedom. 2) I^2 Statistic- The I^2 statistic indicates the proportion of overall variation among studies that is due to true heterogeneity rather than random chance. It ranges from 0% to 100%, with higher values suggesting a greater degree of heterogeneity. In our meta-analysis, the I^2 value was calculated as suggesting [low/moderate/high] heterogeneity among the included studies discussed in the results section. 3) Tau-squared (τ^2) Tau-squared represents the estimated amount of true heterogeneity variance among the effect sizes of the included studies. It provides an indication of the magnitude of between-study variance. In our meta-analysis, the Tau-squared value was calculated indicating magnitude of heterogeneity. Software and tools: Meta-analysis was conducted using JBI SUMARI software.[13]

Subgroup Analysis

Subgroup analysis is a critical component of understanding treatment effects within heterogeneous study populations. In this study, we explored the differences in treatment effects between randomized controlled trials (RCTs) and non-RCTs, elucidating potential implications for our research question regarding the effectiveness of HABIT-ILE in population with cerebral palsy. Studies were categorized into two groups based on study design: RCTs and non-RCTs. The classification of studies into these subgroups was guided by the need to assess the robustness of treatment effects across different study designs. For each subgroup, we conducted separate analyses using forest plots to visualize treatment effects. Effect size measures [standardized mean difference] were calculated and plotted along with corresponding confidence intervals illustrated and described in the result section of this study.

Results

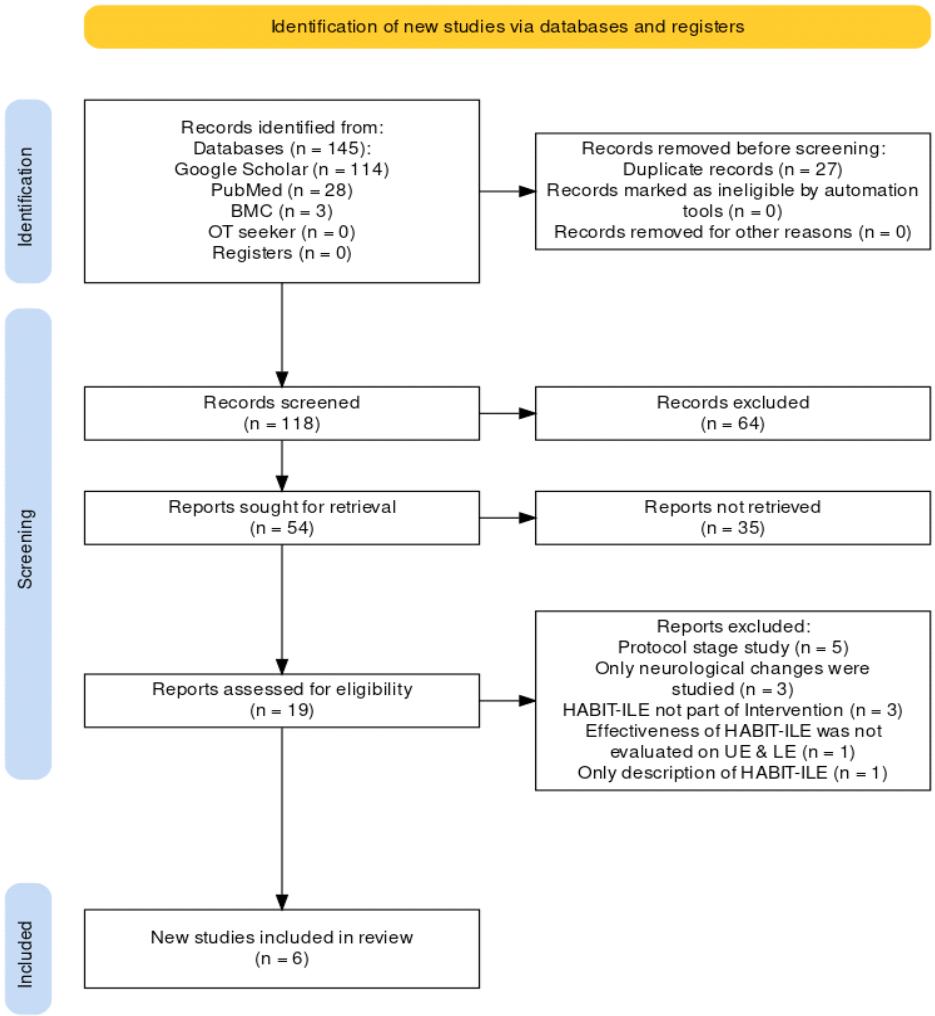


Figure 3: PRISMA flow diagram

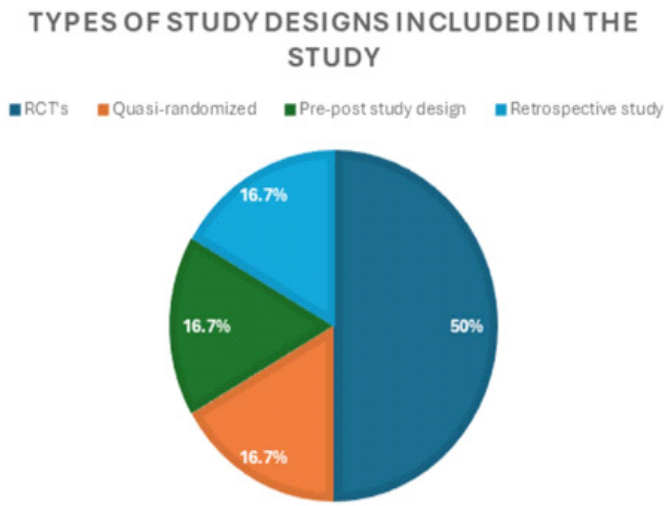
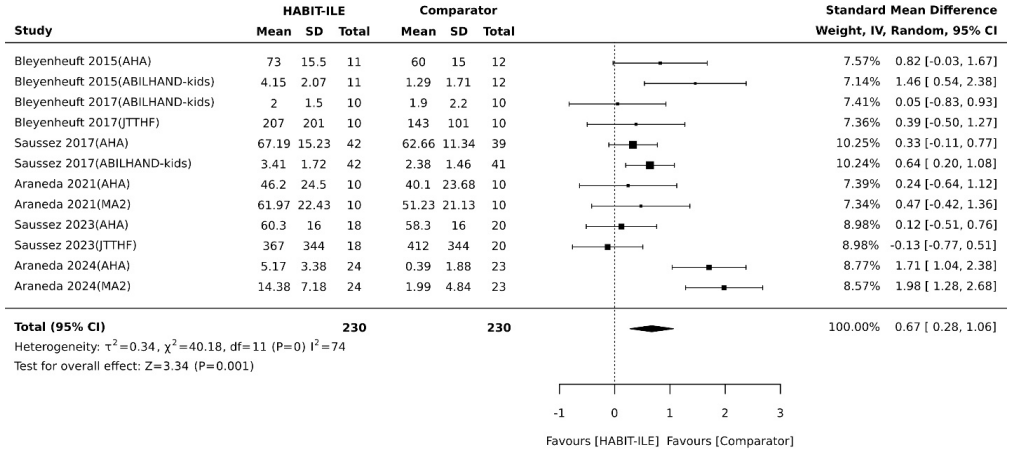


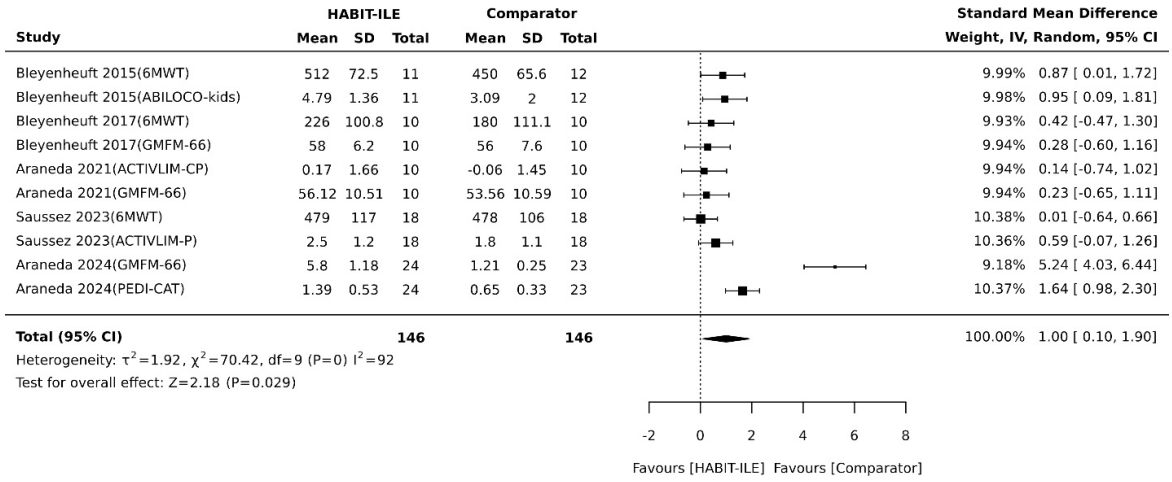
Figure 4: Types of included studies in this systematic review

Meta-analysis

A meta-analysis was conducted for continuous data type by implementing inverse-variance method and a random effects model to account for heterogeneity. The forest plot for the upper extremity domain indicates significant heterogeneity among the studies included. This is evidenced by a tau-squared (τ^2) value of 0.34, a chi-square (χ^2) test statistic of 40.18 with 11 degrees of freedom ($p < 0.001$), and an I-squared (I^2) value of 74%. Despite the observed heterogeneity, the overall effect size is statistically significant, with a Z-value of 3.34 ($p = 0.001$). The forest plot illustrates that the overall effect size, favoring the comparator group, is represented by a diamond with a random effects model yielded standardized mean difference (SMD) of 0.67, with a 95% confidence interval ranging from 0.28 to 1.06.



Graph 1: Forest plot illustrating the effect sizes of various upper extremity measures and overall effect of intervention on upper extremity measures.



Graph 2: Forest plot illustrating the effect sizes of various lower extremity measures and overall effect of intervention on lower extremity measures.

The forest plot analysis conducted for the lower extremity domain reveals substantial heterogeneity among the included studies. The tau-squared (τ^2) statistic of 1.92, along with the chi-square (χ^2) test result of 70.42 with 9 degrees of freedom ($p < 0.001$) and an I-squared (I^2) value of 92%, collectively indicate significant variability among the study results. It is important to note that one of the included

studies, *Saussez et al.*[9] did not assess lower extremity outcomes. Therefore, outcome measures of all other included studies *Bleyenheuft et al.*[7], *Bleyenheuft et al.*[8], *Araneda et al.*[10], *Saussez et al.*[11] and *Araneda et al.*[12] were pooled into forest plot. Despite this limitation, the overall effect size is statistically significant, with a Z-value of 2.18 (p = 0.029). Notably, the forest plot illustrates that the overall effect size favors the comparator group, with the diamond symbol positioned towards this group. It is important to note that the diamond touches the line of no effect on one side but does not cross it, indicating a potential effect in favor of the comparator group. The overall random effects model yielded a standardized mean difference (SMD) of 1.00, with a 95% confidence interval ranging from 0.10 to 1.90. The outcome measures used in the forest plot are provided within brackets alongside the corresponding study names.

Subgroup Analysis

The included studies were stratified into two subgroups: Randomized Controlled Trials (RCTs) and Non-Randomized Controlled Trials (non-RCTs). This division allowed for a more nuanced examination of the data, considering the potential impact of study design on the observed outcomes. The Subgroup analysis revealed the following:

- Upper Extremity Domain (RCTs Subgroup):
  - Heterogeneity: Moderate variability among studies.
  - Effect Size: Statistically significant in favor of the comparator group.
  - Overall SMD: 0.84 (95% CI: 0.17 to 1.52).
- Lower Extremity Domain (RCTs Subgroup):
  - Heterogeneity: Substantial variability.
  - Effect Size: Marginally significant, favoring the comparator group.
  - Overall SMD: 1.48 (95% CI: 0.02 to 2.94)

3. Upper Extremity Domain (Non-RCTs Subgroup):
   - Heterogeneity: Minimal variability.
   - Effect Size: Statistically significant, slightly favoring the comparator group.
   - Overall SMD: 0.42 (95% CI: 0.16 to 0.67).

Despite heterogeneity, the overall effects suggest differences between the interventions.

Discussion

Overall, 6 studies were included in this review, 3 out of which were RCTs and other 3 were non-RCTs. One of the 3 RCTs was rated as having a high risk of bias. This review included 6 studies based on eligibility criteria examining the effectiveness of HABIT-ILE intervention across all included studies. Among the included studies, HABIT-ILE was mostly for children with unilateral spastic cerebral palsy (USCP) for at least 5 hours a day, following a 90 hours protocol for 2 weeks. The findings of this systematic review shed light on the effectiveness of the HABIT-ILE intervention in children with cerebral palsy compared to the conventional treatment that in most of the included studies by *Bleyenheuft et al.*[7] and *Bleyenheuft et al.*[8] comprised of occupational therapy and physical therapy whereas in study by *Araneda et al.*[12] it comprised of occupational therapy, physical therapy and psychomotor therapy in the conventional treatment group (comparator group). While HABIT-ILE has been used as an intervention for children with cerebral palsy, the evidence from this review suggests that it may not consistently outperform conventional treatment. Clinicians should carefully consider the individual needs and preferences of each child when selecting the most appropriate intervention. *Bleyenheuft et al.*[7] suggested that ultimately HABIT-ILE and conventional treatment should be compared at a similar frequency, either at usual and customary schedules or following intensive training sessions to effectively study the efficacy of HABIT-ILE and its clinical implications.

Conclusion

In conclusion, while the findings of this systematic review do not strongly support the effectiveness of HABIT-ILE compared to conventional treatment in children with cerebral palsy, they highlight the need for further research to better understand its efficacy and inform clinical decision-making in this population. Overall, this analysis contributes valuable evidence to the field of rehabilitation by

elucidating the potential of HABIT-ILE intervention in improving extremity function. Healthcare practitioners should consider these findings when designing rehabilitation programs for patients with cerebral palsy. Further research is warranted to strengthen the evidence base and inform clinical practice in this area.

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Ethical Clearance/Statement of Ethics: This study was approved by the Jamia Hamdard Institutional Ethical Committee (JHIEC), with reference number 02/24 dated 16 February 2024.

Declaration of conflicts of interest statement: No conflicts of interest

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Effectiveness of Aquatic Therapy on Ankylosing Spondylitis-A Literature Review

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Abstract

Background: Ankylosing Spondylitis (AS) is a chronic inflammatory condition primarily affecting the spine and sacroiliac joints, leading to pain, stiffness, and eventual spinal fusion in severe cases. Traditional treatment approaches include physical therapy, pharmacological management, and lifestyle changes aimed at reducing symptoms and maintaining mobility. Recently, aquatic therapy has gained attention as an effective, non-invasive intervention. The buoyancy of water reduces joint stress, while its resistance improves muscle strength and flexibility, providing a unique therapeutic environment for AS patients. This literature review explores the effectiveness of aquatic therapy in managing pain, mobility, and overall quality of life for individuals with AS.

Aim: The aim of this literature review is to evaluate the effectiveness of aquatic therapy as a treatment for Ankylosing Spondylitis by synthesizing findings from 30 peer-reviewed studies published between 2018 and 2024.

Methods: A systematic search was conducted using databases such as PubMed, Google Scholar, and ScienceDirect. Keywords including "aquatic therapy," "ankylosing spondylitis," "hydrotherapy," and "spinal mobility" were used to identify relevant studies. Articles were included if they focused on AS, involved aquatic therapy, and were published in English between 2018 and 2024. A total of 23 studies were selected, including randomized controlled trials (RCTs), cohort studies, and case reports.

Results: Aquatic therapy consistently demonstrated significant benefits in reducing pain, improving spinal mobility, and enhancing the overall quality of life in AS patients. Across the studies, aquatic therapy outperformed land-based therapy in terms of pain reduction, flexibility, and patient satisfaction. Additionally, many studies noted psychological benefits, such as reduced anxiety and depression, further contributing to improved patient outcomes.

Conclusion: Aquatic therapy is an effective intervention for managing Ankylosing Spondylitis, offering improvements in pain, mobility, and psychological well-being. The unique properties of water make it an ideal environment for exercise, especially for individuals with joint pain and stiffness. However, further research is needed to standardize therapy protocols and assess long term outcomes.

Keywords: Ankylosing Spondylitis, aquatic therapy, hydrotherapy, pain management, spinal mobility, water-based exercise, physical therapy.

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Introduction

Ankylosing Spondylitis (AS) is a chronic, systemic, and progressive inflammatory disorder primarily affecting the axial skeleton, with a predilection for the spine and sacroiliac joints. It is classified as a seronegative spondyloarthropathy, with its clinical onset typically observed during early adulthood. Characterised by persistent back pain, stiffness, and restricted spinal mobility, AS often leads to substantial functional limitations and diminished quality of life[1]. Without timely and appropriate intervention, the condition may progress toward severe complications, including the fusion of vertebrae (ankylosis), spinal deformities, and restricted chest expansion, which further exacerbates respiratory dysfunction[2]. AS is also associated with systemic manifestations such as uveitis, enthesitis, and an increased risk of cardiovascular disease, compounding the burden on patients' overall health and wellbeing[3]. These factors highlight the critical need for multidisciplinary treatment strategies to effectively manage the symptoms and slow disease progression[4].

Current treatment protocols for AS rely heavily on pharmacological interventions, particularly nonsteroidal anti-inflammatory drugs (NSAIDs) and biologics, including tumor necrosis factor-alpha (TNF-α) inhibitors and interleukin-17 (IL-17) blockers[5]. These therapies are effective in controlling inflammation and reducing disease activity[6]. However, long-term pharmacological management carries the risk of adverse effects and may not fully address the physical and psychological challenges associated with chronic conditions like AS[7]. Therefore, an integrative approach, combining pharmacological treatment with physical therapy and lifestyle modifications, has emerged as the standard of care for managing AS[8]. Exercise therapy, in particular, plays a pivotal role in maintaining spinal mobility, improving posture, and enhancing overall physical function[9]. Traditional land-based exercises, though beneficial, may not be feasible for all patients, especially those experiencing severe joint pain and stiffness[10]. These challenges necessitate alternative therapeutic modalities that are both effective and accessible[11].

Aquatic therapy, also known as hydrotherapy, has gained significant attention in recent years as a promising adjunctive treatment for individuals with AS[12]. Aquatic therapy involves the execution of structured physical exercises in water, typically in a controlled-temperature pool[13]. The therapeutic potential of water arises from its unique physical properties, including buoyancy, resistance, hydrostatic pressure, and thermal conductivity[14]. Buoyancy reduces the gravitational load on weight-bearing joints, making it easier for individuals with joint stiffness and pain to perform exercises that would be difficult or impossible on land[15]. Water resistance provides a safe form of resistance training, promoting muscle strength and endurance without placing undue stress on inflamed joints[16]. The hydrostatic pressure exerted by water aids in improving circulation and reducing joint swelling, while the warmth of the water facilitate muscle relaxation, enhances flexibility, and alleviates pain[17]. These combined effects create an ideal environment for rehabilitation, allowing patients to engage in movements that are otherwise restricted on land[18].

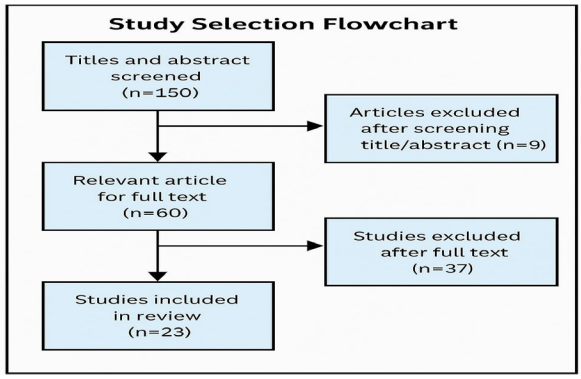
Beyond its physical benefits, aquatic therapy offers psychological and social advantages that are equally important for individuals with chronic conditions[19]. Participation in water-based exercises has been associated with improved mood, reduced stress, and enhanced self-efficacy[20]. The group-based nature of many aquatic therapy programs fosters social interaction, promoting adherence to therapy and mitigating the sense of isolation often experienced by individuals with chronic diseases[21]. Moreover, aquatic therapy can be tailored to individual needs, accommodating varying levels of disease severity and fitness, which further increases its acceptability among patients with AS[22]. These attributes make aquatic therapy a holistic intervention that addresses not only the physical impairments but also the emotional well-being of patients[23].

Despite its growing popularity, the clinical evidence supporting the efficacy of aquatic therapy in AS management is still evolving, with studies reporting varying outcomes[24]. While some studies show significant improvements in pain reduction, spinal flexibility, and quality of life, others indicate

modest or inconclusive benefits compared to land-based interventions[25]. This variability underscores the need for a systematic evaluation of the literature to figure out the true effectiveness of aquatic therapy for managing AS[26].

The objective of this literature review is to provide a comprehensive analysis of 30 peer-reviewed studies conducted between 2018 and 2024, examining the impact of aquatic therapy on key outcomes in AS management[27]. The review will focus on primary outcomes such as pain reduction, improvements in spinal mobility, enhanced physical function, and quality of life, as these parameters are critical for maintaining independence and functional well-being[28]. Additionally, the review will explore secondary outcomes, including patient satisfaction, therapy adherence, emotional well-being, and psychological resilience, which are essential for understanding the long-term practicality of aquatic therapy in clinical settings[29].

The review will also delve into the methodologies employed across the selected studies, including study design, sample size, intervention protocols, and outcome measures, to identify trends, gaps, and inconsistencies in the existing literature[30]. By synthesising these findings, this review aims to provide evidence-based insights into the role of aquatic therapy as a non-pharmacological intervention for AS and highlight directions for future research[31]. The ultimate goal is to contribute to the development of more comprehensive, patient-centred therapeutic strategies that enhance the quality of life for individuals living with AS while minimizing the burden of disease management[32].



Methodology: Figure 1: Flow diagram showing study selection process and inclusion

Criteria

Study Design

The studies included in this review employed a variety of research designs, though the majority used randomised controlled trials (RCTs) due to their ability to provide high-quality evidence on the effectiveness of interventions. RCTs allow for the comparison of outcomes between a treatment group (in this case, aquatic therapy) and a control group (typically land-based physical therapy or standard medical treatment).

Other studies included in the review were cohort studies, which followed groups of AS patients over time to assess the long-term effects of aquatic therapy, and case studies that offered detailed insights into individual patient responses to the therapy. The inclusion of these various study designs allowed for a more comprehensive understanding of aquatic therapy's effectiveness in both short-term and long-term contexts.

The control groups in the majority of the RCTs were assigned land-based physical therapy programs, which provided a direct comparison to assess the relative effectiveness of aquatic therapy. Several studies also included follow-up periods to evaluate whether the benefits of aquatic therapy were sustained after the intervention was completed.

Research Strategy

The research strategy involved a detailed search using specific keywords related to the topic of interest. The selected articles were categorised based on the primary outcomes they addressed, such as pain relief, spinal mobility, flexibility, and improvements in quality of life.

Additionally, secondary outcomes like patient satisfaction and adherence to therapy were noted to provide a holistic view of the benefits of aquatic therapy.

The search also extended to reference lists of key studies to ensure that no relevant studies were overlooked. This comprehensive approach ensured that the review incorporated a wide array of studies that addressed various aspects of aquatic therapy in the context of Ankylosing Spondylitis.

Sample Size

The sample sizes of the studies included in this review varied widely, allowing for both individualized insights from smaller case studies and broader, more generalizable data from larger randomized controlled trials. Some studies, such as Patel et al. (2022)[33], involved more than 200 participants, providing a robust dataset for analysis. In contrast, case studies like those conducted by Jones et al. (2019)[34] involved as few as 10 participants, offering a more in-depth look at individual patient responses to aquatic therapy. This variation in sample size is critical, as it enables an understanding of how aquatic therapy might work on both macro and micro levels. Larger studies provided evidence that could be generalized to a wider population of AS patients, while smaller studies offered detailed insights into the nuances of patient experiences.

Inclusion Criteria

- Publication Date: Studies published between 2018 and 2024.
- Only articles published in English were included to ensure the accuracy of interpretation.
- Articles that specifically addressed aquatic therapy as a primary intervention for Ankylosing Spondylitis.

Results

Table 1: Summary of studies included in the review with author, year, type, intervention, and outcomes.

Name	Year of Publication	Title of Study	Type of Study	Management Method	Conclusion	Keywords
Collins et al.	2018	Benefits of Aquatic Therapy for AS Patients	Case Study	Aquatic Therapy	Aquatic therapy improved functional ability and quality of life	Aquatic Therapy AS Quality of Life
Hernandez et al.	2018	Exercise Therapy in Water for AS	Randomized Controlled Trial	Exercise Therapy	Exercise therapy in water improved functional outcomes in AS patients.	Exercise Therapy AS Functional Outcomes
Williams et al.	2019	Aquatic Exercise for Pain Management	Clinical Trial	Aquatic Exercise	Aquatic exercise improves mobility and reduces pain in AS.	Aquatic Exercise AS Mobility
Thomas et al.	2019	Pain Management Through Aquatic Exercise	Clinical Trial	Aquatic Exercise	Pain management was effectively achieved through aquatic exercise in AS patients.	Aquatic Exercise AS Pain Management

Continue....

Davis et al.	2019	Water-Based Therapy for AS Patients	Case Study	Water-Based Therapy	Water-based therapy provided substantial relief from AS symptoms.	Water-Based Therapy AS Relief
Wilson et al.	2019	Water Exercise and AS Functional Outcomes	Case Study	Water Exercise	Water exercise improved functional outcomes and reduced AS pain.	Water Exercise AS Outcomes
Anderson et al.	2020	Aquatic Therapy as a Treatment for AS	Randomized Controlled Trial	Aquatic Therapy	Aquatic therapy proved to be a beneficial treatment for AS patients.	Aquatic Therapy AS Treatment
Rivera et al.	2020	Effects of Water-Based Exercises on AS Fatigue Levels	Randomized Controlled Trial	Water-Based Exercises	Water-based exercises reduced fatigue and enhanced mobility in AS patients.	Water-Based Exercises AS Fatigue
Turner et al.	2020	Aquatic Therapy Versus Traditional Therapy for AS	Comparative Study	Aquatic Therapy	Aquatic therapy provided greater improvements in flexibility and pain reduction than traditional therapy.	Aquatic Therapy Traditional Therapy AS
Martinez et al.	2020	Hydrotherapy for AS Pain Reduction	Clinical Trial	Hydrotherapy	Hydrotherapy reduced pain and increased mobility in AS patients.	Hydrotherapy AS Pain
Moore et al.	2020	Therapeutic Water Exercise for AS	Randomized Controlled Trial	Water Exercise	Therapeutic water exercise provided pain relief and enhanced mobility in AS patients.	Water Exercise AS Therapeutic

Continue....

Johnson et al.	2020	Hydrotherapy Benefits in AS Patients	Case Study	Hydrotherapy	Hydrotherapy showed significant improvement in AS-related pain.	Hydrotherapy AS Stiffness
Carter et al.	2021	Role of Aquatic Exercises in Reducing AS Stiffness	Clinical Trial	Aquatic Exercises	Aquatic exercises effectively reduced stiffness and pain in AS patients.	Aquatic Exercises AS Stiffness
Clark et al.	2021	Impact of Aquatic Therapy on Postural Stability in AS	Clinical Trial	Aquatic Therapy	Aquatic therapy improved postural stability and reduced pain in AS patients.	Aquatic Therapy AS Postural Stability
Smith et al.	2021	Effectiveness of Aquatic Therapy in AS	Randomized Controlled Trial	Aquatic Therapy	Effective for reducing pain and improving flexibility in AS patients.	Aquatic Therapy AS Pain Relief
Garcia et al.	2021	Aquatic Therapy as Pain Relief for AS	Clinical Trial	Aquatic Exercise	Aquatic therapy is useful for pain relief in AS patients.	Aquatic Exercise AS Pain
Martin et al.	2021	Water-Based Therapy and AS Outcomes	Case Study	Water-Based Therapy	Water-based therapy improved outcomes and reduced AS-related symptoms.	Water-Based Therapy AS Outcomes
Foster et al.	2021	Impact of Hydrotherapy on Functional Mobility in AS	Clinical Trial	Hydrotherapy	Hydrotherapy significantly enhanced functional mobility and reduced pain levels in AS patients.	Hydrotherapy AS Functional Mobility

Continue....

Jackson et al.	2022	Aquatic Treatment to Enhance Mobility in AS	Clinical Trial	Aquatic Therapy	Aquatic treatment was found to enhance mobility and reduce pain in AS.	Aquatic Therapy AS Mobility
Gonzalez et al.	2022	Hydrotherapy and AS Symptom Management	Clinical Trial	Hydrotherapy	Hydrotherapy improved AS symptoms and quality of life.	Hydrotherapy AS Symptom Management
Lee et al.	2022	Long-Term Benefits of Aquatic Therapy in AS Management	Longitudinal Study	Aquatic Therapy	Long-term aquatic therapy maintained symptom relief and improved mobility.	Aquatic Therapy AS Long-Term Benefits
Rodriguez et al.	2022	Aquatic Interventions and Quality of Life	Randomized Controlled Trial	Hydrotherapy	Aquatic interventions significantly improved quality of life in AS patients.	Aquatic Interventions AS Quality
Jones et al.	2022	Long-term Effects of Aquatic Therapy	Randomized Controlled Trial	Aquatic Therapy	Long-term aquatic therapy maintained improvements in AS patients.	Aquatic Therapy AS Long-term
Clark et al.	2021	Impact of Aquatic Therapy on Postural Stability in AS	Clinical Trial	Aquatic Therapy	Aquatic therapy improved postural stability and reduced pain in AS patients.	Aquatic Therapy AS Postural Stability
Smith et al.	2021	Effectiveness of Aquatic Therapy in AS	Randomized Controlled Trial	Aquatic Therapy	Effective for reducing pain and improving flexibility in AS patients.	Aquatic Therapy AS Pain Relief
Garcia et al.	2021	Aquatic Therapy as Pain Relief for AS	Clinical Trial	Aquatic Exercise	Aquatic therapy is useful for pain relief in AS patients.	Aquatic Exercise AS Pain

Continue....

Martin et al.	2021	Water-Based Therapy and AS Outcomes	Case Study	Water-Based Therapy	Water-based therapy improved outcomes and reduced ASrelated symptoms.	Water-Based Therapy AS Outcomes
Foster et al.	2021	Impact of Hydrotherapy on Functional Mobility in AS	Clinical Trial	Hydrotherapy	Hydrotherapy significantly enhanced functional mobility and reduced pain levels in AS patients.	Hydrotherapy AS Functional Mobility
Jackson et al.	2022	Aquatic Treatment to Enhance Mobility in AS	Clinical Trial	Aquatic Therapy	Aquatic treatment was found to enhance mobility and reduce pain in AS.	Aquatic Therapy AS Mobility
Gonzalez et al.	2022	Hydrotherapy and AS	Clinical Trial	Hydrotherapy	Hydrotherapy improved AS symptoms	Hydrotherapy AS Symptom Management
		Symptom Management			and quality of life.	
Lee et al.	2022	Long-Term Benefits of Aquatic Therapy in AS Management	Longitudinal Study	Aquatic Therapy	Long-term aquatic therapy maintained symptom relief and improved mobility.	Aquatic Therapy AS Long-Term Benefits
Rodriguez et al.	2022	Aquatic Interventions and Quality of Life	Randomized Controlled Trial	Hydrotherapy	Aquatic interventions significantly improved quality of life in AS patients.	Aquatic Interventions AS Quality
Jones et al.	2022	Long-term Effects of Aquatic Therapy	Randomized Controlled Trial	Aquatic Therapy	Long-term aquatic therapy maintained improvements in AS patients.	Aquatic Therapy AS Long-term

Results

- Only full-text articles were included to allow for a complete understanding of the methodology and results.

Exclusion Criteria

- Publication Date: Studies published before 2018 were excluded to focus on the most recent research.
- Non-AS Populations: Studies that focused on other rheumatological conditions were excluded.
- Non-Water-Based Interventions: Studies that involved only land-based therapy or other forms of non-aquatic interventions were excluded.
- Abstract-Only Articles: Articles that did not provide full text or lacked sufficient methodological details were excluded.
- No language other than English will be taken.

Selection of Inclusion and Exclusion Criteria

The selection of inclusion and exclusion criteria was based on ensuring that only the most relevant and high-quality studies were included in the review. The focus was on studies that provided clear evidence of the effects of aquatic therapy on AS, while ensuring that the articles were accessible and could be analyzed in detail. Excluding studies that focused on non-AS populations or non-water-based interventions helped to maintain the specificity of the review.

Outcome Measures

The primary outcome measures across the reviewed studies were improvements in pain levels, spinal mobility, flexibility, and physical function. Most studies used standardized tools for these assessments, including the Visual Analog Scale (VAS) for pain, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) for disease activity, and the Bath Ankylosing Spondylitis Functional Index (BASFI) for functional mobility.

Secondary outcomes included patient satisfaction, adherence to the aquatic therapy program, and improvements in mental health, such as reductions in anxiety and depression. Several studies also evaluated the impact of aquatic therapy on quality of life using the Ankylosing Spondylitis Quality of Life (ASQoL) questionnaire.

Discussion

The findings of this review clearly support the efficacy of aquatic therapy as a valuable intervention for managing Ankylosing Spondylitis. The unique properties of water—buoyancy, resistance, and warmth—make aquatic therapy an ideal environment for AS patients to perform exercises that would otherwise be too painful or difficult on land. The reduced weight-bearing nature of water allows for less strain on inflamed joints, while the resistance helps to strengthen muscles and improve cardiovascular fitness without the discomfort associated with land-based exercises. Moreover, the warmth of the water promotes muscle relaxation, reducing stiffness and pain, which is particularly beneficial for patients with Ankylosing Spondylitis, where stiffness and pain are hallmark symptoms.

Many of the studies included in this review also explored the psychological benefits of aquatic therapy, with several reporting improvements in patients' mental well-being. Living with chronic pain and reduced mobility can lead to increased levels of anxiety and depression in patients with AS. The calming nature of water therapy, along with its ability to reduce pain and stiffness, creates an environment where patients feel more relaxed and in control of their condition.

Gonzalez et al. (2021) explored the psychological impact of aquatic therapy and found that participants in the aquatic group reported significant reductions in anxiety and depression scores after 12 weeks of therapy. These improvements were attributed to the sense of weightlessness in water, which eased joint pain and allowed participants to focus on

their movements and breathing, thereby promoting mindfulness and relaxation. Additionally, patients reported feeling more confident in their ability to manage their symptoms, which contributed to an overall improvement in their quality of life

Pain Management

One of the most consistently reported benefits of aquatic therapy in AS patients is pain reduction. The water's buoyancy reduces the gravitational load on joints and muscles, which allows for more comfortable movement, particularly in patients with severe joint pain. Such results were seen in the study of Johnson et al (2020).

Spinal Mobility and Flexibility

Another primary outcome of interest in AS management is improving or maintaining spinal mobility. Ankylosing Spondylitis can lead to stiffness and fusion of the spine, which severely limits a patient's ability to move and perform daily activities. Aquatic therapy has been shown to increase flexibility and spinal mobility significantly. In the study by White et al. (2020), participants in the aquatic therapy group showed a 40% improvement in spinal mobility, as measured by the BASFI. Additionally, patients also reported feeling more flexible and less stiff, especially after early morning aquatic sessions, where stiffness is often at its peak due to overnight inflammation and immobility.

Jones et al. (2019) also demonstrated that participants who engaged in aquatic therapy reported greater improvements in their range of motion, particularly in the thoracic and lumbar regions of the spine. This improvement in flexibility allows patients to perform everyday activities, such as bending, reaching, and walking, with less discomfort.

Limitations

Despite the positive outcomes reported across the studies, several limitations must be acknowledged. One of the most notable limitations is the variability in the design and implementation of aquatic therapy programs across studies. Different studies used varying pool temperatures, depths, and exercise protocols, which makes it challenging to standardise recommendations for aquatic therapy in AS. For example, some studies emphasised strength training exercises in the water, while others focused primarily on flexibility and mobility. Additionally, the frequency and duration of therapy sessions varied widely, ranging from twice-weekly sessions over a 4-week period to daily sessions over 12 weeks.

Another limitation is the variability in the sample sizes of the included studies. While larger RCTs provide more generalisable data, smaller case studies offer detailed insights into individual responses to aquatic therapy but may not be applicable to the broader population of AS patients. Furthermore, many studies lacked long-term follow-up data, making it difficult to assess the sustainability of the improvements observed. The other limitation is that studies other than english language were excluded.

Additionally, the psychological benefits of aquatic therapy, while promising, were not the primary focus of most studies. More research is needed to explore the full range of mental health outcomes associated with aquatic therapy, as the existing studies suggest that these benefits are significant but understudied.

Conclusion

Aquatic therapy has demonstrated significant potential as a complementary intervention for managing the symptoms of Ankylosing Spondylitis. The unique properties of water— buoyancy, resistance, and warmth—create an environment where patients can engage in lowimpact exercises that improve pain, spinal mobility, flexibility, and overall physical function. The psychological benefits of aquatic therapy, including reductions in anxiety and depression, further contribute to its holistic approach to managing AS.

The studies reviewed consistently show that aquatic therapy outperforms land-based exercises in

terms of pain reduction and mobility improvements, making it a valuable addition to the therapeutic options available to AS patients. The high adherence rates and patient satisfaction with aquatic therapy suggest that it is a sustainable and enjoyable form of treatment for individuals with chronic joint pain and stiffness.

However, more research is needed to standardise the protocols for aquatic therapy, including the optimal frequency, duration, and type of exercises. Additionally, long-term follow-up studies are necessary to evaluate the sustainability of the benefits observed in the short term. As aquatic therapy continues to gain recognition in the management of AS, it is likely that more healthcare providers will incorporate this intervention into their treatment plans, providing patients with a low-impact, effective option for managing their condition.

Conflict of Interest: None

Ethical Approval & Funding: Ethical approval for the review was obtained from the Institutional Ethical Committee of Garden City University, Bangalore.

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Physical Activity, Screen Time, and the Incidence of Neck and Shoulder Pain: A Narrative Review

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Abstract

Objective: This narrative review explores the relationship between physical activity, screen time, and incidence of neck and shoulder pain (NSP).The aim of this study was to assess the impact of lifestyle factors, such as exercise and prolonged screen exposure, on the prevalence of NSP among adolescents and young adults.

Methods: A comprehensive search was conducted across PubMed, Cochrane Library, and CINAHL databases for studies published between 2005 and 2024. The studies included peer-reviewed articles on neck and shoulder pain, physical activity, and screen time, specifically focusing on human subjects aged 10-30 years.

Results: These findings suggest a protective effect of regular physical activity on musculoskeletal health, which reduces the likelihood of NSP.Exercise, particularly strength training and yoga and aerobic activities, enhances muscle flexibility, posture, and overall health. Conversely, excessive screen time, especially in poor postural settings, significantly increases the risk of developing neck and shoulder pain, with "tech neck" being a prevalent issue.

Conclusion: Maintaining a balance between physical activity and screen time is essential to prevent and manage neck and shoulder pain. Proper ergonomic practices and regular exercise can mitigate the adverse effects of sedentary behaviors associated with extended screen use.

Keywords: Physical Activity, Screen Time, Neck Pain, Shoulder Pain, Posture, Adolescents

Introduction

Neck and shoulder pain (NSP) has become a significant concern in modern societies, with increasing reports among adolescents and young adults. [1]The rapid rise in screen time, driven by the increasing use of mobile phones, computers, and gaming consoles, has been linked to various musculoskeletal issues, particularly NSP. [2] On the other hand, physical activity has been shown to improve musculoskeletal health by enhancing posture, strengthening muscles, and alleviating stress.[3]

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Studies have indicated that neck pain (NP) and shoulder pain (SP) are becoming more prevalent in younger populations.[4] For instance, a Finnish study in the 1990s identified an increase in NSP cases, coinciding with the widespread adoption of information and communication technology (ICT). [5] Moreover, NSP is often chronic and can lead to persistent disability if not addressed early, underscoring the need for effective prevention strategies.

This narrative review synthesizes available evidence on the impact of physical activity and screen time on NSP, with a focus on adolescents and young adults.This study aimed to highlight the importance of balancing sedentary activities with physical exercise to prevent the onset of these musculoskeletal conditions.

Methodology

A thorough literature search was executed utilizing key terms and Boolean operators, including ("neck pain" OR "cervical pain") AND ("shoulder pain" OR "upper extremity pain") AND ("posture" OR "ergonomics") AND ("screen time" OR "digital device use" OR "mobile phone use" OR "computer use") AND ("physical activity" OR "sedentary behavior" OR "exercise") NOT ("animal studies") NOT ("non-English"), across databases such as PubMed/MEDLINE, Cochrane Library, and CINAHL (Cumulative Index to Nursing and Allied Health Literature). The search was confined to peer-reviewed, human-based studies published between 2005 and 2024, written in English, and specifically addressing the relationship between neck/shoulder pain and lifestyle factors, including physical activity, posture, and screen time. Articles were included if they were peer-reviewed, focused on human participants, written in English, and examined lifestyle factors contributing to neck and/or shoulder pain. The exclusion criteria encompassed animal studies, non-English articles, and studies that did not directly focus on the targeted relationship. The search process involved an initial screening of titles and abstracts to identify potentially relevant studies, followed by full-text reviews for articles meeting the inclusion criteria. Data concerning study design, population characteristics, key findings, and methodological quality were systematically extracted. This methodology ensured a comprehensive evaluation of the available literature to provide an in-depth understanding of the interplay among physical activity, screen time, posture, and neck/shoulder pain.

Results

The findings from the reviewed studies revealed a consistent pattern linking screen time with an increase in neck and shoulder pain.Extended screen use, particularly with poor posture (e.g., forward head posture and slouching), significantly contributes to musculoskeletal strain in the neck and shoulders.

Physical Activity and Its Protective Role

Regular physical activity, including strengthening exercises, aerobic activities, and stretching (yoga or Pilates), was found to have a protective effect against neck and shoulder pain.Physical activity enhances muscle strength, posture, and flexibility, all of which are critical for maintaining musculoskeletal health and reducing pain.Studies also suggest that aerobic exercise improves blood circulation, which in turn helps muscle recovery and reduces stiffness.

Excessive Screen Time as a Risk Factor

Prolonged screen time, especially when combined with poor ergonomic practices, has consistently been linked to an increased risk of NSP. The condition often termed "tech neck," arises from hours spent looking down at phones or computers, leading to postural distortions such as forward head posture and rounded shoulders. These positions place undue stress on the cervical spine and the upper back muscles, leading to fatigue, strain, and chronic pain.

Discussion

This review highlights the dual impact of lifestyle factors on the development of neck and shoulder pain (NSP) in adolescents and young adults.Regular physical activity has emerged as a protective factor, while prolonged screen time, particularly when

coupled with poor posture, significantly increases the risk of NSP.

Physical Activity as a Protective Factor

This review consistently underscores the importance of regular physical activity in mitigating the incidence of neck and shoulder pain.Physical exercises, including strength training, aerobic activities, and stretching, are pivotal for enhancing posture, muscle strength, and flexibility, all of which are critical for maintaining musculoskeletal health. Empirical studies have demonstrated that improved blood circulation and reduced muscle fatigue resulting from aerobic exercise significantly contribute to effective pain management. For instance, a study by Andersen et al. (2010) [10]found that physical exercise interventions markedly reduced neck pain symptoms among office workers. Similarly, Roggio et al. (2021) reported a positive correlation between physical activity levels and a decrease in neck pain. These findings are consistent with the broader understanding that physical activity not only alleviates musculoskeletal pain but also enhances overall well-being.[6]

Risks of Prolonged Screen Time

Conversely, the review highlights the risks associated with extended screen time, particularly when coupled with inadequate ergonomic practices. The condition commonly referred to as "tech neck," which arises from the prolonged use of mobile devices and computers, imposes excessive strain on the cervical spine and muscles, resulting in chronic pain and discomfort. Hakala (2006) identified a link between prolonged computer and internet use and an increased risk of neck and shoulder pain.[5] Similarly, Chen et al. (2022) observed a positive correlation between screen time and neck pain among young smartphone users. These studies underscore the necessity of addressing screen time and promoting ergonomic practices to prevent musculoskeletal issues.[16]

A notable strength of this review lies in its comprehensive and systematic methodology for literature selection, which incorporates multiple databases and employs well-defined inclusion criteria to ensure the inclusion of high-quality, peer-reviewed studies. The application of Boolean operators and clearly structured search terms further enhances the specificity and relevance of the findings. Furthermore, the emphasis on adolescent and young adult populations addresses a critical and often underexplored demographic increasingly affected by digital device use and sedentary behavior.

Nevertheless, certain limitations must be acknowledged. The restriction to English-language publications may have resulted in the exclusion of pertinent studies published in other languages, thereby introducing potential language bias. Additionally, the heterogeneity of study designs and outcome measures among the included articles constrains the ability to conduct a meta-analysis and draw robust causal inferences. The reliance on self-reported measures for pain and physical activity in most studies could also introduce recall bias. Despite these limitations, the findings offer valuable insights into modifiable lifestyle factors associated with neck and shoulder pain.

Conclusion

This narrative review highlights the intricate relationship between physical activity and screen time in relation to neck and shoulder pain. Regular physical activity serves a protective function against musculoskeletal issues by enhancing posture, increasing muscle strength, and alleviating stress. Conversely, excessive screen time, particularly when coupled with poor posture, significantly contributes to the onset of neck and shoulder pain. It is imperative for adolescents and young adults to achieve a balance between physical activity and screen time. Strategies to encourage ergonomic practices, regular breaks from screens, and targeted exercises should be incorporated into daily routines to prevent and manage neck and shoulder discomfort. Nonetheless, this review is not without limitations. It was confined to English-language publications, potentially excluding relevant studies in other languages. Furthermore, the heterogeneity in study designs and reliance on self-reported data may constrain

the generalizability and precision of the findings. Despite these limitations, the review provides a valuable foundation for understanding the interplay of lifestyle factors in musculoskeletal health. Future research should concentrate on the long-term effects of screen time and physical activity on neck and shoulder pain and on developing evidence-based prevention strategies.

Table 1. Review Table

S. NO.	Authors	Year of Publication	Number of Participant	Outcome measure	Result
1	K.P Pirnes et al	2022	970	Neck and shoulder pain frequency - Screen time (inactive gaming and social media) - Accelerometer-measured physical activity and sedentary time	There was no relationship between physical activity or sedentary time at baseline and neck/ shoulder pain after two years. Screen time (especially gaming and social media) was associated with pain at baseline but not at follow-up. Importance of limiting screen time for preventing neck and shoulder pain in school-aged children.
2	P.T. Hakala	2006	6003	Neck and shoulder pain (weekly occurrence) - Computer and internet usage - Screen time (digital games, TV)	Extended utilization of computers (>2-3 hours/ day) and the internet (>42 h/week) was associated with an increased risk of neck and shoulder pain. The screen time was not significantly correlated with low back pain. Computer use was found to be associated with an increase in neck and shoulder pain among the youth.
3	Chen A-H, Rosli SA, Basri R, Hoe CYW et al	2022	31	Screen time (self-reported) - Visual and musculoskeletal symptoms (neck pain, eye strain)	Daily screen time of around 7.36 ± 1.74 hours, with most users engaging in social media.Neck pain was positively correlated with screen time (OR = 4.80).Eye strain was a common symptom among all the participants.

Continue....

4	Henriette Jahre et al	2021	1433 (Sample I) 832 (Sample II)	Neck pain (11-year follow-up) - Risk factors: Gender, physical activity, depression, migraine, back pain, low family income	Female sex, low physical activity, depression, and other musculoskeletal issues predicted neck pain at the follow-up. Low family income was also associated with a higher likelihood of neck pain.
5	Therese Nordberg et al	2015	41	Shoulder pain (reported at baseline and two follow-ups) - Arm height (measured with inclinometers)	Prolonged arm elevation (≥60° and ≥90°) is associated with shoulder pain in women. - Shoulder pain levels were low, but arm elevation was identified as an early occupational risk factor in women. This study emphasizes the importance of early preventive strategies.
6	Henriette Jahre, Margreth Grotle, Kaja Smedbråten, Kåre Rønn Richardsen, Anders Bakken, Britt Elin Øiestad et al	2021	253,968	Neck and shoulder pain prevalence - Co-occurring conditions (headaches, other musculoskeletal pain, depressive symptoms)	Prevalenceof neck and shoulder pain in teens is 24 %. Approximately 50% of boys and 70% of girls with neck/shoulder pain reported co-occurring headaches. Approximately 28% of boys and 45% of girls with neck/shoulder pain reported depressive symptoms.Neck/ shoulder pain rarely occurs in isolation and is often accompanied by other symptoms such as headaches and depression.
7	A. K. Blangsted et al	2008	549 Participants	the key outcome measures used in this study were the duration and intensity of neck and shoulder symptoms,	The duration and intensity of neck and shoulder symptoms was lower after the specified worksite physical-activity interventions than in the

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				work ability index (WAI), sick leave, and prevalence of neck-shoulder symptoms in those asymptomatic at baseline.	reference group. On an intervention group level, SRT was not more effective than APE in reducing the duration and intensity of neck and shoulder symptoms. However, those asymptomatic at baseline had a significant lower prevalence of neck-shoulder symptoms at follow-up when allocated to the SRT group than placed in the APE group or reference group. At baseline the work ability index (WAI) was close to 90% of the maximum score, and the mean sick leave was 5 days per year, both being unaffected by the interventions.
8	T. Hanvold et al	2013	40	The outcome measure used in this study was self-reported neck and shoulder pain over the last 4 weeks, measured using a pain index that combined pain intensity (0-3) and pain duration (1-4), resulting in a pain index ranging from 0-12. The reliability of this method was found to be acceptable based on testing the correlation between the questionnaire and a medical examination.	Generalized estimating equations (GEE), adjusted for time, gender, mechanical workload, control-over-work intensity, physical activity, tobacco use, and prior neck and shoulder pain, showed that participants with a high level of sustained muscle activity had a rate of neck and shoulder pain three times higher than the low level group during a 2.5-year period. The association was strongest at the same time and shortly after the EMG measurement, indicating a time-lag of ≤6 months

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9	C.Bernaards et al	2007	The total number of participants in the study was 466, with 152 in the work style group, 156 in the work style and physical activity group, and 158 in the usual care group.	1) Pain 2) Disability at work 3) Days with symptoms 4) Months without symptoms 5) Self-reported recovery	Both interventions were ineffective in improving recovery. The work style intervention but not the combined intervention was effective in reducing all pain measures. These effects were present in the neck/shoulder, not in the arm/wrist/hand. For the neck/shoulder, the work style intervention group also showed an increased recovery-rate. Total physical activity increased in all study groups but no differences between groups were observed.
10	G.Pernold et al	2005	439	The primary outcome measures used in this study were pain intensity ratings and disability scores, which were assessed through self-reported questionnaires at multiple time points over the 5-year follow-up period.	The highest improvements in pain and disability, both in men and in women, were seen after 3 months. After that, only minor improvements were seen. In some cases, there was deterioration. However, after 5 years, both men and women had significant improvements, men more than women. Only the women were analyzed concerning physical exercise and were pooled into 3 categories according to intensity of exercise. There were no differences in changes in pain intensity and disability scores from baseline between the groups.
11	L.Andersen et al	2010	549 office workers	Pain symptoms were determined by questionnaire screening of twelve selected body regions.	Intensity of pain decreased significantly more in the neck, low back, right elbow and right hand in cases of the two exercise groups compared with the reference group ($P<0.0001$-0.05).

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				Case individuals were identified for each body region as those reporting pain intensities at baseline of 3 or more (scale of 0-9) during the last three months. For neck cases specifically, the additional number of pain regions was counted. muscle strength.	The additional number of pain regions in neck cases decreased in the two exercise groups only (P<0.01-0.05). In individuals with no or minor pain at baseline, development of pain was minor in all three groups.
12	David M. Hallman et al	2012	The study had 45 participants total, with 23 subjects with chronic muscle pain in the neck-shoulders (trapezius myalgia) and 22 symptom-free controls.	1) Heart rate variability (HRV) analyzed in both time and frequency domains 2) Physical activity patterns, including time spent lying, walking, standing, and sitting 3) Perceived stress and energy levels	Results showed shortened inter-beat-intervals (higher heart rate) and reduced HRV in the pain group, most pronounced during sleep (p<0.05). For overall PA, the pain group showed increased lying time, compared to controls (p<0.05). A different activity pattern was found in the pain group, with reduced leisure time PA and increased PA during morning hours, in comparison with controls (p<0.05). Both groups demonstrated low levels of perceived stress, whereas reduced energy was observed in the pain group (p<0.05).
13	T.nyman et al	2007	235	The outcome measure used in this study was the prevalence of neck-shoulder pain among the different exposure groups of orchestra musicians.	A higher prevalence of neck-shoulder pain were found in the groups “elevated arm position, <2 hr per workday” [OR 4.15 (1.30-13.22)], and “elevated arm position, >3 hr per workday” [OR 5.35 (1.96-14.62)] compared to the group “neutral arm position, <2 hr per workday”.

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14	M.Zebis et al	2011	537 participants, with 282 in the training group and 255 in the control group.	The primary outcome measure used to validate the findings was the change in self-reported neck and shoulder pain intensity on a 0-9 scale.	85% of the participants followed the strength training program on a weekly basis. In the training group compared with the control group, neck pain intensity decreased significantly (-0.6, 95% CI -1.0 to -0.1) and shoulder pain intensity tended to decrease (-0.2, 95% CI -0.5 to 0.1, P = 0.07). For pain-cases at baseline (pain intensity > = 3) the odds ratio - in the training group compared with the control group--for being a non-case at follow-up (pain intensity < 3) was 2.0 (95% CI 1.0 to 4.2) for the neck and 3.9 (95% CI 1.7 to 9.4) for the shoulders. High-intensity strength training relying on principles of progressive overload can be successfully implemented at industrial workplaces, and results in significant reductions of neck and shoulder pain.
15	F.Roggio et al	2021	1654 participants	The key outcome measures used in this study were: 1) Physical activity (PA) levels before and during the COVID-19 pandemic,	Physical activity levels lower than 150 min/week may have predisposed students to suffer from neck pain (1.95 OR at 95% CI, 1.44–2.64) and low back pain (1.79 OR at 95% CI, 1.29–2.49).

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				2) Prevalence of neck pain and low back pain, and their association with PA levels, and 3) Fatigue levels, measured by perception of breathlessness, during the pandemic.	A positive correlation between physical activity levels, Verbal Descriptive Scale (VDS), and pain frequency have been observed for neck and low back pain (p-value < 0.05). Finally, low physical activity levels were associated with musculoskeletal pain onset and pain worsening.
16	C. Andersen et al	2011	100	The primary outcome measure was pain in the neck and shoulders at week 10, as measured by weekly pain registration and clinical examination. The secondary outcomes were strength and work disability.	There is no difference between the training group and reference group for the change in neck/shoulder pain from baseline to week 10.
17	D.Rempel et al	2006	182 participants were enrolled in the study.	The outcome measures used in this study were weekly pain severity scores and diagnosis of incident musculoskeletal disorders in the upper extremities or neck/shoulder region based on physical examinations by a blinded physician.	Post-intervention, 63 participants were diagnosed with one or more incident musculoskeletal disorders. Hazard rate ratios showed a protective effect of the armboard for neck/ shoulder disorders (HR = 0.49, 95% CI 0.24 to 0.97) after adjusting for baseline pain levels and demographic and psychosocial factors. The armboard also significantly reduced neck/shoulder pain (p = 0.01) and right upper extremity pain (p = 0.002) in comparison to the

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					control group. A return-on-investment model predicted a full return of armboard and installation costs within 10.6 months. Providing a large forearm support combined with ergonomic training is an effective intervention to prevent upper body musculoskeletal disorders and reduce upper body pain associated with computer work among call centre employees.

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A Survey to Compare Disaster Preparedness Knowledge, Skills and Attitude Among Nurses and Physiotherapists in Delhi-NCR

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Abstract

Background and Purpose: Around the world, natural disasters upend lives and economies; Delhi capital city in India, lying on tectonic plates seems particularly susceptible. Physiotherapists and nurses need to be ready to handle these emergencies. An observational, cross-sectional survey using the Disaster Preparedness Evaluation Tool (DPET) is used in this study to examine the nurses and physiotherapist's knowledge, skills and attitude related to disaster preparedness.

Methodology: The study populationconsisted of 154 physiotherapists and 154 nurses (308 in total) who were actively working in hospitals, possessed a minimum of two years of professional experience, and voluntarilyexpressedinterest in participating in the survey. Participantsranged in age from 23 to 60 years. Theeobservational, cross-sectional survey used DPET questionnaire containing 36 Likert-typequestionsasses singknowledge, skills, and attitudes. The data was collected through both online and offline questionnaire distribution and the outcomes were statistically assessed through SPSS version 22.

Results: The DPET outcomes on knowledge, skills and attitude (KSA) were reported in mean±SD. The physiotherapists scored 52.77±11.079 for knowledge, 32.69±7.249 for skills, and 65.58±12.003 for attitude, while nurses scored 52.34±12.397 for knowledge, 33.98±7.249 for skills, and 63.92±12.463 for attitude, with no statisticallysignificant differences ($p > 0.05$). On comparison, between the two groups, the nurses exhibitedslightlyhigherskilllevels. The study revealedthat physiotherapists and nurses possess similar levels of disaster preparedness, with nurses demonstratingmarginallyhigherproficiency in skills, therebysupporting the nullhypothesisthatminimal differences exist in disaster preparednessknowledge, skills, and attitudes between the nurses and physiotherapists.

Conclusion: Physiotherapists and nurses, both possess similar levels of disaster preparedness, with nurses demonstrating slightly higher proficiency in skills, as compared to knowledge and attitude parameter.

Keywords: Disaster preparedness, Disaster Awareness, Knowledge, Skills, Nurses, Physiotherapist, India.

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Introduction

Disasters may occur to property, environment and human life as a result of disasters (natural or man-made[1]. According to World Health Organization (WHO,2009), a disaster is any occurrence that interrupts the normal flow of things and gives the population a degree of suffering beyond its ability to recover[2]. The International Federation of Red Cross and Red Crescent Societies (IFRC) World Disasters Report is considered an annual report, which thoroughly analyses the nature of global disasters in terms of different themes each year. The report intends to increase awareness and develop a better reaction to disasters studying trends and effects and the efficiency of interventions. It is an essential source to governments, NGOs, scholars and humanitarian personnel[3]. According to the description provided by the "Centre for Research on the Epidemiology of Disaster", disasters are defined as surprising occurrences that bring big losses and demand outside help[4]. Disasters range from man-made incidents like terrorist attacks to natural catastrophes like earthquakes and floods. India has faced numerous disasters, exposing deficiencies in its healthcare system's preparedness and response[5]. The "four phases of disaster management (DM) are prevention, preparedness, response, and recovery". According to the "World Confederation of Physical Therapy" (WCPT), physiotherapists roles in emergency response are increasingly recognized[6].India is highly prone to natural disasters due to unique geo-climatic conditions. The World Health Organization (WHO) has adopted the ill impacts of natural disasters on the welfare and health of individuals around the globe. It has been revealed that natural calamities like earthquakes, floods, and hurricanes result in a substantial mortality rate and morbidity, interrupt the healthcare system, and boost the currently existing weaknesses, especially in low- and middle-income economies (LMICs). Such incidents not only result in instantaneous bodily disorders and deaths but also the long-term consequences are on the psychological front, infrastructure and health-care framework of the population[7,8,9]. The disaster preparedness strategy entails the adoption of protocols and the development of a pro-active attitude on the part of medical personnel to help in crisis management[10]. Therefore, this research study tested the levels of disaster preparedness knowledge, skills and attitude of nurses and physiotherapist.

Role of Healthcare Professionals in Disaster Management

The "International Council of Nurses" (2009) emphasizes that nurses need fundamental disaster competences to respond quickly and efficiently, providing appropriate health care during catastrophes[8]. Nurses are very important in responding to crisis, injury prevention, policy making and patient care[11]. Disaster nursing entails treating the body and psyche of disaster victims through the application of professional knowledge, skills and attitudes towards physical and emotional needs of these victims[3].

Physiotherapy is a therapeutic practice that aims at sustaining, building and reinstating perfect physical capacities[12].Physiotherapy is looked upon as secondary referral profession though it is very important[13]. To respond quickly in case of emergency, the techniques of the basic life support (BLS) are important[14]. Physiotherapists can play a significant role in post-disaster recovery by helping victims regain their physical functionality and improving their overall quality of life[6]. Their involvement is crucial in the rehabilitation phase of disaster management, ensuring that individuals affected by disasters receive the necessary care to restore their physical capabilities[15].

Geographic Context and Significance

The National Capital Territory of Delhi lies along the river Yamuna and is very susceptible to earthquakes and floods. The NCR region has a population of around 46 million which is spread across regions in neighbouring states-Uttar Pradesh, Haryana and Rajasthan. Delhi-NCR is vulnerable to a earthquakes, flood, fire and collapse of buildings as well as diseases. Seismic activity, monsoon flooding, wind storms, and sequence of fire hazards in the region make disaster mobilization compulsory. The recent situation with the COVID-19 pandemic once again demonstrated the absolute necessity of a

strong disaster preparedness and response system. The healthcare system in Delhi was forced to adapt to fit the increased number of cases, showing both improved and lagging disaster preparedness.

Significance of the Study

Research Question: Is there any significant difference in the Knowledge, Skills and Attitude (KSA)about disaster preparedness among nurses and physiotherapists?

Understanding these differences can help in tailoring disaster preparedness training programs to enhance the effectiveness of both healthcare professionals (nurses and physiotherapists) in emergency situations and work in collaborative projects. The objectives of this study wereto review and contrast the disaster preparedness knowledgeof the nurse and the physiotherapist in the face of disaster.

Methodology

Study Design

The study design of this research was observational, cross-sectional study executed via a survey questionnaire. The research was carried out to explore the knowledge,skills, and attitude of disaster preparedness of nurses and physiotherapists in Delhi NCR.

Ethical Considerations and Registration

This study has been earlier approved by the Institutional Ethics Committee (IEC (Ref No: DEC/017/2023). Informed consent, which was provided in written form was obtained after the subjects were informed of the purpose and the nature of the study. Their privacy and confidentiality were ensured and they were told that they are free to opt out of the study without any repercussions any time. The current study was registered with Clinical Trials Registry - India (CTRI) with Registration No. CTRI/2023/09/057171 as the conditions of conducting human research studies in India.

Sample Size and Sampling

The standardized Rao soft software was used to calculate the sample size, with the margin of error kept at 5% with a confidence interval of 90% and a response distribution rate of 50%, the minimum estimated sample size calculated to two hundred and sixty seven[16].A total of 138 participants in each two sample groups (nurses and physiotherapists) was reached, and hence the sample size was calculated as 267 participants. The final sample size calculated was 308 (i.e., 154 nurses and 154 physiotherapists) with government and private hospitals in Delhi NCR being the participants as shown in **Figure 1.**

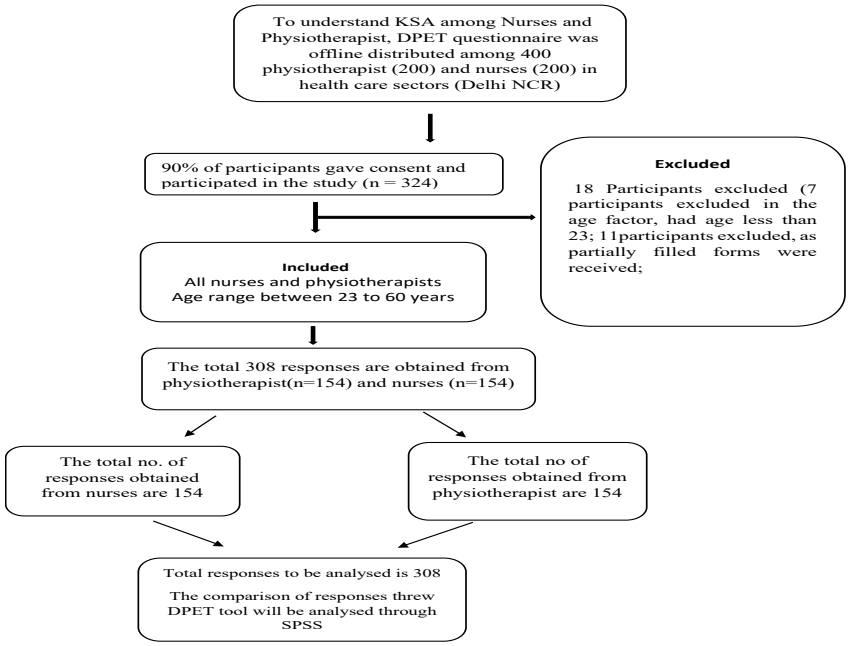

Figure1: Flow Chart of participants selection

Inclusion Criteria

Nurses and physiotherapists were recruited as the researchers in active practice in hospitals, had experience of at least two years, and demonstrated the wish to participate in the survey voluntarily. The age category of the participants varied between 23 and 60 years and both males and females were enrolled in the study field in order to provide various background gender representatives.

Exclusion Criteria

The other allied health professionals were not included in the study, except nurses and physiotherapists to ensure that the study concentrated on the particular comparison between the two healthcare practitioners. Moreover, incomplete survey questionnaires were not used during final analysis and refusals by people not to formally take part in the study were also discounted as a data integrity measure. Individuals below the age of 23 years were also not allowed to take part in order to be consistent with the already established minimum number of years of professional experience criteria.

Data Collection

The questionnaire was of the standard 6 -point Likert type (Disaster Preparedness Evaluation Tool (DPET)[17]. The survey was sent both online and offline to physiotherapists and nurses working in the sphere of healthcare. 400 copies of forms were distributed (200 to physiotherapists and 200 to nurses). 81.5% of the respondents (n=324) agreed to participate in the study and signed the consent. Data was collected between March 23, 2023 and May 22, 2023 after 308 participants were declared as the usable data. All the data collected was validated and stored in MS Excel for statistical analysis.

Statistical Analysis

The SPSS 22.0 was used in statistical analysis. The Kolmogorov-Smirnov testwas used to test the normality of study variables (knowledge, skills and attitude). The data was found to be non-normality distributed. So, Mann-Whitney U test used for comparative approach of knowledge, skills and attitude between physiotherapists and nurses.

Results

Mann-Whitney U tests were done to indicate whether differences between the two groups were significant or not. The findings revealed that the p-value of noting, skill as well as attitude all were greater than 0.05 which indicates that there was no statistically significant difference between the two groups in relation to the above aspects of disaster preparedness. With regard to knowledge, 0.85 with regard to skills, 0.51 and 0.25 with regard to attitude (all values $p>0.05$), which rejects the alternate hypothesis of significant differences between physiotherapist and nurses with respect to disaster preparedness.

Disaster Knowledge

The first variable tested by the DPET was the knowledge-related area that contained 13 questions with a range of 1 to 6 (strongly disagree to strongly agree). The Knowledge of the Physiotherapists (n=154) and Nurses (n=154) had mean ± standard deviations of 52.77±11.079 and 52.34±12.379 respectively.

Disaster Skills

The skills-related domain was developed with 8 DPET items and the responses could vary between 1 to 6 (strongly disagree to strongly agree). The values of the mean ±standard deviations of Skills of Nurses (n=154) and Physiotherapists (n=154) were 33.98±7.249 and 32.69±7.307 respectively. The observed values indicate that the competencies of both cadres of professionals were skewed to normal.

Disaster Attitude

A total number of 15 DPET items were used to measure the attitude domain, values were on a scale of 1 to 6 (strongly disagree to strongly agree). Pearson

correlation showed the mean control ± standard deviations of Attitude for Physiotherapist and Nurses as 65.58±12.003 and 63.92±12.463 respectively. The numbers are observed to show that the attitude of both professional groups were supposed to be normal.

Summary of Statistical Analysis

Table 1. Non-parametric test (Knowledge, Skills, Attitude) results

Variable	Mann-Whitney test	p-value	Hypothesis H0
Knowledge	.855	p=.855	H0 retained
Skills	.051	p=.051	H0 retained
Attitude	.259	p=.259	H0 retained

Table 2. Descriptive statistical variables by professions (Physiotherapists and Nurses)

Variable	Physioth-erapists (N=154)		Nurses (N=154)	
	Mean	SD	Mean	SD
Knowledge	52.77	11.079	52.34	12.397
Skills	32.69	7.307	33.98	7.249
Attitude	65.58	12.003	63.92	12.463

Discussion

The role of disaster preparedness within medical personnel especially nurses and physiotherapist to reduce the effects of disaster, and effectual response and compartment is very important. Such preparedness of these professionals is necessary in the Delhi-NCR region considering how prone to both natural and manmade disasters one is in the area. Thrwi et al., 2024)reported that although nurses are moderately prepared in terms of disaster preparedness, there is a big deficit in terms of skills and psychological preparedness which deserves to be addressed[17]. A study done by Labrague &Hammad 2023, dwell on the knowledge, skill and attitudes of healthcare professionals relating to disaster preparedness have shown that though nurses are usually at the forefront in the event of disaster, their level of preparedness is typically low and this is mainly because of poor disaster response training and education. This disparity has emphasized the necessity to conduct wide-ranging training programs that would improve their preparedness and performance during disasters[18]. Similar results were found in the studies done by Usher et al., 2015 and Wee, 2011, explored the disaster issues of preparedness of nurses, where the nurses with different qualifications showed no significant difference in the disaster preparedness knowledge, skills, and attitudes[19-20].

Research done by Ezhilarasi NM et alreported how nurses were readiness to respond to disasters and effect of disaster management educational intervention program on it.The disaster educational intervention program changed the knowledge in the nurses, found significant improvement in disaster preparedness, when the same nurses were tested after the program[9].Labrague et al. studied Philippine nurses' perceptions of disaster preparedness and found that only 20% felt sufficiently prepared, with 57.7% unaware of workplace disaster management procedures[2].

Dissimilar results were found according toYounis NM et al.,where the awareness of the nurses regarding disaster preparedness in Mosul Teaching Hospital was high and the attitude is neutral, and the readiness is satisfactory [21].Md.Khalid et al., a descriptive survey on the knowledge, skills, and attitudes toward the disaster management in a megapolis showed that disaster management preparedness of nurses in Dhaka was at moderate levels and required further development[22].Basnet et al. conducted a study on disaster preparedness among nurses in Saudi Arabia, revealing moderate awareness (70.07± 10.01), with below-average knowledge and practice levels, but a positive attitude towards disaster preparedness[23].

Patel et al. conducted a cross-sectional survey on healthcare professionals' attitudes towards disaster management in Gujarat, finding that 44.8% had experienced a disaster at work and 45.8% had

received disaster management training. The study highlighted the need for improvement in hospital staff's and patients' attitudes towards disaster vulnerability[1].The level of knowledge and attitude of Iranian nurses towards bioterrorism was assessed by Gorji HA et al. and it was observed to have lack of knowledge and attitude of bioterrorism[24].

Limitations

There are a number of limitations that should be noted in this study. To begin with, it revolved solely around the response and recovery aspect of the disaster nursing disaster, and left out the prevention and mitigation aspects, which are part and parcel in the provisions of a complete disaster preparedness. The fact that a convenience sampling methodology was used to select the nurses and physiotherapists can have created a sampling bias that restricted the representation of the results. Also, the small-scale sample of 308 respondents limits the applicability of findings into the overall healthcare population. The geographical focus of the study was restricted to the area of Delhi NCR, and cannot be generalized to the diversity of the experiences and level of preparedness in other areas. There is also a possibility of reporting bias in the self-reported data collected by the questionnaires as there is a likelihood that answers given depend on the individuals' views and social desirability. In addition to that, any trend or variation in the preparedness level over the years is not possible on account of the cross-sectional nature of the study, which only provides a snapshot at a particular time. Finally, the lack of qualitative data restrains the extent of knowledge on personal stories and facts about the experiences of the participants and corresponding ideas that might have been used to contextualize the quantitative results.

Future Research Directions

In accordance with the results of the present study and its limitations, a number of the future research directions can be proposed to contribute to the discussion and better disaster preparedness in healthcare professionals. The extended geographical investigation of various regions across India would be more representative and homogeneous of the national preparedness levels. It is advisable to undertake longitudinal studies to observe variations in knowledge of disaster preparedness, skills, and attitudes over a period, especially to measured training interventions. A mixed-methods approach to data collection that combines a qualitative research approach with enabling tools like interviews and focus groups will be capable of providing more insightful information on the experiences, opinions, and issues of healthcare providers. Future studies are also needed on the design and testing of organized disaster preparedness education initiatives that are specifically set up to reflect the roles and responsibilities of nurses and the physiotherapists. Moreover, expanding it to include other healthcare professionals (doctors, paramedics, and emergency medical technicians, etc.) would allow making meaningful inter-professional comparisons. The approach would be enhanced by integrating empirical examination of real skill by employing simulated and demonstration-based performance, unlike self-reported information that only monitors preparedness on paper. Lastly, policy impact research is important in determining the changes caused by implementation of the current disaster management policies to improve the preparedness and response capacities of the health worker in the ground.

Conclusion

This study provides valuable insights into the disaster preparedness knowledge, skills, and attitudes of nurses and physiotherapists in the Delhi-National Capital Region. Despite the critical roles these healthcare professionals play in disaster response, the findings indicate no significant differences between the two groups in terms of preparedness. However, notable variations were observed in qualifications when compared pair-wise. The research underscores the need for ongoing educational programs and training to enhance

disaster preparedness, as evidenced by previous studies showing improvements post-intervention. Additionally, the study highlights the importance of comprehensive disaster management strategies, including the need for heightened awareness and readiness among healthcare professionals. Future research with larger sample sizes and broader geographic coverage is essential to further understand and improve disaster preparedness in the healthcare sector. Addressing these gaps will ensure that nurses and physiotherapists are better equipped to handle disasters, ultimately contributing to improved health outcomes and saving lives.

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Effects of 8-Weeks Throwers Ten Program Vs Plyometric Training on Shoulder Performance in Overhead Athletes-A Pilot Study

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Abstract

Background: Thrower'sten exercise program evidenced in previous research to improve strength, power, endurance and has proved to be effective in rehabilitating the muscles of the shoulder complex and preventing injuries in overhead athletes. The main purpose of this present pilot study is to find out whether Thrower's ten exercise program is beneficial in improving the shoulder performancecomparing with plyometric training.

Methods: A total of 40 male athletes were screened between the age groups of 18 and 25 and randomly allocated to Throwers ten group and plyometric training group respectively. Shoulder strength and performance of the athletes is measured using seated medicine ball throw test and closed kinetic chain upper extremity stability test. Participants in Throwers ten group were trained for throwers ten program for a period of 8 weeks, Plyometric group participant were trained for plyometric training for 8 weeks.

Result: Throwers ten program showed substantial difference in improving the shoulder performance when compared to plyometric training. Post test values of throwers ten program in seated medicine ball throw test and closed kinetic chain upper extremity stability test had a significant difference ($p < 0.001$).

Conclusion: Throwers ten program is found to be more effective than plyometric training in improving the shoulder performance among overhead athletes.

Keywords: Throwers ten program, plyometric training, shoulder performance, seated medicine ball throw test.

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Introduction

The shoulder joint facilitates a wide range of movements for the upper limb encompassing actions of the elbow, wrist, and hands. Muscles surrounding the shoulder joint play a crucial role in stabilizing this complex structure. Sports players, in particular, heavily rely on their shoulder joints during matches. [1,2]

For overhead throwers, achieving precise movements relies heavily on a delicate balance between stability and mobility.This balance is necessary to fulfill the functional requirements of repetitive actions on the shoulder complex.[3,4]

The act of throwing overhead demands exceptional skill and precision. During pitching, athletes engage the shoulder complex extensively, subjecting it to considerable forces. Over time, athletes develop adaptive changes in response to the repetitive stresses of overhead throwing, which should also be addressed in treatment.[5,6]

The Thrower's ten program(T10 program) demonstrated effectiveness in enhancing shoulder performance by enhancing both the shoulder joint's mobility and stability. The program typically consist of a set of exercises specifically designed to target the muscles and movements involved in overhead throwing activities.[7,8] By incorporating exercises that focus on strength, flexibility, and dynamic stability, it helps in optimizing shoulder function, mitigate the risk of injury and boost performance in athletes engaged in throwing activities.[9]

The T10 program encompasses a comprehensive range of movements, addressing various aspects crucial for throwing athletes which was established in 1991 by Wilk et al.[6,8] This program focuses on motions specific to throwing, advanced neuromuscular control, dynamic stabilization, strength, endurance, and coordination.This program's targeted exercises focus on strengthening the muscles involved in shoulder retraction, improving proprioception to reduce joint position error, and enhancing overall throwing mechanics.[10]

Plyometrics is a term used in both rehabilitation and conditioning literature to describe activities that leverage the stretch-shortening cycle.[11] These activities strive to optimize force generation or improve performance by tapping into the elastic energy stored within muscles during the eccentric phase of movement and swiftly transitioning to a concentric contraction. This training method is particularly effective in improving explosive power, speed, and agility in athletes.[12]

Plyometric training has also made its way into the field of rehabilitation. Recently published rehabilitation protocols incorporate plyometric exercises as a method to enhance function and aid in the return to sport.[13,14] These protocols recognize the value of plyometric training in rebuilding strength, coordination, and overall athleticism following injury, helping individuals regain the ability to participate in sports activities safely and effectively.[15,16]

The Closed kinetic chain upper extremity stability test(CKCUEST) serves as valuable tool for evaluating shoulder strength and function. This test provides clinicians with valuable insights into an individual's shoulder stability and functional capabilities, aiding in the diagnosis and treatment planning for various shoulder-related conditions and injuries.[17,18]

The seated medicine ball throw test(SMBT) provides a more detailed approximation of movement, closely mimicking the pushing mechanism found in the specific sports identified within this study. Consequently, the involvement of the muscular kinetic chain closely mirrors the coordinated movement patterns observed in the SMBT. Additionally, utilizing the SMBT for validation allows for a more sport-specific assessment of explosive power capabilities.[19] Hence, this present pilot study is to find out the effect of Thrower's ten exercise Vs plyometric training in improving the shoulder performance in overhead athletes.

Method

Study design and participant selection:

The research was conducted in the Physical Education Department of a university in the southern part of India.. Athletes engaged in lifting the hand above the head activities such as Volleyball, Handball, and Basketball were selected for this particular study. Prior to participant recruitment, the study proposal was presented to the Institutional Scientific Research Board (ISRB) and received approval. Ethical clearance was granted for the treatment protocol of the study and the study was approved by the Institutional Scientific Review Board on human subjects (01/035/ 2023/ ISRB/ PGSR / SCPT). [Date:18/04/2023]]."

Inclusion and Exclusion Criteria

Participants were chosen according to the SMBT and CKCUEST.Inclusion criteria included age of 18-25 years and gender - male. Exclusion criteria included of athletes having recent shoulder injury, who underwent recent shoulder surgeries. A thorough analysis has been conducted using prevalence studies and the sample size has been calculated at the beginning of the study using sample size calculator and derived with 40 participants for the study. After providing a detailed explanation of the study to each individual, informed consent was obtained from all 40 participants. Utilizing a closed envelope method, the participants were then randomly allocated into two groups, each consisting of 20 members.

Procedure

Two groups, Group A and Group B, were randomly assigned to participants. At the beginning of the study subjects from both group underwent pre-test which included SMBT and CKCUEST. Group A underwent eight weeks of T10 program Each week, there were three sessions, each lasting forty five minutes. Group B underwent eight weeks ofplyometric training. Each week, there were three sessions, each lasting forty five minutes.After the treatment, participants underwent assessment using the SMBT and CKCUEST. Data on post-test values were collected. Both pre-treatment and post-treatment scores were recorded and subjected to statistical analysis. The findings of this study are specific to a male population aged 18 to 25, which may influence the outcomes. As a result, the generalizability of these results to other age groups and female populations remains uncertain.

Table 1. The T10 program for the T10 group.[10]

	THROWERS TEN GROUP
	T10 PROGRAM
Week 1-4 (Red theraband) Week 5-8 (Green theraband)	1. D2 flexion and extension 2. Internal and external rotation at 90 abduction 3. Supraspinatus and deltoid strengthening 4. Prone shoulder abduction – D2 flexion 5. Prone shoulder extension 6. Biceps and triceps strengthening 7. Rowing 8. Wrist flexion and extension, forearm supination
Week 5-8	Pushups and pullups

Table 2. Plyometric training for the Plyometric group.

	PLYOMETRIC GROUP
	PLYOMETRIC TRAINING
Week 1-4 [2-lbs ball(1 hand drill) and 6-lbs ball (2 – hand drills)] Week 5-8 [2.5-lbs ball(1 hand drill) and 10 -lbs ball (2 – hand drills)]	1. Elastic external rotation 2. Elastic 90/90 external rotation 3. Overhead soccer throw 4. 90/90 external rotation side throw 5. Deceleration baseball throw 6. Baseball throw

Table 3. Parameters for week 1-4 for T10 and plyometric group

PROTOCOLS	WEEK 1-4				
	Repetitions	Sets	Rest interval(sec)	Duration (min)	Frequency (per week)
T10 program	8	3	30	45	3
Plyometric training	10	3	30	45	3

Table 4. Parameters for week 5-8 for T10 and plyometric group

PROTOCOLS	WEEK 5-8				
	Repetitions	Sets	Rest interval(sec)	Duration (min)	Frequency (per week)
T10 program	10	3	30	45	3
Plyometric training	15	3	30	45	3

Outcome Measure

SMBT: The participants were directed to take a seat on the surface with their head, shoulders, and back supported by the wall. Ask the patient to keep their legs without bending the knee on the floor, and they held a two kilograms medicine ball with both upper limbs in a 90° position of abducting the shoulder and flexing the elbows. To ensure consistency, the medicine ball was coated in chalk using in gym, leaving a neat mark on the surface after the throw. A tape which is used to measure was extended across a span of 10 meters on the surface. Athletes were required to propel the medicine ball straight ahead in a linear trajectory, aiming to achieve maximum distance while maintaining full contact with their head, shoulders, and back supported by the wall. Following three trial runs, four trial runs were conducted, 1-minute rest period between the trial runs. To accommodate variations in leth of the arm, the medicine ball was released with arms stretched out in front. The throwing span was calculated by subtracting the distance between the wall and the nearest end of the chalk mark relative to the overall distance achieved.

CKCUEST: Participants are required to assume a push-up position, with 91.4 cm distance between their hands and marked two strips of tape on the surface. Both shoulders should be perpendicular to each other, and the back and lower body should maintain alignment, while the feet are kept within the shoulder-width. From this starting position, participants are instructed to reach across their body with their dominant hand to touch their less used hand, then return to the initial position. Subsequently, the repeat the movement with the less used hand reaching across to touch the dominant hand. The goal is to execute the maximum number of alternating touches possible. within a 15-second timeframe While maintaining the proper form for a push-up. One submaximal familiarization trial is conducted initially, followed by three maximal performance trials and each trial is followed by a 45-second rest period.. Timing is controlled by the first investigator using a stopwatch, while the another investigator keeps track the number of touches aloud. The assessment commences when the second investigator says “go” and concludes when the same investigator says “stop”. This protocol is designed to assess upper body strength, endurance, and coordination under specific conditions, ensuring consistency and accuracy in performance evaluation.

Results

Data was collected using SMBT and CKCUEST before intervention as pre-test values and after intervention as post-test values and was tabulated and statistically analyzed. Pre-test and post-test SMBT and CKCUEST values were examined using paired-t test for T10 group and Plyometric group.

Both group post-test SMBT and CKCUEST values was analyzed using unpaired-t test.

Pre-test and post-test SMBT and CKCUEST values analyzed using paired-t test for T10 group shows a significant increase in shoulder performance. Table 5 showed the T10 group assessed using SMBT and CKCUEST. There is a significant statistical difference [P< 0.001] in the midst of the changes observed after treatment within the group and that would have happened randomly. It was found that SMBT and CKCUEST scores were improved significantly following T10 program.

Table 5: Mean and standard deviation of Throwers ten group(group A).

S NO	OUTCOME	THROWERS TEN GROUP				P VALUE
		Pre test		Post test		
		Mean	SD	Mean	SD	
1	Seated medicine ball throw test	211.3	5.858	311.4	6.073	p < 0.001
2	Closed kinetic chain upper extremity stability test	16.4	2.741	27.5	1.468	

Table 6 showed the Plyometric group assessed using SMBT and CKCUEST. Changes observed after treatment within the group significantly differ [P< 0.001] from those that would occur randomly. It was found that SMBT and CKCUEST scores were improved significantly following Plyometric training.

Table 6. Mean and standard deviation of Plyometric group (group B).

S NO	OUTCOME	PLYOMETRIC GROUP				P VALUE
		Pre test		Post test		
		Mean	SD	Mean	SD	
1	Seated medicine ball throw test	210.55	5.924	270.7	5.894	p < 0.001
2	Closed kinetic chain upper extremity stability test	16.25	2.593	17.8	2.375	

Both group post-test SMBT and CKCUEST values analyzed using unpaired-t test shows a significant difference. Table 7 showed the T10 group and Plyometric group's post test values assessed using SMBT and CKCUEST. Statistically significant difference exists between the mean and standard deviation values of the two groups, a difference that would not be expected by chance (p < 0.001).

Table 7. Post test Mean and SD of Throwers ten group and plyometric group

S NO	OUTCOME	Throwers ten group		Plyometric group		P VALUE
		Post test		Post test		
		Mean	SD	Mean	SD	
1	Seated medicine ball throw test	311.4	6.073	270.7	5.894	p < 0.001
2	Closed kinetic chain upper extremity stability test	27.5	1.468	17.8	2.375	

The T10 group demonstrated a notable improvement in the shoulder performance after 8 weeks, with a p-value of < 0.001. While both groups showed enhancement, the T10 program exhibited a more significant effect than Plyometric training within the 8-week protocol, particularly in improving shoulder performance among overhead athletes, as assessed by the SMBT and CKCUEST.

Discussion

The objective of the present study was to examine the shoulder performances among overhead athletes. The purpose of the study was to assess the efficacy of T10 program for shoulder performance among overhead athletes. Our result suggested that T10 program have a significant impact in improving shoulder performance in overhead athletes. For overhead throwers, achieving precise movements relies heavily on a delicate balance between stability and mobility. The T10 program and plyometric exercises have demonstrated effectiveness in enhancing shoulder performance by improving both mobility and stability of the shoulder joint.[10] These programs typically consist of a set of exercises specifically designed to target the muscles and movements involved in overhead throwing activities.[4]

Gokalp, Ozge MS et al. (2020) conducted a study investigating the impact of T10 exercises on upper limb performance. Their research indicated that the T10 The exercises prove to be effective in enhancing the strength of the muscles around the shoulder girdle and rotator cuff.[10] In a separate study, Nilesh Maharudra Andhare et al. (2018) examined the effect of the T10 program on performance in fast bowlers through a randomized control trial revealed that it is beneficial for improving the performance of throwing distance in fast bowlers.[11]

Plyometric training has also made its way into the field of rehabilitation. Recently published rehabilitation protocols incorporate plyometric exercises as a method to enhance function and aid in the return to sport.[20] Jeffery F. Vossen et al. (2000) conducted a study comparing the effects of Dynamic Push Up Training (DPU) and Plyometric Push-Up Training (PPU) on upper-body power and strength. Their findings revealed that both DPU and PPU training programs led to significant improvements in ball put and chest press tests, with the PPU program showing greater enhancements.[21]

The CKCUEST serves as an assessment tool in orthopedic and sports medicine clinics for numerous years.[22,23] Germanna Medeiros Barbosa et al. (2024) conducted a study focusing on the measurement properties for physical performance tests focusing on the upper extremities in athletes. They concluded that CKCUEST demonstrates adequate reliability between sessions and within sessions supported by evidence of moderate to high quality.[24]

The Medicine Ball Throw (MBT) or SMBT is cost-effective, straightforward to administer, and requires minimal equipment, making it suitable for field testing.George Beckham et al;(2019) concluded a study and stated that SMBT proves to be a dependable method for evaluating upper body explosiveness among college-aged individuals who are recreationally active.[25]

The statistical analysis of the present study suggests that the T10 program significantly improved the shoulder performance in overhead athletes. The strength of the study was that T10 program and plyometric training are simple, easy to administer and cost effective.

Limitation and Suggestion

The limited sample size in the study raises concerns regarding the comprehensiveness to which its results can be applied to broader populations. As a result, future studies should endeavor to overcome these limitations by incorporating larger and more diverse sample populations thereby facilitating a more comprehensive understanding of the phenomenon across a broader spectrum of individuals.

Conclusion

Throwers ten program is found to be more effective than plyometric training in improving the shoulder performance among overhead athletes.

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Conflict of Interest: The authors disclosed no conflict of interest.

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Relationship between Gender and Postural Defects in Adolescents

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Abstract

Introduction: The human body posture takes a place in the mother's womb and physically begins with the birth of the child. In literature, the assessed frequency of presence of postural defects depends on the method of assessment and the adopted criteria of correct body posture. The aim of the study was to assess the relationship between gender and body posture defects.

Materials and Methods: The presented cross-sectional study includes 58 people, 29 boys and 29 girls, students of the secondary school. Assessment of body posture was based on visual analysis and palpation of the body in the sagittal and frontal planes. In addition, the following clinical tests were used: Thomas test, Ober's test, Patrick's test, and toe-floor functional test. The physical activity was also considered.

Results: The results of research show there is relationship between the sex of the participants and the occurrence of body posture defects in the sagittal plane.

Conclusions: 1. The gender of adolescents may predispose to a specific posture defect.

2. Insufficient amount of physical activity can be a contributing factor of posture defects.

Keywords: Physical activity; defect; posture

Introduction

The human body posture takes a place already in the mother's womb and physically begins with the birth of the child [1]. There are significant nosological discrepancies in the literature regarding the posture defect. According to Professor Wiktor Dega, it is a set of postural abnormalities defined as minor single deviations from correct posture, which may be repaired with the use of appropriate exercises, passive or active [2]. In literature, the assessed frequency of presence of postural defects depends on the method of assessment and the adopted criteria of correct body posture. Studies concerning the conditions of children and teenagers' health have shown that the incidence of postural defects in this population ranges from 30 to 60% [3,4]. Health Behavior in School aged Children (HBSC) results,

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concerning the health of children in Europe, coordinated in Poland by the Institute of Mother and Child clearly show that recently, there has been an increase in the number of factors conducive to the development of postural defects [5]. Excess in sedentary activity is observed, defined as the type of activities related to low energy expenditure, most often in a sitting position (spending time in front of TV, a computer). The authors of the report have observed that in the period of 2002–2010, the rate of children watching TV decreased, while playing the computer increased and they are forecasting that the time spent in front of a computer will be getting longer and longer in relation to introducing e-books for school. Moreover, the report of HBSC indicates that Poland has the highest rate of obesity and overweight among adolescents in Europe. Maciałczyk-Paprocka et al. carried out the research with group of 2,732 children. Results of the study confirmed the relationship between obesity and more frequent presence of postural defects. It is worth to emphasizing that 74% of obese children had abnormalities in body built [6]. The most frequently diagnosed abnormality were valgity of the knees and platypodia. In turn, among children with correct body weight, the most frequently observed ones were kyphosis and funnel shaped thorax. Obesity in children leads to limiting physical activity and problems related to the osteomuscular and ligament system, such as slipped capital femoral epiphysis or the Blount's disease [7].

We can distinguish three main factors that affect of body posture:

Environmental factors include primarily a sedentary lifestyle. Young people spend from 5 to 7 hours sitting at school, 2 to 4 hours doing homework and 1 to 2 hours eating meals. In addition, most of them are also resting by sitting down, playing computer games, watching TV, reading. Consequently, sedentary lifestyle is one of the main causes of body posture defects. The environmental factors also include: poorly chosen footwear and clothes, incorrect arrangement of the bag or backpack, a desk or school bench, bad lighting [8].

Morphological factors include changes in muscle tone, with certain muscle groups becoming contracted, tense, stretched or weakened. As a consequence, it leads to incorrect positioning of individual parts of the body in relation to each other and at a later stage to postural defects [8].

Physiological factors are responsible for the habitual misalignment of posture. This positioning does not require any special effort and the adoption of the correct body posture requires the tension of certain muscle groups and controlling one's own body, which is already an effort, therefore the person takes a "comfortable" position. The causes of habitual inappropriate posture include, for example, myopia, hearing impairment, body height, as well as deep sensation and mental state [8].

The aim of the study was to assess the relationship between gender and body posture defects.

Materials and Methods

In the study participated 58 people, 29 boys and 29 girls, students of the secondary school in Nowy Dwor Mazowiecki in Poland. The children's parents and children gave their informed consent to participate in the study. The respondents attended the first and second year of the high school. The mean age of boys was 16.55 ± 0.51 years, and of girls - 16.34 ± 0.48 years. The body weight of boys ranged from 52 kg to 95 kg, and girls from 40 kg to 60 kg. The body height of boys was 1.56 m to 1.92 m, and of girls 1.54 m to 1.78 m.

Assessment of body posture boys and girls was based on visual analysis and palpation of the body in the sagittal and frontal planes. In addition, the following clinical tests were used: Thomas test, Ober's test, Patrick's test, and toe-floor functional test, which were aimed at assessing the flexibility of the subjects. All tests were performed in accordance with the methodology provided by K. Buckup [9].

Observations from the examination were recorded in the patient's examination card, which is based on the Kasperczyk scoring method. Zero points were assigned when the orientation of the

tested elements was the same, normal, normal and / or neutral and when the test result was negative, one point was awarded when a slight deviation from the normal condition was observed, and in the remaining cases two points were assigned. The patient could be scored from 0 to 72 points, more points mean the worse body posture. For the purposes of the study, the number of points for the correct posture, was determined less than 22 points (up to 30% of the maximum number of points), the average posture was in the range of 23-54 points (from 31% to 75% of the maximum number of points) and incorrect attitude, exceeded 55 points (more than 75% of the maximum number of points) [8]. An attempt was also made to evaluate the physical activity of this group of young people and their preferences regarding the type of exercise and the most popular sports. For this purpose, a questionnaire consisting of 16 questions was prepared, including one record question. These questions concerned the physical activity practiced by the examined person, the time devoted to exercise, preferences as to taking up a specific form of exercise, factors that make it difficult to take up physical activity. Each of the surveyed persons completed the questionnaire independently. On the basis of the created questionnaire, it is possible to determine the influence of activity on physical development of boys and girls. The level of physical activity in this age group was also determined and it was checked whether the respondents met the condition of the recommended physical activity. The MVPA (moderate to vigorous physical activity) index indicates that optimal physical activity come to 60 minutes of moderate to vigorous exercise, 5 days per week, Selected data are presented in the charts. Graphic design was done in Microsoft Office Excel 2007. The STATISTICA 6 program was used to calculate the data.

Results

The characteristics of selected parameters the body structure of the examined persons are presented in Table 1 and Table 2. Body Mass Index (BMI) was calculated on the basis of the body structure parameters like body weight and height.

Table 1. Characteristics of selected build parameters of the examined boys

	BOYS		
	X	**SD**	**Range of values**
Body weight [kg]	74.45	13.51	52 - 95
Body height [m]	1.75	0.08	1,56 - 1,92
Age	16.55	0.51	16 - 17
Body Mass Index (BMI) [kg/m2]	24.12	3.53	16.98 – 31.99

X – mean; SD – standard deviation

Table 2. Characteristics of selected build parameters of the examined girls

	GIRLS		
	X	**SD**	**Range of values**
Body weight [kg]	54.40	9.25	40 - 69
Body height [m]	1.66	0.07	1.54 – 1.78
Age	16.34	0.48	16 - 17
Body Mass Index (BMI) [kg/m2]	19.79	2.92	16.18 – 26.30

X – mean; SD – standard deviation

Body posture defect was observed and assessed in the sagittal plane. The relationship between gender and postural defect is presented in the Figure 1. It turned out that the most common posture defects in girls were valgus knees and round-concave back. In boys, such defects as valgus knees and flat back.

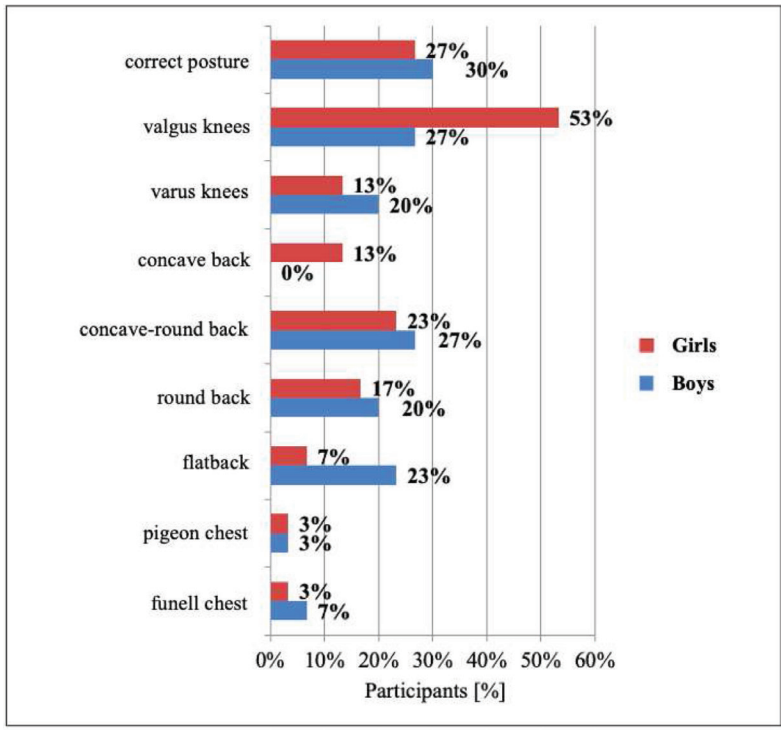

Figure 1: The relationship between gender and postural defect

Observing the frequency of sagittal posture defects and lower limb defects depends on gender, it was noticed that approximately 20% of boys had a flat back and varus knees, and approximately 20% had a round back and valgus knees (Fig. 2). There were the same number of girls with valgus knees and flat back as girls with valgus knees and round-concave back (Fig. 2).

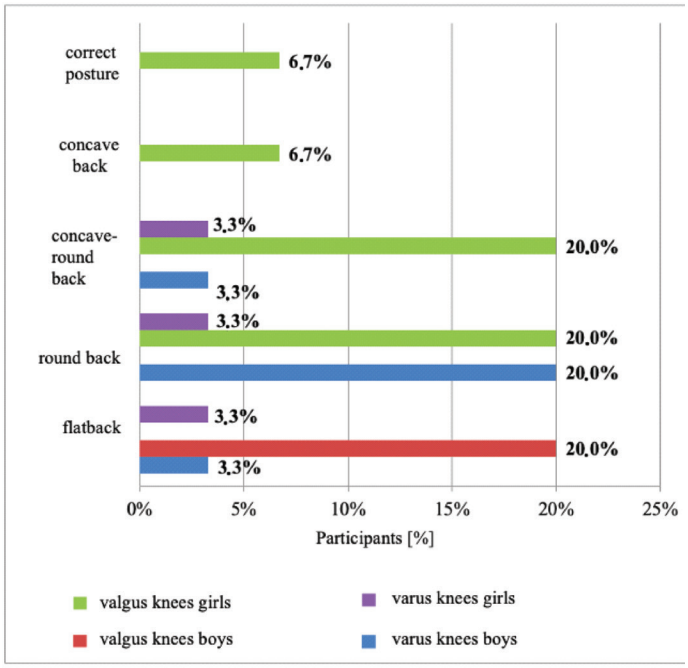

Figure 2: The relationship between body posture defects in the sagittal plane and lower limb defects

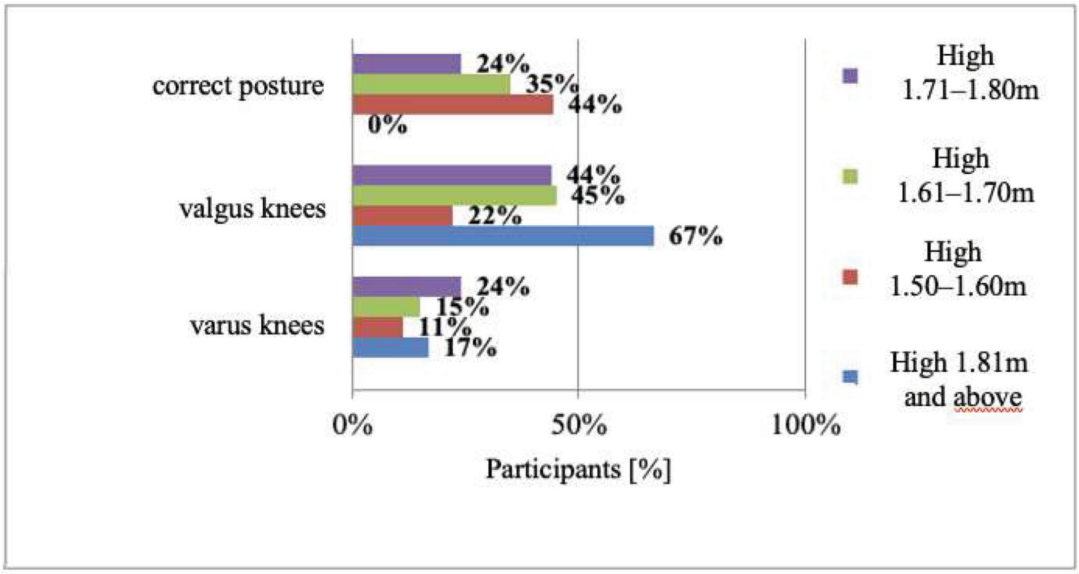

Figure 3: The relationship between height, gender, body posture and lower limbs defects in the sagittal plane

The occurrence of posture defects in the sagittal plane and defects of the lower limbs were associated with on body height and sex examined persons. (Fig. 3). None of the boys measuring 1.81 m or above had the correct body posture, and the most common posture defects in this group were valgus knees and round back. The largest number of people with the correct posture was in the 1.5 - 1.6 m group. The participants were also asked about physical activity. They clearly indicated recreation as a form of physical activity and believed that physical activity is important for health. The participants stated in the questionnaire, that lack of time (16.7 %), lack of motivation (16.7 %) and lack of opportunities provided by the environment (16.7 %) were the most frequently mentioned factors hindering physical activity. All of the mentioned functional tests were positive, which suggested incorrect muscle group tension.

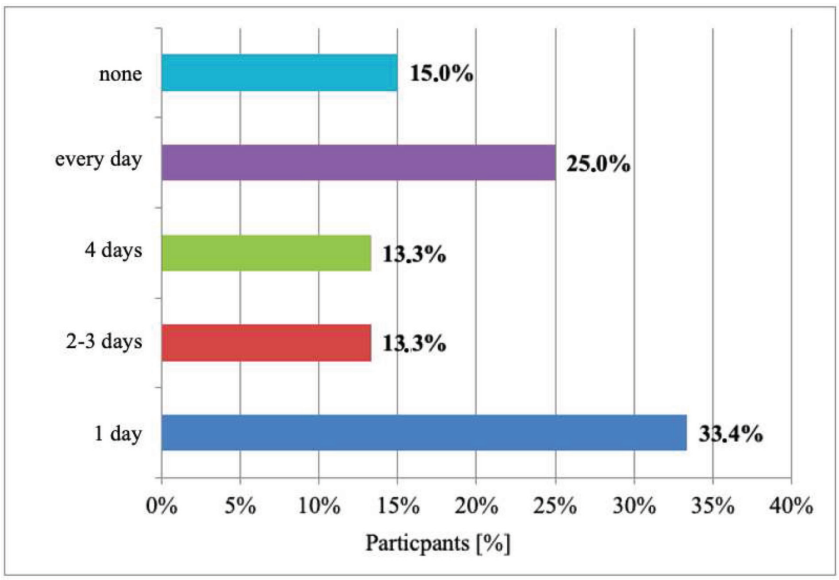

Figure 4: How many times a week do you undertake physical activity?

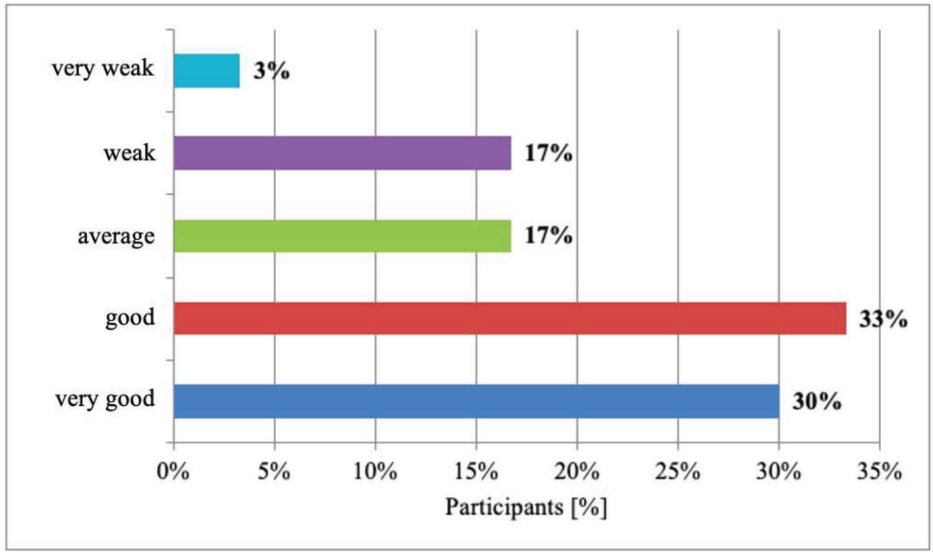

Figure 5: How will you assess your current physical fitness?

Discussion

There have been long discussions about what characterizes the correct human posture and how to describe it. Chudak et al. (2011) and Kasperczyk (2004) wrote in their works that correct posture depends on the correct shaping of the bone-ligament system, a well-developed and efficient muscular system, and an efficiently functioning nervous system. Moreover, the authors stressed that the symmetry of the body's long axis is important in the study of body posture. When observing the patient from behind, the correct body posture is expressed when the line leading from the external occipital tuberosity passes through the spinous processes of the spine, the buttock gap and falls on the center of the support plane (quadrilateral of support), and the reference points on the right and left sides of the body are equidistant from this line [10]. The position of the head, the shape of the spine curves in the sagittal plane and its position in the frontal and transverse planes, the arch of the chest, the position of the pelvis, hip and knee joints, and the arch of the feet are also subject to observation [8]. Posture can be easily measured, but it is difficult to analyze the obtained results, and in particular to assess the curvature of the spine in the sagittal plane. So far, no clear boundaries between physiological and pathological curvature have been established, and therefore some researchers, when assessing the curvature of the spine, take into account the mean values of measurements from other studies using the same method [11]. Walicka-Cupryś et al. (2010a) noted significant differences in the reported results due to the use of different research methods by different authors. It should also be remembered that these results are not the limits of the norm, but only reference points that are used to assess body posture, identify the presence of posture defects or establish corrective procedures [11]. Moreover, the same authors wrote that despite the fact that body posture is individually variable, it is subject to assessment both in individuals and in a homogeneously selected group, where it is defined as correct or incorrect. However, in the assessment of body posture, the following research method is important (accuracy, repeatability of the method) and the knowledge of the criteria of the method parameters [11]. Science looks for the causes of posture defects and many authors argue that the most common cause of changes in posture is a child's more sedentary lifestyle. Hagner et al. (2010) confirm this fact in their work, examining the body posture of the same children in the age of 6 and 10. The results of the research showed that there were more body posture defects in older children - 41.47% of 76 people aged 6 years old had good posture, and only 28.83% of people aged 10 years. Moreover, the authors stated

that the increase in the incidence of postural defects in children by 14.64% in the first years of education is alarming and preventive measures should be introduced in primary schools [12]. However, Wiernicka (2010) described in her work that no sudden changes in body posture were observed between the age of 9 and 11 of a child. However, it was noticed that, if the posture defects have already developed, they usually get worse in the following years. The author encourages a careful assessment and observation of children's body posture, as these preventive measures have a chance to reduce the risk or even prevent the development of posture defects. In order to convince the public opinion to take preventive measures to combat posture defects among children and adolescents in schools, many authors in their works prove the consequences of these defects. Stępień et al. (2007) proved in a group of 61 people with idiopathic scoliosis I°, II° and III° according to the Cobb angle that the symmetry of the load on the feet during walking is disturbed (during the shifting and rebound phase). The reason for this is probably the abnormalities of the spine's movements in the transverse plane (rotation and counter-rotation). On the other hand, the load on the lower limbs while walking depends on the size and location of the curvature of the spine. Numerous asymmetries in the respondents are compensated for in the motor system and may lead to further disorders, because they favor the already existing defects and help to create new ones [13]. The authors argue that further research on this topic is necessary. The study by Wilczyński (2010) concerned the relationship between foot loading and body posture in the sagittal plane in a group of 503 people, including 206 people with a faulty posture. It turned out that children with defective body posture obtained higher values of mean X (SPOX) and Y (SPOY) load points on the stabilometric platform, but these differences were not statistically significant. The author stated the need for further research on balance in people with posture defects [14]. Afeltowicz-Mich et al. (2010) studied the effect of lateral curvatures of the spine on the mobility of the chest in 37 people on the basis of parameters such as the size of the Cobb angle of curvature, the value of rotation of the apical vertebra according to Perdiolle, the length of the curves, method of treatment (therapeutic corsets) and physical activity (physiotherapy). The authors proved that the first two parameters are not related to the chest movement. Moreover, they noted that corset treatment in people who exercise as part of physical therapy has no significant effect on the mobility of the chest [15]. Problems in the posture of children and adolescents are always topical and require constant monitoring. In order to increase the ability to assess body posture and posture defects, scientists are constantly working on new, more reliable, reproducible techniques for studying and measuring the locomotor system.

Physical activity is a proven and often used form of preventive measures, and at the same time fighting with existing posture defects. Physical activity is the most important factor determining the health, mental and physical development of children and adolescents, and in adults it improves the quality of life. According to the World Health Organization (WHO), the state of health is "a state of complete physical, mental and social well-being, with the complete absence of disease or disability"[16]. Chabros et al. (2008) concluded that in order to protect children and adolescents from the consequences of lack of exercise, it is very important to make this group of people aware of the beneficial effects of physical activity on health and to encourage them to change their lifestyle to a more active one. Physical activity recommended for children and adolescents is one that is undertaken at least 5 days a week and lasts no less than 60 minutes [17]. Based on other sources, incl. American College of Sports Medicine, American Heart Association, World Health Organization, Wojtyla-Buciora et al. (2010) and Grzegorczyk et al. (2008) wrote that the recommended optimal activity is 5 days a week for 60 minutes of moderate to vigorous physical activity (MVPA) in young people and for 30 minutes in the elderly. In the presented study, a physical activity survey was also used. Among young people aged 16-17 from Nowy Dwor Mazowiecki, over 83% of respondents stated that they do some physical activity, and the same number of people believed that it had a beneficial effect on their health. However, only 25% of the respondents

spent their time actively every day, the majority of people (33.4%) declared taking up exercise only once a week, and 15% answered that they are not active at all during the week. The duration of such additional physical activity was not longer than an hour during the day - 25% declared less than an hour of exercise during the day, and 33.4% one hour of exercise. It can therefore be concluded that in the studied group of young people from Nowy Dwor Mazowiecki, the undertaken by respondents physical activity was insufficient and too short to meet the minimum defined by the MVPA index.

Monteiro et al. (2011) concluded that higher levels of physical activity in adolescents had a protective effect on body image dissatisfaction independent of BMI or gender [18]. Additionally, Neumark-Sztainer et al. (2006) observed among females that lower levels of body satisfaction predicted lower levels of physical activity independent of BMI, however this study examined longitudinal associations between body satisfaction and health behaviors in adolescent boys and girls [19]. Finne et al., indicates body image was a statistically significant positive predictor of MVPA for adolescents [20]. The results of the cited studies confirm our observations to some extent. Satisfaction with one's own body can affect the desire to engage in physical activity. Insufficient physical activity correlates with posture defects.

Our research shows that there is a relationship between the sex of the examined people and the occurrence of body posture defects in the sagittal plane. Girls in the 16-17 age group are more likely to have valgus knees than boys of the same age, while boys are more likely to have a flatback and a concave back.

There is also a relationship between the occurrence of body posture defects in the sagittal plane and lower limb defects in the examined people. Boys had flat back and varus knees or had round back and valgus knees, and girls had valgus and flat back or round-concave back.

The self-assessment of the physical fitness of the surveyed adolescents showed that more than half of the respondents described it as very good and good. However, due to the fact that the physical activity undertaken by this group is not consistent with the MVPA index, it can be concluded that this self-assessment is too optimistic, and despite this, it is necessary to convince the respondents to increase the frequency of the form of exercise.

Conclusions

1. The gender of adolescents may predispose to a specific posture defect.
2. Insufficient amount of physical activity may cause posture defects.

Study Limitations

The first serious limitation is the number of participants taking part in the study. 58 people (29 in each group) makes the sample not representative. Due to the small sample size, and groups not meeting some requirements of statistical tests, it is not possible to conduct an accurate, reliable and credible statistical analysis. Its interpretation would be burdened with an error. Another significant limitation is the observation assessment itself, which is not perfect and objective. In the future, it is worth considering a larger study group, usin measurement tools such as the Spine 3D platform, Mora 4G camera, and stabilometric platforms, which will certainly allow for accurate quantitative and qualitative measurements.

Compliance with Ethical Standards

The study has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Patient Consent Statement

All study participants and their legal guardian, provided informed written consent prior to study enrollment.

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Original Article

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Effect of Physiotherapy Interventions on Amaxophobia Among Car Driving Population- A Pilot Study

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Abstract

Background: Amaxophobia, a type of situational or driving fear, is an anxiety disorder marked by an excessive fear of specific stimuli related to driving, in which exposure produces higher anxiety levels. When this phobia strikes, a person might experience such severe anxiety that they are unable to drive or travel in any vehicle. Anxiety- and fear-regulating brain regions receive input via the vagal nerve. By targeting on the vagus nerve, taVNSprovides a non-invasive means of influencing anxiety-related neural circuits. The purpose of this study was to determine the effectiveness of physiotherapy interventions in alleviating amaxophobiasymptoms and improving driving relatedconfidence among car drivers,emphasizing its potential significance in enhancing mental well-being.

Methods: Total 20 car-driving professionals diagnosed with amaxophobia symptoms were chosen through random allocation and divided into two groups, A and B; each group consists of 10 participants. Transcutaneous auricular vagal nerve stimulation of frequency 20 Hz with the Jacobson relaxation technique was given to one group, and the other group received taVNS of frequency 30 Hz with the Jacobson relaxation technique for a period of four weeks. James Whetstone's measure of amaxophobia was used as an outcome measure in this study.

Results: Following the four-week intervention, both groups' scores on the James Whetstone scale of amaxophobia significantly decreased. ($P = <0.001$). The rate was noticeably greater in Group A than in Group B. These results contribute to the exploration of non-invasive strategies to enhance the well-being of driving professionals working in demanding environments.

Conclusion: The findings suggested that transcutaneous auricular vagal nerve stimulation found to be beneficial and effective intervention in alleviating the symptoms of amaxophobia and improving driving related confidence among car drivers.

Keywords: Concha cymba, driving fear, Vagal nerve, Jacobson relaxation technique, transcutaneous vagal stimulation.

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Introduction

Amaxophobia, a type of situational or driving fear, is an anxiety disorder marked by an excessive fear of particular stimuli related to driving, in which these exposure produces higher anxiety levels, leading to the development of confrontational behaviour's, contributing to significant distress. This condition reflects the complex challenges inherent in modern societal living [1]. For the majority of people, driving plays an essential role and significant portion of their daily lives. Driving is known to be significantly influenced by emotions, particularly in terms of human behaviour in which they have a direct impact on driving ability[2]. It appears that driving phobia is quite common and about fifteen percent of drivers report having amaxophobia manifestations. [3]. Approximately one percent of population suffer from severe driving phobiaand these people are predominantly young women [4].

Anxiety can be categorized into four main types: panic attacks, societal anxiety, specific phobias, and generalized anxiety disorder [5]. In terms of classification, Amaxophobia falls under anxiety disorders as a specific phobia [6]. Several diagnoses, including social anxiety, panic disorder, and PTSD, are considered to be a component of driving fear. [7]. Frequent vehicle crashes are the leading cause of driving fear or amaxophobia. Therefore, amaxophobia frequently develops in response to a particularly traumatic car accident that results in injuries. For instance, symptoms may include might heightened perspiration, tachycardia or hyperventilation and person might feel fear of losing control while driving [8]. Studies found that amaxophobia symptoms are also reported by certain unskilled drivers and passengers who have never been in a catastrophic car accident. In certain cases, the driving fear may be a symptom of agoraphobia [9].

The diagnostic tools for driving anxiety are Driving Behaviour Survey, Driving Cognition Questionnaire, Driving and Riding Avoidance Scale, Vehicle Anxiety Questionnaire, Driving Anxiety Questionnaire, Automobile Anxiety Inventory, James Whetstone of Amaxophobia [10] [11] [12][13]. The pharmacological management of anxiety includes benzodiazepines, selective serotonin reuptake inhibitorsand other atypical neuroleptic agents. The adverse effects of drugs need to be understood by both patients and doctors. [14]. Behavior therapy is the most widely administered as a course of therapy for driving related fear and anxiety[15]. Additional techniques for treating anxiety include mindfulness-based approaches, acceptance and commitment therapy, metacognitive therapy, non-invasive stimulation methods and other physical activities [14].

Vagus nerve stimulation (VNS) is a powerful anticonvulsant that has also been shown to have antidepressant properties. in chronic depression that is resistant to treatment. Because the vagus nerve transmits information to brain areas including the insula, hippocampus and orbitofrontal cortex that are crucial for controlling anxiety, this pathway may contribute to the perception or manifestation of different physical and cognitive symptoms that are distinctive of anxiety disorders [16].Ventureyra was the one who first proposed t-VNS device. Since then, studies have demonstrated that these devices can achieve the same level of effectiveness as implantable devices, in addition to offering the advantages of portability, low cost, non-invasiveness, and reduced side effects[17]. Since parasympathetic activity is regulated by the vagal system, targeted treatment by stimulating the vagal nerve can be used in stressful situations.In recent years, investigations including electrophysiology and neuroimaging have shown that central vagal circuits are activated by taVNS similarly as vagus nerve stimulation with an implanted electrode [18] [19] [20] [21] [22]. This study demonstrated that stimulating the thevagus nerve's auricular branch with transcutaneous VNS which activates vagal pathways similarly to an implanted VNS. Therefore, taVNS reveals the improved parasympathetic function [23]. The non-invasive technique of taVNS is effective in lowering the levels of anxiety [24]. Progressive muscle relaxation can be used as an adjunct therapy to traditional medical care to minimize the intensity of anxiety and sleep disruptions [25]. Depression, anxiety, and tension can be effectively reduced using Jacobson relaxation [26]. The purpose of this research is to find that which extent the driving phobia influenced by transcutaneous auricular vagal nerve stimulation (taVNS).

Materials and Methods

Study Design and Participation Selection

From April 2023 to December 2023, a study was conducted for nine months. The car drivers were invited for this study through social advertisements; the advertisements were circulated through mail and other social platforms, and car drivers who came for other complaints to a tertiary suburban hospital in the southern part of India were also invited.

Inclusion and Exclusion Criteria

Participants of both genders between the ages of 25 and 35 who had experienced trauma in the past, as well as those who have had regular driving experience before the triggering incident, had scores of greater than 40 on the James Whetstone's scale of amaxophobia scale (components such as feeling anxious and nervous when vehicle approach or motorists blow their horn,perspire more than normal while in vehicle were the chief complaints) and participants with valid car driving license were included in this study. Participants with color blindness, photophobia, blurred vision, hearing aids, other neurological illnesses, cardiovascular diseases, and recent injuries were excluded, as were those with a GAD-7 score below 14 (adults less than 14 were deemed to have mild to moderate anxiety symptoms). The study included 20 car drivers who met the inclusion and exclusion criteria. All 20 participants were informed about the study and provided their informed consent using the closed-envelope procedure.

Demographic Details

FEATURES	N
Age	
25-30	11
31-35	9
Gender	
Male	18
Female	2
Work status	
Full-time	13
Part-time	4
Self-employed	3

Procedure

20 driving professionals were divided into two groups, A and B. Each group consists of 10 participants. A pre-test, such as James whetstone's measure of amaxophobia, was administered before the intervention. During the course of four weeks, Group A underwent transcutaneous auricular vagal nerve stimulation (taVNS) of frequency 20Hz**,** 0.2ms pulse width, 1 milliamperes amplitudewith Jacobson relaxation exercises andGroup B underwent taVNS of frequency 30Hz, 0.2ms pulse width, 1 milliamperes amplitudewith Jacobson relaxationexercises for a four-week period, with four sessions per week and 60 minutes allotted for each session. 30 minutes for taVNS and 30 minutes for Jacobson relaxation exercise**.** During vagal nerve stimulation, the electrodes were positioned over the left ear's cymba concha, an area that receives nerve supply from the auricular branch of the vagus nerve with stimulation intensity set to the highest level the patient could tolerate was chosen as the stimulation setting. Participants in the Jacobson relaxation exercise was told to close their eyes and find a comfortable seat. Tighten the muscle and hold it for slow counts of five seconds during this portion of the exercise cycle. Then, rapidly and totally relax the muscle for ten seconds. After every step, to help you calm down, take three deep breaths, in via your nose and out through your mouth. The James Whetstone measure of amaxophobia post-tests values were evaluated after four weeks following the intervention.

Figure 1: Jacobson relaxation technique- shoulder in relaxed position

Figure 2: Jacobson relaxation technique- Forearm muscle contraction

Figure 3: Jacobson relaxation technique- Elbow flexors contraction

Figure 4: Transcutaneous auricular vagal nerve stimulation

Outcome Measure

James Whetstone Measure of Amaxophobia

James Whetstone has developed a comprehensive measure for amaxophobia, or the fear of driving, known as the Vehicle Anxiety questionnaire. This assessment tool explores driving phobia across 6 distinct dimensions: Compensating driving related behaviours, Passenger anxieties, Physical manifestations of anxiety, Limitations to mobility, Avoidance behaviours and Challenges to personal and relationship stability. Respondents answer the questionnaire using a scoring system. The total score provides an indication of the severity of the driving phobia, with higher scores suggesting a greater level of anxiety. This scale demonstrates excellent criterion validity and convergent validity.

Statistical Analysis

Both groups were given a post-test after the 4-week intervention, which included the James Whetstone measure of amaxophobia. The pre- and post-test results for the two groups were compared using the Wilcoxon Signed Rank Test for James Whetstone measure of amaxophobia. The post-test variances for James Whetstone measure of amaxophobia for both groups were assessed using the Mann-Whitney Rank Sum Test was analysed.

Table 1. Pre-test and post-test values of group a obtained using wilcoxon signed rank test

TEST	MEDIAN	25%	75%	W value	Z value	P value
PRE-TEST	48.500	46.500	50.250			
POST-TEST	25.500	23.500	27.250	-55.000	-3.051	=0.002

Table 2. Pre-test and post-test values of group b were obtained using wilcoxon signed rank test

TEST	MEDIAN	25%	75%	W value	Z value	P value
PRE-TEST	49.000	46.250	52.000			
POST-TEST	37.500	35.750	38.250	-55.000	-2.823	=0.002

Table 3. Post-test values group a and group b obtained using mann-whitney rank sum test

TEST	MEDIAN	25%	75%	T value	P value
PRE-TEST	25.500	23.500	27.250		
POST-TEST	37.500	35.750	38.250	55.000	=<0.001

Results

In the statistical evaluation of the collected data for James Whetstone measure of amaxophobia, both the pre- and post-values of groups A and B were evaluated with the Wilcoxon Signed Rank Test. In the pre-test of group A, 48.500 was the median value, 46.500 was 25% of the value, and 50.250 was 75% of the value. In the post-test, 25.500 was the median value, 23.500 was 25% of the value, and 27.250 was 75% of the value. A difference that was statistically significant was discovered (P = 0.002). In the pre-test of group B, 49.000 was the median value, 46.250 was 25% of the value, and 52.000 was 75% of the value. In the post-test, 37.500 was the median value, 35.750 was 25% of the value, and 38.250 was 75% of the value. A difference that was statistically significant was discovered (P = 0.002). The post-test results for the James Whetstone measure of amaxophobia were examined using the Mann-Whitney Rank Sum Test between groups A and B. In Group A, 25.500 was the median value, 23.500 was 25% of the value, and 27.250 was 75% of the value. In group B, 37.500 was the median value, 35.750 was 25% of the value, and 38.250 was 75% of the value. The two groups' median values differ beyond what would be assumed by chance; a difference that was statistically significant was discovered (P = <0.001). There was a statistically significant variance between groups A and B post-test. The P-value was = < 0.001 in the James Whetstone measure of amaxophobia post-test.

Discussion

Our study was designed to alleviate amaxophobia symptoms among car drivers who previously underwent driving anxiety or past negative traumatic experience that exists among certain car drivers. Amaxophobia, a type of driving fear, marked by an excessive fear of particular stimuli related to driving, in which these exposure produces higher anxiety levels[1]. There are various treatments aimed at lowering anxiety levels. taVNSis one such treatment that can both lower anxiety levels and enhance sleep quality. It is a less-invasive method that involves applying an electrical current through surface electrodes at specific sites. Usually, it impacts either the auricular or the cervical branch of the vagus nerve.[27]. Yating Wu et al., previously a s conducted a study on the use of taVNS in patients with primary insomnia. Participants underwent this stimulation twice daily for 20 minutes over the course of a month. They concluded that taVNS at 20 Hz improved their reduced their anxiety, quality of sleep and depression with good safety [28]. Yue Jiao et al., conducted an experimental study in which they discovered that, after four weeks, taVNSdecreased anxiety,depression and reduced insomnia, [29]. Smith,J et al., also concluded that taVNS exhibits as a non-invasive and potentially effective treatment for phobias[30]and also taVNS offers a promising approach for individuals who are unresponsive to traditional treatments. There are additional techniques for lowering anxiety levels. The Jacobson relaxation technique is one of the treatments[25]. Akbari Ali et al., conducted an experimental study in which they concluded that relaxation techniques such as Jacobson and Benson are beneficial in lowering anxiety, depressionin multiple sclerosis patients [26]. In addition, Vignesh Srinivasan et al., suggested that taVNShas been shown to be a potent and successful intervention for reducing anxiety, thus highlighting the potential importance of this technique in improving mental health. [24]. taVNS is a non-invasive, targeted treatment for severe or treatment-resistant amaxophobia, offering a unique mechanism of action and biologically informed strategy for reducing phobic symptoms[31]. Recently,New Zealand studies report a prevalence of driving anxiety from 25 to 69% according to the age range of the population considered (18–87; 55–72; or over 65). In addition,

these data agree on an over-representation of women among people concerned by this anxiety

The statistical analysis of this study indicates that interventions of taVNSwith frequency of 20Hz combined with the Jacobson relaxation technique proved to be more effective at lowering amaxophobia symptoms and improves the driving confidence among car driving individuals. The strength of this study lies in the non-invasiveness, simple and affordability, all these characteristics make the interventions accessible and feasible for implementation, potentially increasing their utility in real-world settings.

Limitation

The limitation of this study includes small sample size with specific region. The recommendation includes, that this study can be done among two-wheeler and truck drivers with large sample size. This approach would offer a more comprehensive understanding of the effectiveness of interventions and strengthen the evidence base for their implementation in clinical practice.

Conclusion

It has been determined from the present research that taVNSis a safer and more effective method to alleviate the symptoms of Amaxophobia and improving driving confidence among car driving individuals.

Ethical Clearance*:* 01/018/2023/ISRB/PGSR/SCPT

Conflict of Interest: The author declares no conflict of interest.

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Original Article

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Effect of Constraint- Induced Movement Therapy and Mirror Box Therapy for Fine Motor Function in Stroke Patients – A Feasibility Study

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Abstract

Background: Stroke generally leads to substantial impairment of fine motor function, particularly in the upper limbs, impairing independence and quality of life. Mirror Box Therapy and Constraint-Induced Movement Therapy (CIMT) are two cutting-edge rehabilitation methods that use neuroplasticity to improve motor recovery. By limiting the unaffected side, CIMT encourages functional use of the affected limb, whereas Mirror Box Therapy uses visual feedback to encourage motor imagery and cortical reorganization. This study investigates the feasibility and combined effects of CIMT and Mirror Box Therapy in improving fine motor function in stroke patients.

Methods: The study was conducted with 20 participants of population in post MCA stroke patients aPrivateMedical College and hospital, Chennai using random sampling technique based on inclusion and exclusion criteria. The study was explained to the subjects and the written consent was obtained from the subjects. The participants were split into two groups, Group A- 10 and Group B- 10. Group A was treated with CIMT and task -oriented training. Group B was treated with mirror box therapy and task -oriented training.

Conclusion-Cimt: Group showed substantial difference in improving fine motor activities in contrast to Mirror Box group, post-test values of CIMTgroup in Fugl Meyer Upper Extremity scale value where the p value is < 0.0001. The investigation finds that Constraint-induced movement therapy along with task -oriented training was effective in improving fine motor activities among the geriatric stroke patients.

Keywords: MCA stroke; CIMT; mirror box therapy; task-oriented training; fugl Meyer scale.

Introduction

Acute Ischemic Stroke (AIS) is strongly indicated by the quick onset of impairments associated to the nervous system. This occurs due to the existence of an acute vascular aetiology that affects the central nervous system locally and lasts for at least 24 hours.

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It causes significant disruptions to the associated functions of the affected areas and may even be fatal.Approximations suggest that stroke occurs in approximately 12.2 million individuals each year, positioning it as the second leading cause of mortality globally, after coronary artery disease [1]. It also affects an estimated 795,000 patients in the United States, according to estimates [2]. Furthermore, research findings indicate that stroke accounts for approximately half of the cases of disability and heightened health complications among individuals aged 65 and above, ranking it as the third most prevalent cause following stroke survival[3,4]. In order to prevent serious neurologic impairments and the fast-increasing insult of the ischemic penumbra, time is of the essence in managing stroke. Therefore, early intervention offers a window of opportunity to prevent the emergence of serious complications and death, improving the prognosis in the process. Additionally, the data surrounding the treatment of stroke is rapidly evolving [4].

The term "Malignant MCA Infarction" (MMI) originated from the higher risk of cerebral oedema and rapid neurologic impairment experienced by patients with Large Hemispheric Infarcts (LHIs). The presence of hypodensity covering over 50% of the Middle Cerebral Artery (MCA) region or an infarction volume exceeding 145 cc within 14 hours of symptom onset are highly dependable indicators of a severe outcome, marked by elevated internal cerebral pressure, shearing risk, and the necessity for DHC.Surgical decompression with DHC stands as the definitive intervention to mitigate heightened intracranial pressure and prevent herniation in cases of LHI accompanied by substantial oedema [5].

Revascularization and limiting subsequent neuronal damage are the main objectives of advanced stroke care. For certain individuals, Endovascular Thrombectomy (EVT) and Intravenous (IV) thrombolysis are now accessible. If a patient's oxygen saturation falls below 94%, additional oxygen may be required. Final airway management is necessary due to the rapid decline in neurologic function, loss of consciousness that follows, and impairment of reflexes that support the airway. If the impending airway loss is not recognised, it could lead to consequences like hypoxemia, hypercapnia, and aspiration, all of which could cause secondary brain injury. Up to 80% of patients have significant morbidity rates when they have large MCA or ICA infarcts. Early mobilisation is thought to be essential for optimising the restoration of function and self-reliance after AIS. Neuroplasticity and cortical reorganisation, according to animal models, factors that facilitate functional improvement typically reach their peak from a one to two weeks post-stroke and persist for approximately one month. Early intervention considered to further enhance this dynamic phase following a stroke and aid patients in acquiring adaptive strategies for any remaining impairments. Even among patients in intensive care units, research shows that early and intensivesessions for rehabilitation are related to enhanced functional outcomes.It is still debatable at what point early mobilisation should begin and at what level. According to the third phase A clinical trial called A Highly Earlier Physical Therapy Treatment shortly after Stroke (AVERT), there was a decreased likelihood of a favourable outcome when early mobilisation (less than 24 hours after stroke) was paired with regular, extended rehabilitation sessions. Nevertheless, the dose-response analysis revealed that while longer out-of-bed sessions lower the likelihood of a successful result, brief and frequent mobilisations may be helpful in the early stages following an acute stroke [5].

One of the most prevalent outcomes following a stroke is weakness affecting one side of the body, particularly the upper limb (UL), which affects 80% of patients. More research into innovative solutions is necessary since, despite recent major advancements in rehabilitation approaches, movement and functional recovery remain inadequate. While modern exercise therapy can help stroke patients achieve greater motor control and enhancement of functionality in the upper limb., they still do not result in complete functional recovery for people who have suffered moderate to severe strokes. Merely 20% of individuals who have experienced a stroke recover typical hand function, with fewer than 50% utilizing the affected arm and hand for any form of activity.

This makes restoration of upper limb and hand capabilities, the most difficult problem to treat. It is vital to look into cutting-edge therapies to enhance upper limb function given the significance of hand function for day- to- day activities[6].

CIMT is a neurological rehabilitation technique employed to regain motor function in the upper limb subacute-stroke.CIMT operates on the principle of limiting the usage of the unaffected limb while promoting the engagement of the impaired side, aiming to enhance functionality in the affected limb post-stroke.To assist stroke patients,use their affected limb more frequently, enhance the quality of their movement in everyday situations, CIMT primarily employs mobility approaches, behavioural strategies, and restriction. This method fosters the utilization of the affected limb, addressing and potentially reversing the tendency to neglect or underuse it, while also providing ample opportunities for repetitive practice to improve its structural as well as functional training[7].

Altschuler et al. discovered in a pilot investigation that Mirror Therapy (MT) might be a helpful supplementary treatment for stroke victims. In order to increase brain plasticity, this therapy uses visual feedback to activate the mirror neuron system and activate the motor cortex in one hemisphere of the brain. According to a number of recent reviews and meta-analyses, MT is more effective than other physical practices in improving motor function of the UE and ADL in stroke participants. This is chiefly evident in advancements to the Modified Barthel Index (MBI) and the Fugl-Meyer Assessment Upper Extremity (FMA-UE) [8].

It has been observed that Task-Oriented Training (TOT) produces notably favourable results were observed in motor control and task-specific performance related to daily activities. One of the primary drawbacks of TOT is that patients often become disinterested and bored when completing repetitive tasks, which can negatively impact their training performance and ultimately affect their therapeutic outcome. Using data from the FMA-UE scale, which covers joint range of motion from 0 to 24 points, the primary focus of the study was to assess changes in the progression of upper limb motor and functional recovery, measured on a scale ranging from 0 to 66 points for motor function, 0 to 12 points for sensory function, and 0 to 24 points for joint pain [9].

The need for studying CIMT and Mirror Box Therapy in stroke patients arises from stroke's high incidence of permanent disability, often resulting in persistent fine motor deficits. Current rehabilitation methods may not fully address these impairments, making alternative therapies like CIMT and Mirror Box Therapy, which promote neuroplasticity and motor recovery, particularly promising. This study aims to assess their feasibility, patient adherence, and effectiveness to improve rehabilitation strategies and outcomes for stroke patients.

Stroke is a leading cause of long-term disability, with many survivors experiencing persistent fine motor deficits that significantly affect their quality of life. Constraint-Induced Movement Therapy (CIMT) and Mirror Box Therapy (MBT) have shown promise individually, but there is limited evidence on their combined or comparative effectiveness for fine motor function. Most studies focus on gross motor recovery or include diverse stroke populations, often overlooking the specific challenges of fine motor deficits. Additionally, the feasibility of implementing these interventions in resource-limited settings, along with factors such as patient adherence and tolerance, remains underexplored. This research aimed to assess the efficacy of CIMT and MBT in improving fine motor function in individuals recovering from stroke.

Materials and Methods

The study was approved by the Institutional Scientific Review Board on human subjects (01/024/2023/ISRB/PGSR/SCPT). The study procedure was explained, and the subject was willing to receive the treatment. The study procedure was explained to the subject, who expressed a willingness to receive the treatment. Written, informed consent was obtained from the subject for the publication of this study, and their anonymity was maintained.

This experimental study focused on post-MCA stroke patients aged 40 to 65 years, employing convenient sampling. A total of 20 subjects were included based on specific criteria: participants of both genders with MCA stroke diagnosed within six weeks, capable of active wrist extension and thumb abduction, able to communicate simply and receive care, and maintain a sitting position for at least 30 minutes. Patients were excluded from the study if they had depression that could impact their ability to participate in treatment, if they were unable to engage in active task training due to musculoskeletal problems such as MAS spasticity level II or higher, or if they had conditions like complicated region pain syndrome or adhesive capsulitis secondary.

STUDY PROCEDURE-The study was conducted with 20 participants with past MCA Stroke patients at Tertiary Hospital, Chennai using convenient sampling technique method according to the criteria for inclusion and exclusion. The participants were briefed on the study, and their written consent was obtained before proceeding with any procedures. Participants was divided into two groups, Group A- 10 and Group B- 10. Group A received CIMT and task -oriented training for a period of 6 weeks, four sessions per week, lasting for 45 minutes and advised the patients to wear the CIMT for 6 hours. Also, asked them to do their Daily tasks with the CIMT. The patient was positioned in a relaxed sitting position, then the fabricated splint was applied to unaffected hand. The following activities were given during the treatment:Glass grasping or grasp, eating, turning and getting up from bed, picking object like shapes, grooming, combing hair without comb, brushing, etc. Patient's attender was educated regarding the CIMT and trained their attender to help with the patient's ADL by their own.

Group B underwent a six-week treatment regimen comprising mirror box therapy and task-oriented training, consisting of four weekly sessions each lasting 45 minutes. Patients were seated in a relaxed position and instructed to place their impaired hand within the mirror enclosure. Various activities were prescribed during the sessions, including picking shapes, grasping a ball, picking up sand, pressing clay, and crushing paper, among others.Materials used are fabricated splint, mirror box, hand resistance band, paper, pen, glass, clay, peg board, and sand.

OUTCOME MEASURE-Fugl- Meyer Assessment Upper Extremity (FMA- UE)scale is used to evaluate the sensorimotor dysfunction in stroke survivors. Joint range of motion, motor function, sensation, balance, and joint pain are the five domains that can be evaluated separately. The 33 items on the scale are individually rated on a range of 0 to 2, with 0 denoting unable to execute, Two complete performances and one-half performance. Scores below 31 on the FMA-UE Scale indicated "no to poor" upper extremity capacity, 32–47 indicated "limited capability," 48–52 indicated "markable capability," and 53–66 indicated "total" upper extremity ability.

Results and Discussion

Data was analyzed usingFMA- UE scale before intervention as pre-test values and after intervention as post-test values was tabulated and statistically analyzed.Significant improvements in fine motor activities were observed within both groups post-intervention.

Table 1 . Fugl Meyer Assessment Upper Extremity Scale Pre-test and Post-test values of Group- A obtained using Paired t- Test

TEST	MEAN	MEDIAN	SD	P value
PRE- TEST	34.4	32.5	2.59	<0.0001
POST- TEST	45.0	40.5	4.50	<0.0001

Table 2. Fugl Meyer Assessment Upper Extremity Scale Pre-test and Post-test values of conventional Group- B obtained using Paired t- Test

TEST	MEAN	MEDIAN	SD	P value
PRE- TEST	34	34	1.76	<0.0001
POST- TEST	37.5	37	2.80	<0.0001

Table 3. Fugl Meyer Assessment Upper Extremity Scale Post-test values of Group- A and - B obtained using unpaired t- Test

GROUP	MEAN	MEDIAN	SD	P value
GROUP- A	45.0	40.5	4.50	<0.0001
GROUP- B	37.5	37	2.80	<0.0001

Group- A showed a significant effect in improving the fine motor function at 4 weeks, with a p value which was < 0.0001. Though both the group showed an improvement, there was a significant effect of CIMT along with task-oriented training than the mirror therapy along with task-oriented training within 4 weeks protocol in improving fine motor functions among the stroke patients using FMA- UEscale.

Our result suggested to CIMT with Task oriented training have a significant impact in MCA stroke. Based on prior research, factors underlying brain plasticity, such as alterations in membrane excitability of neurons, inhibition elimination, and enhancements in synaptic transmission (For instance, considering phenomena such as Long-Term Potentiation and Long-Term Depression.), facilitate the restoration of neuron circuits crucial for upper limb mobility and function. This discourages compensatory phenomena that typically emerge in the early stages. For instance, studies have revealed that following constrained induced movement therapy, motor output maps in the damaged hemisphere enlarge by approximately 40%, indicating that successful remission correlates with a gradual return to normal intensity and activation levels, diverging from the predominant activation observed in thenot impacted hemisphere[10].

Our systematic evaluation aimed to assess the effectiveness of combining repetitive Transcranial Magnetic Stimulation (rTMS)with task-oriented training to improve upper limb dysfunction in stroke patients.Meta-analysis outcome indicated that this combined approach significantlyEnhanced manual dexterity, upper limb motor skills, daily life tasks proficiency, and nerve conduction capabilities compared to the control group. Notably, the improvement in nerve conduction function was particularly notable compared to the control group [11].

Numerous clinical trials are presently investigating the impact of combining constraint-induced movement therapy with various technologies, such as robotic therapy. One example is the study examining Revised Constraint-Induced Therapy using robotic assistancein individuals with spastic hemiplegic stroke following Botulinum Toxin A injection[12].

This comprehensive review and meta-analysis examined the effectiveness of constraint-induced movement therapy (CIMT) Among stroke patients who maintain upper limb function and cognitive abilities. The findings indicate that CIMT is more advantageous than conventional rehabilitation therapy in enhancing upper limb functional capacity, as measured by the functional capacity assessment within the Wolf Motor Function Test. Moreover, significant improvements in activity outcomes, including Scales assessing the quality of movement and quantity of usageas assessed by the Motor Activity Log, were particularly notable among individuals who have experienced stroke in the chronic stage, consistent with previous research findings[12,13].

Previous research has combined motor training (MT) with activity of daily living, illustrating that MT paradigms can enhance motor recovery in the paretic upper extremity of stroke patients. While numerous MT protocols have been proposed, few have successfully integrated practical bimanual tasks involving both upper extremities. Rodrigues et al. introduced bilateral task-based MT, which involves coordinating both arms to manipulate a single object within a mirror environment. Stroke, a neurological condition often resulting in chronic disability, necessitates therapeutic interventions that encompass activities with defined objectives and treatments aimed at improving upper limb functions. Such interventions should address the psychological and social challenges encountered by patients in their performance environment, as well as factors affecting their Quality of Life (QoL)[14].

Conclusion

Combining constraint-induced movement therapy with task-oriented training demonstrated greater efficacy compared to mirror therapyalong with task-oriented training in improving fine motor functions among the stroke participants.

The strength of the study was that CIMT, task-oriented training, mirror box therapy are simple and cost effective. The limitation of this study includes long hours of giving the fabricated splint to the patients. So, use of modified CIMT can be used instead of traditional CIMT which can help the study much better. Therefore, further studies can be done with advanced treatment techniques.

This feasibility study has limitations, including a small sample size, short intervention duration, and the absence of a control group, which limit the generalizability of the findings. The homogeneity of the study population and reliance on subjective outcome measures may reduce applicability to diverse stroke patients. Additionally, the findings may not translate well to resource-limited settings due to equipment and expertise requirements. Recruitment and retention challenges could also affect the study's representativeness. Future research should focus on larger, controlled trials with diverse populations, longer follow-up periods to assess long-term effects, and adaptations for resource-limited environments to enhance clinical applicability.

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Effects of Pelvic Floor Muscle Training on Peak Expiratory Flow Rate and Muscle Strength in Postpartum Women - An Experimental Study

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Abstract

Background: The pelvic floor muscles primarily protect the end of pelvic organs andare also involved in breathing during speaking, deep breathing and coughing. The diaphragm and pelvic floor have a symbiotic relationship,and the pelvic floor muscle contraction protects the endpelvicorgans against increased abdominal pressure under the body's certain reactions such as deep breathing and coughing and helps breathing by relieving anal and urethral obstructions. Pregnancy affects the Pelvic floor muscle strength which may affect the respiratory function. Peak Expiratory Flow Rate is defined as the maximal flow achieved during expirationdelivered with a maximal force starting from maximal lung inflation. HET's MMT is a unique transvaginal/transrectal manual muscle testing scale exclusively designed for the evaluation of pelvic floor muscles.Therefore, the study intends to measure the effect of training of pelvic floor muscles on the peak expiratory flow rate and the strength of PFM.

Objective: The objective of the study is to measure the effectiveness of pelvic floor muscle training on peak expiratory flow rate and strength of pelvic floor muscles in post-partum women andto determine the correlation between pelvic floor muscle strength and pulmonary function.

Methodology: 15 subjects fulfilling the inclusion criteria were selected for the study. Baseline data pre pelvic floor muscle strength and pelvic expiratory floor rate were measured using HET's MMT and peak flow meter. Kegel's exercises were given to all the 15 subjects for a period of 6 weeks again post pelvic floor muscle strength and pelvic expiratory flow rate was measured.

Results: The present study wasan experimental study. After the data analysis, the resultshowed significant improvement as the mean pre and post value of PFMS and PEFR from -0.13 to 0.73 and 452L/min to 476L/min respectively. Spearman's row was used for correlation between PFMS and PEFR,r =0.689 which shows a moderate correlation of PFMS and PEFR.

Conclusion: The present study reveals that there is a significant effectiveness of pelvic floor muscle exercise on pelvic floor muscle strength and peak expiratory flow rate and a moderate positive correlation between PFM strength and PEFR.

Keywords: Kegel's exercise, post-partum women, pulmonary function, Peak expiratory flow rate, urinary incontinence.

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Introduction

Pelvic floor lies in funnel shaped pelvic Cavity bounded by bones, ligaments and muscles. These group of muscles are present in both males and females. They form a sling or hammock across thebase of the pelvis that separates the pelvic cavity above from the perineal region below .[1]In females the pelvic floor mainly consists of two main muscles the levator ani and the coccygeus .They are designed to keep the pelvic organs bladder, uterus and rectum in place.[2] These muscles are involved in breathing, coughing, speaking, regulating storage and evacuation of urine and stool .The diaphragm and pelvic floor have a symbiotic relationship,when we inhale,our diaphragm moves down so that the air from atmosphere can enter inside the lungs,as diaphragm descends down the pelvic floor also relaxes and goes down and allows space for the abdominal contents and when we exhale the diaphragm elevates and the pelvic floor also elevates and therefore pelvic floor muscles works in coordination with diaphragm, these muscle also contract together with abdominal muscles and helps in increasing and generating the intraabdominal pressure allowing the diaphragm to move upward.[3,4,5] Therefore understanding the synergy between these muscles is important to provide better pelvic health including control of incontinence, prolapse, pelvic pain and bowel dysfunction. Pregnancy stretches the abdominal muscles and also the load on the PFM increases due weight of foetuswhich affects the efficacy of PFM and increases the load on the back muscles leading to backache, Urinary Incontinence, poor posture.[6,7] Vaginal birth places the levator ani under tissue stretch ratios of up to 3.3 and the pudendal nerve under strains of up to 33%, respectively thereby increasing the risk of levator ani defects leading to genital organ prolapse and urinary incontinence and may also alter the respiratory function.[8]

Respiratory function following postpartum is also altered due to hormonal changes and mechanical effects. Hormonal changes are one of the main cause of ventilatory changes in respiratory functions. Mechanical effects that occur with pregnancy are progressive uterine distension which causes decrease in lung volume and chest wall changes occurs which displaces the diaphragm upwards.[9] Peak expiratory flow rateis the maximal flow achieved during expiration, determined by size of the lungs, elasticity, strength of the lung and speed of the respiratory muscles and is mainly affected in obstructive lung diseases,therefore it is one of the important measure of lung function.[10]

Park et al. (2015)[11]and Talasz et al. (2010)[12] have studied the effect of PFM on the pulmonary function and PFMS in females of young age group. But there is lack of data regarding the effect of PFM exercises on Pulmonary Function and Pelvic floor muscle strength in the postpartum women following vaginal delivery. Han D et al attempted to identify the effects of one-time Kegel exercises on pulmonary function and reported that the vital capacity was improved in certain categories. However, one-time Kegel exercises may not be sufficient for reinforcing the PFM.[13]

Therefore, the purpose of this study was to examine the effects of self-disciplined Kegel exercises performed for 6 weeks on PFM strength which was assessed by using HET'S MMT and determine whether PFM reinforcement could improve pulmonary function by assessing Peak expiratory flow rate.

Material and Methodology

15 Postpartum women with normal delivery enrolled for the study were recruited by convenient sampling based on the inclusion and exclusion criteria after obtaining the informed consent. The study was carried out at various maternity hospitals ofGuwahati. Approval for the study was taken bythe institutional ethical committee, College of Physiotherapy and Medical Sciences as per the ethical guidelines for biomedical research on human subjects with reference number CPMS/DV/ SSHUS/1232/JUL21.

Inclusion and Exclusion Criteria

Post-Partum women of age group 25-30 with normal delivery, having no history of neurological, musculoskeletal, or cardiorespiratory diseaseand

not participating in any other form of program were included and postpartum women having multiple pregnancies, with complicated pregnancies,were excluded.

Assessment Parameters

Base line data Pre Pelvic floor muscle strength was measured by HET's MMT with intra rater reliability 0.92 and inter rater reliability 0.93.The scale had a grading from 3(Strong upward and inward pull against resistance) to -3 Asymptomatic penetration(laxity) with a baseline value 0 which indicates the baseline tone of the pelvic floor musclesand Peak Expiratory Flow Rate(PEFR) which ranges from 400 to 700 L/min in healthy adults were measured using and Peak flow meter. Pelvic floor muscle strength and Peak expiratory flow rate was measured again after 6 weeks exercises.

Methodology

Prior to the conduction of experimental study, an explanation of the entire procedure was given to the subjects and education on the functioning of pelvicfloormuscles as well as the benefits of pelvic floor muscle exercise was given to the subjects.

Estimated Sample size: 30

$n=(Z_{1-\alpha}/2+Z_{1-\beta)/d}{}^{2}$

$n=^{2}$

$n= (5/.4)^2=29.1$

- $Z_{1-\alpha}/2=1.96$ *(Z-value for 95% confidence level)*
- $Z_{1-\beta}=1.28$*(Z-value for 90% power)*
- d=0.6*(Effect size, Cohen's d – moderate effect size)*

To assess Peak ExpiratoryFlow rate subject made to sit straight,hold the mouth piece of the device tightly with lips and then take a deep breath and blow out the air as hard and as quickly as possible ensuring complete emptying of lungs as shown in Fig 1. The procedure was repeated thrice and the best reading was considered .

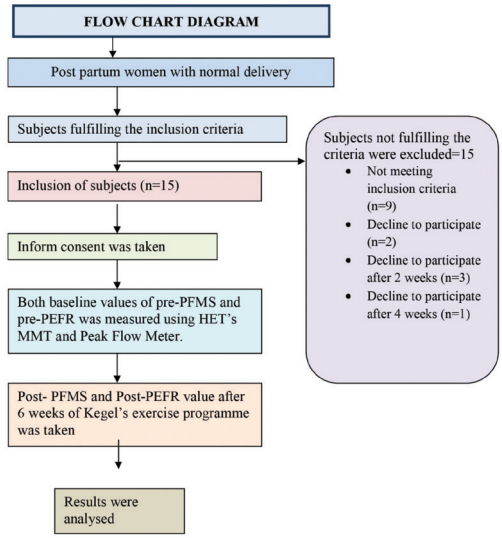

Figure 1: Flow diagramfor the steps of conduction of the experimental study.

To assess pelvic floor muscle strength Subject was made to lie down in crook lying position, maintaining the sterility,index and middle finger was inserted in the vaginal opening,the subject was asked to tighten the muscles around the fingers and the baseline strength of the pelvic floor muscles was recorded.Kegel's exercise(to increase the strength of pelvic floor muscles) was taught to the subjects in which they were asked tohold the pelvic floor muscles as tightly as they can for 8-10 seconds, then relax for 8 seconds and 8 repetitions were performed. The Subjects were asked to continue the exercises every day at home for a period of 6weeks for 3 times per day as shown in Fig 2Weekly 3 sessions were supervised, and verbal feedback was obtained at the end of every week.

Figure 2: Subject performing the peak expiratory flow test.

Figure 3: Performing Kegel's Exercise

Statistical Analysis

- Statistical analysis was done using SPSS software version 25. Normality check was done using Shapiro-wilk test and Kolmogorov-Smirnov. The difference between the pre and post values for variables PEFR and Pelvic floor muscle strength was assessed using Nonparametric test – Wilcoxon signed-rank test Correlational analysis to study the correlation between PEFR and strength of Pelvic floor muscles Spearman's rho test was used. Statistical Significance was set at P < 0.05 .P< 0.001 is considered highly significant .

Results and Interpretations

Table 1. Normality check

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	15	27	35	30.67	2.469
Pre_PFMS	15	-3	2	-.13	1.807
Post_PFMS	15	-3	3	.73	2.251
Pre_PEFR	15	380	580	452.00	72.526
Post_PEFR	15	400	600	476.00	73.756

*Significant at p<0.05 **Significant at p<0.01 ***Significant at p<0.001

Table 1. Shows that the pre and post values of PFMS & PEFR do not follow normality assumption. So, we must use nonparametric tests for the analysis.

Table 2. Wilcoxon sign rank test

Test Statistics			
	Z	Asymp. Sig. (2-tailed)	Remark
Post_PFMS - Pre_PFMS	-1.968[b]	0.041	*
Post_PEFR - Pre_PEFR	-3.520[b]	0.000	***

*Significant at p<0.05 **Significant at p<0.001 ***indicates as P is 0.000 it is highly significant.

Table 2 shows that there is significant difference between pre and post values of PFMS & PEFR.

Table 3: Correlation between pfms and pefr

Correlations				
	Post_PFMS			
	Correlation Coefficient	Sig. (2-tailed)	N	Remark
Post_PEFR	.689**	0.004	15	**

Table 3 shows r **value is Significant at p<0.01, here P value is 0.004 which indicates r value is significant and as r value is 0.689 indicates positive moderate correlation peak expiratory flow rate and Pelvic floor muscle strength, suggests if the strength of PFMS increases the PEFR should increase.

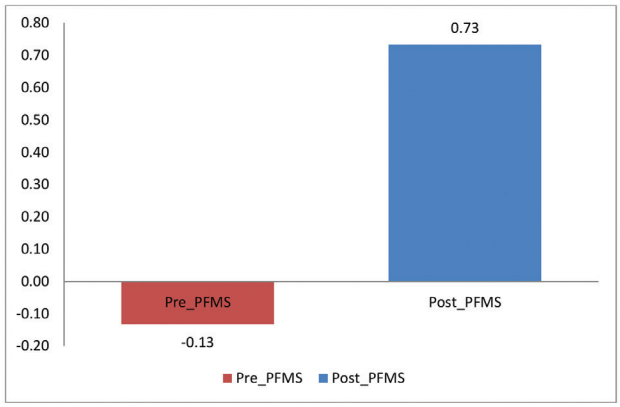

Figure 1: Graphical Presentation for Mean of Pre and Post Pfms

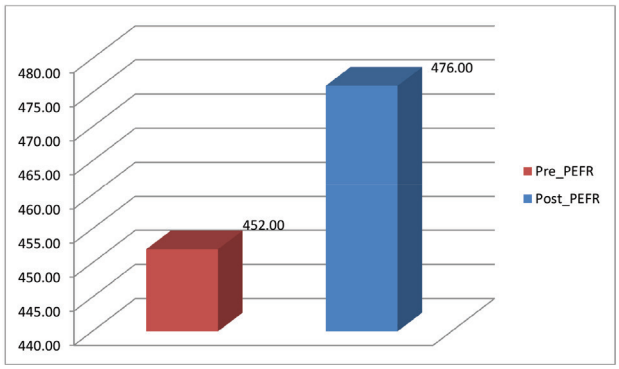

Figure 2. Graphical Presentation for Mean of Pre and Post Pefr

Discussion

On analysing the pre and post intervention mean of PEFR and PFMS the results shows that post intervention significant improvement in the pelvic floor muscle strength and peak expiratory flow rate with P< 0.001was seen after 6 weeks of regular strengthening of pelvic floor muscles and a positive moderate correlation with r = 0.68 between Pelvic floor Muscle Strength and Peak Expiratory Flow Rate which indicates that as the strength of pelvic floor muscles also increases the peak expiratory flow rate also increases thereby helping with forceful expiration .As we know in normal breathing, during inspiration the diaphragm contracts and moves downwards while relaxes and moves upwards during expiration.[13] However, when forced expiration or coughing occurs, the anterior and lateral abdominal muscles contract, thereby generating pressure that strongly moves the diaphragm upward.[13,14] Contraction of Pelvic floor muscles contribute to maintain the abdominal pressure. PelvicFloor Muscles and deep abdominal muscles are involved in breathing through their coordinated contractions[15]. Han D et.al (2015)[16] explained the effect of pelvic floor muscle exercises on pulmonary function and concluded thatthere is a symbiotic relationship between pelvic floor muscles and diaphragm, and they work in coordination to provide better pelvic health. As in our study we have seen that strengthening of pelvic floor muscles increased the peak expiratory flow rate which is an important measure of lung function mainly for obstructive lung diseases as per the GINA[17] (Global Initiative for Asthma)guidelines. Also helps to monitor the respiratory condition as the PEFR will fall with inflammation and exacerbation. Therefore training of pelvic floor muscles becomes very important for a pregnant women already suffering with Asthma also for females with who have undergone vaginal delivery and Caesarean section as the pelvic floor muscles are stretched throughout pregnancy and the abdominals becomes weaker due to Caesarean section .Eventually preventing urinary incontinence and pelvic organ prolapse in later phase of life .

Conclusion: The study concludes that training the pelvic floor muscles will help in not only preventing from the risk of urinary incontinence and prolapse of uterus but also helps in improving the respiratory function by improving the peak expiratory flow rate

Limitations of the Study: The results of current study were based on convenient Sampling and had a small sample size. There was no follow up to determine long term effects of the treatment and the duration of intervention was short.

Future Recommendations: Study can be done with larger sample size. Follow up can be taken to determine long term effects of the treatment

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Effect of Wearing A Mask on Functional Capacity in Healthy Adults During Covid 19 Pandemic: A Descriptive Study

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Abstract

This study is done with the aim to explore the effect of wearing N95 respirators on functional capacity test – 6 minute walk test distance in healthy Indian young volunteers, and also to understand the gender specific difference in distance covered.

Design: Observational study.

Participants: Hundred participants who volunteered.

Intervention: 6MWT in healthy Indian volunteers without mask and with mask.

Outcome Measures: Aerobic capacity, anthropometric measurements (age, height, weight, Body mass Index(BMI)) and distance covered wearing mask and without wearing mask, Rating of perceived Exertion (RPE).

Results: Hundred participants completed the study. The mean 6 Minute Walk Distance (6MWD) without mask was 460.90 ± 69.254 and of with mask 459.60 ± 69.977. It was found that 6MWD with mask has a negative correlation with age (r= -0.21), height (r= -0.213), weight (r= -0.271), BMI (r= -0.195). Values derived from standard equation when compared with the distance covered by males and females without mask and with mask were significantly less than expected values. The standard distance walked by males (608.79 ± 30.5) with mean distance walked without mask (447.7 ± 72.7) (95% CI 130.1 to 190) and with mask (448.4 ± 68.9) (95% CI 130.6 to 191.4). The expected standard distance for females is (542.8 ± 33.3) while the mean distance walked without mask (466.52 ± 69.2) (95% CI 57.1 to 95.5) and with mask (464.9 ± 68.6) (95% CI 58.9 to 96.9).

Conclusion: This study concludes that the distance covered in 6MWT wearing N95 mask and without wearing mask was not significantly different but was significantly lesser than the expected distance to be walked as calculated by the standard equation.

Recommendation: A similar study should be conducted in diseased population to check for clinical use.

Key words: six-minute walk test, Functional capacity, Indian population, N95 mask, Physical activity, functional walk test

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Introduction

COVID 19 pandemic necessitated universal masking as a way of source control by means of cloth mask or N95 respirators.[1,2] Due to continued spread of COVID 19, the Indian government implemented measures that included the closure of non-essential services including fitness and recreational facilities, which could have a long term negative impact on physical health.[3] Various studies conducted during the pandemic have found that physical activity levels (vigorous, moderate, walking and overall) decreased while sitting time increased by 5-8 hours per day.[4] Accumulated physical inactivity over weeks and months, might impact the immune system function, increasing susceptibility to infection and possibly exacerbating the pathophysiology of illnesses seen in older adults such as cardiovascular disease, cancer and inflammatory disorders.[5]

Functional capacity is the ability of an individual to perform aerobic work as defined by VO_2 max at physical exertion. The ability to conduct activities of daily living that demand continuous aerobic metabolism is measured by functional capacity.[6] Walking is a component of everyone's daily routine, yet it varies from person to person. [7,8]

There are variety of tests that can be used to determine a patient's functional capacity.[9] 6-minute walk test (6MWT) is a reliable and valid test with established guidelines to perform it.[10] It is easy to administer, better tolerated, reproducible, validated and inexpensive, corresponds to submaximal moderate exercise and more reflective of activities of daily living than other walk tests.[11] 6MWT is a useful instrument for assessing functional capacity in individuals with cardiovascular, pulmonary diseases, heart failure, end stage lung disease, left ventricular dysfunction, cystic fibrosis.[10,12,13,14] When compared to typical bicycle ergometer and treadmill exercise tests, the 6MWT exhibits a good correlation with work load, heart rate, SpO_2, dyspnoea response and fatigue.[15] The 6MWT can be performed by many elderly, frail to severely limited patients who cannot be tested with standard maximum cycle ergometer or treadmill exercise test.[16] A study conducted by Ramanathan et al in 2014 derived the equation for 6 MWD by considering Age, height, weight and gender. These variables were taken in regression analysis to derive at the reference equations for healthy Indian individuals separate for each gender:[17]

Male–561.022-(2.507xage [years]) + (1.505xweight [kg]) - (0.055xheight [cm])

Female-30.425-(0.809xage [years]) - (2.074xweight [kg]) + (4.235xheight [cm])

The impact of wearing a face mask on the six-minute walk distance must be better studied because the 6MWT is commonly administered within a healthcare facility.[18] With the advanced technology used in health and wellness, mobile health has been growing tremendously in the recent decade. The wrist worn device capable of measuring a wide range of parameters, including heart rate, steps taken, distance travelled and time. The apple watch is a commercially available device that measures heart rate using photo plethysmography. Measuring heart rate when walking and recovering from walking has a high level of validity.[19] Although N95 respirators are commonly used by healthcare personnel, their physiological impact during such activity is unknown.

In this study, the research question that we aiming to answer were:

1. What is the effect of wearing N95 respirators on functional capacity test –6 minute walk test distance in healthy Indian young volunteers?
2. How much is it different in males and females?

Method

Design

This was an observational study. Healthy individuals who volunteered for the study were recruited. Before commencing the program, they underwent baseline assessments and were given instruction to perform 6MWT. The participants were made to wear the Apple watch for the test to record the distance covered and heart rate during and after

the test. Participants were questioned about their level of exertion using BORG's RPE Scale before and after the test.

Participants, Therapists, Centers

Between July 2021 and September 2021, healthy young Indian individuals were approached and assessed for eligibility. The eligible volunteers were invited to participate.

- Inclusion Criteria -
- Apparently healthy individuals
- Age group- of 18 years to 60 years
- Ready to sign informed consent to participate.

Exclusion Criteria-

- Participants with underlying cardiopulmonary illness.
- History of any cardiovascular surgeries or complaints of respiratory distress
- Age less than 18 years

History of any chronic disease influencing their exercise capacity, chronic smoker, Impaired cognition, metabolic, neuromuscular or musculoskeletal diseases which hamper their walking capacity or use of walking aids.

Data Collection

Baseline Assessment

The health status of 100 volunteers was enquired through verbal interview and were screened for any recent hospitalization. Demographic data, Heart rate, height, weight and BMI was recorded.

Procedure

The 6MWT procedure was performed in isolated open space following COVID 19 norms the test area had a flat, straight, hard surface and 30m long track. Two trials of 6MWT with and without N95 face mask were performed with a rest of 10 minutes in between. Heart rate at the end of the test that is 6 minute, 1 minute and 2 minutes after the test and distance covered were measured using Apple watch SE (A2355, 40mm) and weight using weighing scale (Omron, Model HM 286). Instructions given to the subjects were adapted from the guidelines of the American Thoracic Society (ATS) 2002 [6]for 6 MWT. Immediately Post-test, Borg's Rating of Perceived Exertion along with vitals and distance covered was recorded. This test was performed with and without N95 face mask and same recordings were taken for both.

Data Analysis

Statistical analysis was performed using the statistical package for social sciences (SPSS) version 20. Descriptive statistics were obtained for demographic data. All the data were reported as mean ± SD. The following tests were performed - Pearson co-efficient to evaluate the correlation between the dependent variable 6MWD and independent variables such as age, height, weight, BMI and Paired t-test was administered to find the difference in the 6MWD between males and females with the mask and without mask. To determine the precision of some estimates, 95% CIs were calculated.

Results

The characteristics of participants are summarized in Table 1. 69% were women and 31% were male. Pearson's correlation was done to find out the association between 6MWD with and without mask with age, height, weight and BMI (Table 2). It was found that 6MWD with mask has a negative correlation with age (r= -0.21), height (r= -0.213), weight (r= -0.271), BMI (r= -0.195) but statistically significant positive correlation with height and weight. Results also showed that the 6MWD without mask has a positive correlation with age (r = 0.18) but is not statistically significant. Average distance walked without mask (460.90 ± 69.254) was more than the distance walked with mask (459.60m ± 69.977). But the mean difference between with and without mask was found 1.3 ± 0.723 (Table 3). The standard error estimate of the 6MWD for male and female is projected in (Table 4, 6) Independent paired t- test was carried out for males to compare the standard distance walked (608.79 ± 30.496) with

means of distance walked without mask (447.74 ± 72.650) (95% CI 130.900 to 189.809) and with mask (448.39 ± 68.901) (95% CI 130.605 to 191.395), t value was found for without mask (t = 11.118) and with mask (t = 10.818) and the difference significantly less than expected (Table 5). Similar test was performed for females and was found that the standard distance walked (542.78 ± 33.292) and means obtained for distance walked without mask (466.52 ± 69.172) (95% CI 57.061 to 95.461) and with mask (464.93 ± 68.613) (95% CI 58.818 to 96.892), t value was found for without mask (t = 7.926) and with mask (t = 8.161) which was significantly different from the expected values (p = 0.000) (Table 7). Also it was found that mean 6MWD of female volunteers was more than the male volunteers. Independent t–test was performed for 6MWD without mask and with mask for 100 volunteers showed (t = -0.463) with standard error mean (2.806) (-6.867 to 4.267). The results showed that the distance walked with or without mask were not significantly different both in male and female population (Table 8).

Table 1. Anthropometric data of the study sample

	N	Minimum	Maximum	Mean	SD
Age (years)	100	18	60	27	9.6
Height (cm)	100	121	170	163	10.4
Weight (kg)	100	36	110	64	15
BMI(kg/m^2)	100	15.6	40.8	24	4.5

Table 2. Pearson's correlation with independent variables.

	Pearson's correlation (r)		Sig (2- tailed test)	
	With mask	**Without mask**	**With mask**	**Without mask**
Age	-0.21	0.18	0.837	0.856
Height	-0.213*	-0.208*	0.034	0.038
Weight	-0.271**	-0.252*	0.006	0.012
BMI	-0.195	-0.179	0.052	0.074

**Correlation is significant at 0.01 level (2-tailed test)

*Correlation is significant at 0.05 level (2-tailed test)

Table 3. Comparison between with and without mask 6MWD

	Without mask Mean ± SD	With mask Mean ± SD
Distance (meters)	460.90 ± 69.9	459.60 ±69.25
Difference in distance (meters)	1.3 ±0.72	

Table 4. Comparison between 6MWD of Male with and without mask

	N	Mean ± SD	Std. Error Mean
With mask distance	31	447.74 ± 72.650	13.048
Without mask distance	31	448.39 ± 68.901	12.375

Table 5. Comparison between Standard distance and distance walked by male with mask and without mask

	N	Mean ± SD	Standard error	t	Significance (2- tailed test)
Expected distance	31	608.74 ± 30.5	5.5		
Distance with mask	31	447.74 ± 72.7	13.1	10.9	0.000
Distance without mask	31	448.39 ± 68.9	12.4	11.1	0.000

Table 6. Comparison between 6MWD of Female with and without mask

	N	Mean	SD	Std. Error Mean
Distance with mask	69	464.93	68.6	8.260
Distance without mask	69	466.52	69.2	8.327

Table 7. Comparison between Standard distance and distance walked with mask and without mask of female

	N	Mean ± SD	Standard error	t	Significance (2- tailed test)
Expected distance	69	542.78 ± 33.3	4.0		
Distance with mask	69	464.93 ± 68.6	8.26	8.2	0.000
Distance without mask	69	466.52 ±69. 2	8.3	7.9	0.000

Table 8. Comparison of 6MWD with mask and without mask

	N	Mean	SD	Std. Error Mean
Distance with mask	100	459.6	69.98	6.998
Distance without mask	100	460.9	69.3	6.925

Discussion

In this study, assessing the impact of a N95 face mask on distance covered in 6MWT performance in healthy volunteers, we found no significant difference between the distance walked with mask and without mask. But when compared to the expected distance walked calculated using reference equation we found significant decrease in the distance walked in both the trials with mask and without mask. We may anticipate that it is the culmination of sedentary lifestyle due to COVID–19 lockdown which would have reduced the overall cardiovascular function of individuals, thus the distance covered in 6MWT. Looking at the Dyspnoea on Exertion on Borg's Rating of Perceived Exertion scale, in this study, Similar to the study done by Kevin M. Swiatek et al on Impact of Face Masks on 6-Minute Walk Test in Healthy Volunteers [18]. It is accepted that the BDS is a standard component of the 6MWT and American Thoracic society recommends that patient provides a subjective 0 to 10 score to describe their fatigue and also to estimate the exercise intensity in the healthy as well as diseased population at the conclusion of the walk. 6MWD without mask has a positive correlation with age (r = 0.18) but is not statistically significant. Average distance walked without mask (460.90 ± 69.254) was more than the distance walked with mask (459.60m ± 69.977). Thus the mean difference between with and without mask was found 1.3 ± 0.723 and is not statistically significant. The reason for this might be adaptation to walk with N95 face mask as a means of universal masking.

Similarly, the changes observed in the HR pre and post 6MWT and RPE post-test indicates that, cardio-pulmonary system of an individual is being stressed during the test and N95 face mask flattering the changes in the heart rate and RPE during the test.

What was already known on this topic? The 6MWT is used universally to evaluate the submaximal functional capacity in healthy and diseased population. The Covid -19 made the universal masking a compulsion. The use of mask is associated with dyspnoea on submaximal challenging

What this study adds: this study answer the question of N95 Mask use during the 6 MWT and it was found that the mean 6MWD was not significantly different

Conclusion and Implications: This study concludes that the distance covered in 6MWT wearing N95 mask and without wearing mask was not significantly different but was significantly lesser than the expected distance walked as calculated by the standard equation. Thus indicating overall reduction in functional capacity in both male and female population.

Strength and Limitation: 6MWD remain unaffected in both the gender with masking and utilization of mask may not affect the 6MWT results in both the gender. Though the limitation of the study is that we utilized the convenience sampling and only young volunteers with female volunteers more than male volunteers participated.

Recommendation: Since masks do not significantly hinder moderate activity, high-risk individuals (older adults, those with chronic conditions) can be encouraged to wear masks during outdoor activities in higher-risk environments without fear of significant reduction in exercise capacity. A similar study should be conducted in the diseased population and a larger sample size will help to draw the values for clinical use

Footnotes*:*

Ethics approval: This study was approved by Institutional Ethics Committee at SDM College of Medical Sciences and Hospital (SDMIEC/2021/55). Written informed consent was obtained from all the volunteers.

Competing Interest*:* This study has no conflict of interest

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List of Abbreviations

- COVID 19 - Coronavirus Disease 19
- VO2 max – Maximum oxygen uptake
- 6MWT – six-minute walk test
- 6MWD – six-minute walk distance
- SpO2 – Oxygen saturation
- RPE – Rating of perceived exertion
- BMI – Body mass index
- ATS – American Thoracic Society
- BDS - Borgs Dyspnoea Scale

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Insurance and Awareness: A cross-sectional Study on Awareness of Health Insurance, Covering Physiotherapy Treatment Among General Population and Physiotherapists

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Abstract

Introduction: Physiotherapy plays a vital role in managing chronic and disabling conditions, yet its insurance coverage remains underutilized due to limited awareness of coverage and claim procedures. This gap may result in financial burden and delayed rehabilitation. With the growing prevalence of lifestyle-related and long-term health issues, improving awareness is essential. This study aims to assess the level of awareness about physiotherapy insurance coverage among the general population and physiotherapists to support better access to insured rehabilitative care.

Methodology: A cross-sectional observational study was conducted between March 2025 and May 2025 using self-structured Google Forms questionnaires to assess awareness of physiotherapy insurance coverage. A total of 91 participants from the general population and 70 physiotherapists were enrolled. Inclusion criteria were age ≥18 years for the general population and at least one year of clinical experience for physiotherapists. Participants who refused to participate and physiotherapists who do not directly interact with patients were excluded.

Results: The results show that only 45.7% of physiotherapists and 34.1% of the general population were aware that physiotherapy can be covered by insurance. Key information sources for physiotherapists were colleagues (27.1%) and hospitals (24.3%). Additionally, 59.3% of the general population lacked health insurance, and only 70.3% had access to physiotherapy services in their area.

Conclusion: This study reveals a major gap in awareness of physiotherapy insurance coverage among physiotherapists and the general population, highlighting the need for education, policy reform and public awareness to improve access and utilization of insured physiotherapy services.

Key words: Awareness, Health insurance, Physiotherapy

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Introduction

According to the Health Insurance Association of America, health insurance is defined as "coverage that provides for the payments of benefits as a result of sickness or injury. It includes insurance for losses from accident, medical expense, disability, or accidental death and dismemberment".[1] Health insurance or medical insurance is insurance that covers the whole or a part of the risk of a person incurring medical expenses.[2] The World Health Organization (WHO) estimates that out-of-pocket expenditure of over 15–20 % of total health expenditure or 40 % of household net income of subsistence needs can lead to financial catastrophe.[3] Insurance coverage for therapy and rehabilitation services has been a dynamic process over the past several decades.[4]

India requires an affordable, mandatory universal health insurance policy, especially for those below the poverty line. Insurers should adopt innovative models, promote portability, and reduce customer turnover. [5]

Physiotherapy insurance constitutes a category of health insurance that specifically encompasses the expenses related to physiotherapy treatments. Physiotherapy insurance helps control high treatment costs by reducing financial burden. Top plans offer benefits like no copayment, tax savings, restoration, daycare, domiciliary care, and free annual check-ups. Types of physiotherapy insurance include health insurance policies, professional liability insurance, public liability insurance etc. Physiotherapy insurance requires medical necessity, a concerned doctor's prescription, adherence to policy terms, waiting periods, and pre-authorization. Reviewing policy details and consulting the insurer ensures eligibility and proper claim processing. To claim physiotherapy expenses, obtain a doctor's prescription, verify policy coverage, maintain records, submit documents for reimbursement or cashless approval and follow up to ensure timely and successful claim processing.[6]

In this study, we examined awareness of physiotherapy coverage under both government and private health insurance schemes in India. Government schemes such as the Ayushman Bharat health insurance scheme may include physiotherapy services, particularly as part of inpatient rehabilitation or chronic disease management. However, the extent of coverage can vary depending on the hospital and the specific state-level implementation.[7]

For private health insurance, coverage of physiotherapy also varies. Some insurers provide it under post-hospitalization or outpatient care, but this is often subject to limitations or specific conditions. Typically, physiotherapy is covered only when linked to injuries or surgeries and not as a standalone treatment.

Despite the increasing burden of musculoskeletal and neurological disorders, physiotherapy remains underutilized, particularly due to limited awareness of health insurance coverage for these services. With the rising prevalence of diseases and an ageing population, there is an urgent need to improve both public and professional awareness about physiotherapy insurance claims. Understanding the current level of knowledge, identifying barriers and exploring perceptions regarding physiotherapy insurance claims is essential to bridge this gap. Therefore, this study aims to assess the awareness about physiotherapy insurance coverage among both general population and physiotherapists.

Material and Methods

This cross-sectional observational study was conducted using a self-structured questionnaire developed through Google Forms. Separate questionnaires were designed for physiotherapists and the general population, focusing on demographic data, knowledge, awareness and suggestions regarding physiotherapy insurance coverage. This tool was developed to evaluate participants' awareness of physiotherapy insurance coverage. Content and face validity of the questionnaire were reviewed by a panel of experts (n=3) in physiotherapy and public health. A pilot study was conducted on 10 participants to assess clarity and feasibility of the questionnaire.

Cronbach's alpha for internal consistency was calculated and found to be 0.81, indicating acceptable reliability

A total of 91 participants from the general population and 70 Physiotherapists were enrolled in the study between March 2025 and May 2025. Inclusion criteria included individuals aged 18 years or above from the general population and physiotherapists with at least one year of clinical experience. Participants who refused to participate and physiotherapists who do not directly interact with patients were excluded.

Participants from the general population were selected from both urban and rural areas to ensure diverse representation. Physiotherapists were approached through professional networks and academic contacts. All participants were informed about the purpose of the study and informed consent was obtained prior to participation.

Result

The study included 70 physiotherapists, the majority (94.3%) of whom belonged to the 18–30 years age group. Among them, 74.3% were females and 25.7% were males. Additionally, the study involved 91 participants from the general population, comprising 57.1% females and 42.9% males. Of these, 50.5% were from urban areas and 49.5% were from rural areas, as shown in Table 1.

Table 1. Demographic profile of participants included in study

Demographic Profile of Physiotherapist		**n (%)**
Age (years)	18-30	66(94.3%)
	31-45	4(5.7%)
Gender	Female	52(74.3%)
	Male	18(25.7%)
Demographic Profile of General Population		
Age (years)	18-30	54(59.3%)
	31-45	25(27.5%)
	46-60	7(7.7%)
	60+	5(5.5%)
Gender	Male	52(57.1%)
	Female	39(42.9%)
Residential area	Urban	46(50.5%)
	Rural	45(49.5%)

The results show that only 45.7% of physiotherapists are aware that insurance covers physiotherapy and their primary sources of information are from Physiotherapist colleague (27.1%) and hospitals (24.3%), however 35.7% of physiotherapists are not aware before this survey. Lack of awareness among physiotherapists (34.3%) and patients (31.4%) are major obstacles to physiotherapy insurance coverage. Only 14.3% of Physiotherapist inform their patients about physiotherapy coverage while 60% don't inform their patients due to their own lack of awareness. According to physiotherapists, the main challenge they face regarding physiotherapy insurance claims is the lack of awareness among patients about insurance benefits, as reported by 58.6% of respondents. 94.3% are interested in receiving training or workshops on physiotherapy insurance policies. 97.1% of physiotherapists support policy reforms. (as shown in table 2)

Table 2. Frequency distribution of the items included in questionnaire for Physiotherapists

Questions	Sub questions	n (%)
Are you aware that insurance covers physiotherapy?	yes	32(45.7%)
	no	38(54.3%)
Where did you learn about physiotherapy insurance coverage?	Doctor/Hospital	17(24.3%)
	Physiotherapist colleague	19(27.1%)
	Insurance provider	1(1.4%)
	Online source	7(10%)
	Word of mouth	1(1.4%)
	I was not aware before this survey	25(35.7%)
What do you think are the biggest obstacles to insurance coverage for physiotherapy?	Lack of awareness among patients	22(31.4%)
	Lack of awareness among physiotherapists	24(34.3%)
	Insurance policies do not prioritize physiotherapy	19(27.1%)
	Complicated claim process	3(4.3%)
	Insurance companies provide limited coverage	2(2.9%)
Do you inform your patients about possible insurance coverage for physiotherapy?	Yes, always	10(14.3%)
	Sometimes	17(24.3%)
	No, because I am not aware of insurance details	42(60%)
	No, because it is not my responsibility	1(1.4%)
What are the main challenges you face regarding physiotherapy insurance claims?	Patients are unaware of their insurance benefits	41(58.6%)
	Insurance companies deny physiotherapy claims frequently	9(12.9%)
	Paperwork and approval processes are too complex	19(27.1%)
	others	1(1.4%)
Would you be interested in receiving training or workshops on physiotherapy insurance policies?	Yes	66(94.3%)
	No	4(5.7%)
Recommendations and future improvements		**n (%)**
How do you think awareness about physiotherapy insurance can be improved?	Public awareness campaigns	24(34.3%)
	Educating physiotherapist about insurance policies	26(37.1%)
	Making insurance claim processes simpler	11(15.7%)
	Including physiotherapy more explicitly in standard insurance plans	9(12.9%)
Would you support a policy change that mandate health insurance providers to include physiotherapy as a standard benefit?	Yes	68(97.1%)
	No	2(2.9%)

Among the general population, 33% had received physiotherapy treatment, while only 70.3% reported having access to physiotherapy services in their area. Very few portions of participants (34.1%) are aware of insurance coverage of physiotherapy treatment. Even 59.3% of participants do not have a health insurance policy. Only 4.4% of participants had successfully claimed insurance for physiotherapy, 5.5% had their claims denied and 28.6% had never made a claim. 69.2% of participants believe that physiotherapist plays a vital role in educating patients about insurance coverage. Majority of participants (92.3%) support policy change that mandatory include physiotherapy as standard benefits in health insurance policies. (as shown in table 3)

Table 3. Frequency distribution of the items included in questionnaire for General Population

Questions	Sub questions	n (%)
Have you ever undergone physiotherapy treatment?	Yes	30(33%)
	No	61(67%)
Do you have access to physical therapy services in your area?	Yes	64(70.3%)
	No	17(18.7%)
	Not sure	10(11%)
Are you aware that health insurance can cover physiotherapy treatments?	Yes	31(34.1%)
	No	60(65.9%)
Where did you learn about physiotherapy insurance coverage?	Doctor /Hospital	9(9.9%)
	Physiotherapist	9(9.9%)
	Insurance provider	1(1.1%)
	Online sources	9(9.9%)
	Word of mouth	5(5.5%)
	I was not aware before this survey	58(63.7%)
Does your current health insurance policy cover physiotherapy	Yes	7(7.7%)
	No	15(16.5%)
	Not sure	15(16.5%)
	Don't have health insurance	54(59.3%)
If yes, what types of physiotherapy services does your insurance cover	In-hospital physiotherapy	18 (19.6%)
	Outpatient physiotherapy	9 (9.9%)
	Home-based physiotherapy	5 (5.4%)
	Specialized treatments	1(1.1%)
	Not sure	58 (63.2)
Types of insurance agency	Government	8(8.8%)
	Private	13(14.3%)
	Don't have health insurance	70(76.9%)
Have you ever tried to claim insurance for physiotherapy	Yes (successfully)	4(4.4%)
	Yes (denied)	5(5.5%)
	No	26(28.6%)
	Don't have health insurance	56(61.5%)

Continue....

If denied, what was the reason?	Insurance does not cover physiotherapy	4(4.4%)
	Lack of proper documentation	7(7.8%)
	Insurance company rejected without explanation	3(3.3%)
	Don't have health insurance	76(84.4%)
What do you think are the biggest obstacles to insurance coverage for physiotherapy?	Lack of awareness among patients	19(20.9%)
	Lack of awareness among physiotherapists	34(37.4%)
	Insurance policies do not prioritize physiotherapy	11(12%)
	Complicated claim process	10(11%)
	Insurance companies provide limited coverage	17(18.7%)
Do you believe that physiotherapists should play a role in educating patients about insurance coverage	Yes	63(69.2%)
	No	7(7.7%)
	Not sure	21(23.1%)
Recommendations and future improvement		**n (%)**
How do you think awareness about physiotherapy insurance can be improved?	Public awareness campaigns	9(9.9%)
	Educating physiotherapist about insurance policies	0%
	Making insurance claim processes simpler	4(4.4%)
	Including physiotherapy more explicitly in standard insurance plans	2(2.2%)
	All of the above	76(83.5%)
Would you support a policy change that mandate health insurance providers to include physiotherapy as a standard benefit?	Yes	84(92.3%)
	No	7(7.7%)

Discussion

This study aims to evaluate the level of awareness regarding physiotherapy insurance coverage among both physiotherapists and the general population. The findings reveal a significant knowledge gap, as the majority of physiotherapists were unaware that health insurance could cover physiotherapy treatment. The main sources of information on this topic were colleagues (27.1%) and hospitals (24.3%). A considerable number of physiotherapists reported having no prior knowledge about insurance coverage for physiotherapy services before participating in this survey. This lack of awareness directly impacts their ability to educate patients effectively about their insurance options and benefits related to physiotherapy treatment.

Among the general population, awareness was even lower—only 34.1% were aware that physiotherapy could be included in health insurance coverage. Additionally, over half of the respondents did not have any health insurance at all. These results point to systemic issues, such as limited public education and the inadequate inclusion of physiotherapy in standard insurance policies.

Furthermore, the majority of participants believed that awareness could be improved through a combination of strategies, including public campaigns, simplifying the claims process and incorporating physiotherapy into regular health insurance plans. Based on the data, it is evident that both physiotherapists and the general population need greater awareness of the benefits associated

with physiotherapy insurance coverage. Another key finding was that only 70.3% of the general population had access to physiotherapy services in their area, indicating unequal availability across different regions.

The findings of the current study regarding limited awareness of physiotherapy insurance are supported by Shahabi et al. (2021) [8], who emphasized the importance of improving insurance coverage for physiotherapy services. Their study highlighted the role of evidence-informed policymaking in enhancing the accessibility and sustainability of such services within the health insurance system. This reinforces the need to increase awareness and understanding of physiotherapy insurance among the general population and healthcare providers to ensure better utilization and support for these essential services.

Another study by conducted by Kaitlin Pyrz, et al. (2024)[9] also revealed that a significant portion of practicing physical therapists in Alabama perceive inadequate insurance coverage for physical therapy services, particularly for common orthopedic conditions. This finding underscores systemic challenges in current reimbursement structures and emphasizes the pressing need to enhance awareness of physiotherapy-related insurance benefits among patients, healthcare providers, and insurers. Raising this awareness is crucial, as it can empower patients to access timely and appropriate physiotherapy, support physiotherapists in guiding patients about their entitlements, and influence healthcare policy toward more inclusive coverage. Ultimately, improved awareness and education regarding health insurance can lead to better treatment compliance, enhanced rehabilitation outcomes, and greater overall patient well-being—both physically and financially.

The findings from the study conducted at King Fahd Hospital of the University, Al Khobar, highlight that access to physiotherapy services remains a significant concern, even among individuals with health insurance coverage. Many participants reported difficulties in accessing physical therapy due to high costs, limited options provided by insurance, and a general lack of support from insurance companies. There was also notable dissatisfaction regarding the role of insurers in facilitating access to care. Additionally, the perceived variability in the quality of care across different facilities and the absence of direct access to physiotherapy services further emphasize existing challenges. These insights point to the need for improved health insurance frameworks that promote equitable, affordable, and timely access to physiotherapy, minimizing financial and systemic barriers to essential care.[10]

IRDA (Insurance Regulatory and Development Authority) must foster competition, while governments should introduce insurance education in school curricula to enhance public understanding and participation, so that individuals are better informed about their rights, benefits, and options related to health insurance, including physiotherapy coverage. However, the study had certain limitations, such as a relatively small sample size.

Additionally, there is a notable lack of published literature on awareness of health insurance covering physiotherapy treatment among the general population and physiotherapists. This highlights an urgent need for further research in this area to better understand the knowledge gaps, misconceptions, and barriers that may hinder the utilization of insurance benefits for physiotherapy services. Enhancing awareness is essential for promoting informed healthcare decisions and ensuring more equitable access to rehabilitation care.

Conclusion

This study identifies a critical gap in awareness of physiotherapy health insurance coverage among both physiotherapists and the general population. The findings underscore the need for targeted educational initiatives for physiotherapists, comprehensive health policy reforms and increased public awareness campaigns to improve understanding, access and utilization of physiotherapy services through insurance. Despite high demand and favorable attitudes toward policy change, knowledge deficits and systemic obstacles hinder utilization. Addressing the issues related

to physiotherapy health insurance requires multi-level strategies, including targeted professional education, public awareness campaigns to improve understanding of coverage options, simplification of insurance procedures and legislative mandates to ensure inclusive and equitable coverage for physiotherapy services.

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