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RESEARCH ARTICLE

THE IMPACT OF HYDRO THERAPY TO IMPROVE FUNCTIONAL STATUS FOLLOWING SPINAL CORD INJURY: NARRATIVE REVIEW

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ABSTRACT

Background: Studies involving aquatic therapy have assessed individuals with long-term illnesses like multiple sclerosis, stroke, Parkinson's disease, osteoarthritis, persistent pain, cerebral palsy, and spinal cord injury (SCI). Aquatic treatment has been shown to enhance strength, range of motion, balance, and coordination in adult patients with neurological deficits found significant gains in lower extremity strength, balance, and ambulation in patients with spinal cord injury. Damage to the spinal cord that results in either temporary or permanent alterations to its function is referred to as spinal cord injury (SCI). Although SCI are less frequent than many other types of accidents, they can have disastrous physical and psychological effects. After SCI, very few people fully restore neurologic function. Deficits resulting in tetraplegia and neurological completeness are caused by a notable percentage of SCIs. Nearly 90% of all spinal cord injuries are traumatic, and they are frequently the result of violent crimes, falls, sports injuries, and auto accidents. The patient's life may be severely impacted by them. Lesions in the cervical region cause quadriplegia, whereas injury to the lower thorax causes paraplegia. Acute SCI commonly occurs due to sudden trauma to the spine and results in fractures and vertebrae dislocation. The initial stage immediately after the injury is known as primary injury with features of bone fragments and spinal ligament tearing. SCI is accomplished in two phases: the first phase includes the destruction of neural parenchyma, disruption of axonal network, haemorrhage and disruption of glial membrane. ***Aim:*** To understand the impact of hydrotherapy to improve functional status following SCI. ***Objectives****:* To conduct a comprehensive review of exisiting literature to analyze the documented impact of hydrotherapy on functional status in individuals with spinal cord injury. ***Methodology:*** The influence of hydrotherapy to enhance functional status following SCI was the subject of a case study and a comprehensive review that were completed. **RESULT:** Data from the selected studies were extracted under the headings of title /author, type of study design, intervention /device /technique elaborated in the study, and key highlights of the study and was tabulated systematically. ***Conclusion:*** Physiotherapy management increases functional status in SCI

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INTRODUCTION

Studies involving aquatic therapy have assessed individuals with long-term illnesses like multiple sclerosis, stroke, Parkinson's disease, osteoarthritis, persistent pain, cerebral palsy, and spinal cord injury (SCI). Each of these investigations has made use of reliable, evidence-based metrics unique population and unmistakably show considerable functional advancements. Aquatic treatment has been shown to enhance strength, range of motion, balance, and coordination in adult patients with neurological deficits found significant gains in lower extremity strength, balance, and ambulation in patients with spinal cord injuries. Furthermore, flexibility, strength, balance, function, pain reduction, mood, and self-efficacy have all been recognized as benefits by SCI patients.

Adult SCI patients receiving aquatic therapies showed improvements in their functional activities and spasticity. [1] Simple, autonomous swimming activities provide multisystem exercise, massage, hydration, and other health benefits because of how beneficial the buoyant environment is and as a result, the aquatic treatment profession has grown. [2]. The following basic hydrodynamics principles are related to the therapeutic advantages of hydrotherapy: hydrostatic pressure, buoyancy, drag, and Thermodynamics. Archimedes' law of buoyancy, which states that the upward buoyant force applied to an item submerged in water is equal to the weight of the water (or fluid) that the object displaces, is used to explain density. This indicates that because the human body is less dense than water, it experiences a buoyant force equivalent to the weight of the water displaced by the body's immersion, which causes the

body to rise to the surface. Therefore, buoyancy happens when a person submerges themselves in water, displacing water and gradually relieving the pull of gravity on their submerged joints. By submerging the sufferer.[3] Damage to the spinal cord that results in either temporary or permanent alterations to its function is referred to as spinal cord injury (SCI). [4] Although spinal cord injuries (SCIs) are less frequent than many other types of accidents, they can have disastrous physical and psychological effects. After SCI, very few people fully restore neurologic function. Deficits resulting in tetraplegia and neurological completeness are caused by a notable percentage of SCIs. The enormous lifetime expenditures associated with maintaining SCI and associated secondary disorders place a heavy burden on those who have the condition, their families, and society at large. Therefore, prevention is essential given the significant financial and personal costs associated with SCI. [5] In the context of rehabilitation, spinal cord injury (SCI) is treated therapeutically with aquatic therapy. A survey of the available research turned up five randomized controlled trials (RCTs), 38–42.One controlled clinical trial, two test-retest studies with a single group, one case report, two case-control studies, forty-three, forty-eight, and one longitudinal research are among the others.49 A total of 387 patients with spinal cord injuries (AIS A-D) who had aquatic therapy following their SCI were included in these investigations research 40, 47 revealed strong evidence supporting the efficacy of aquatic therapy; however, other research were unable to establish substantial causation due to small sample numbers or the lack of a control group.41, 43–46, 48, and 49 The length of therapy in each of these trials spanned four weeks to three months, with two hours a week on average spent in water treatment. Two investigations, one a non-matched case-control study and the other a randomized control experiment, examined the Swimming exercise's impact on spinal cord damage sufferers' lung function.41, 48 While the on-land therapy group only experienced a significant improvement in forced expiratory reserve (FER), the randomized control trial found that aquatic therapy improved pulmonary function in SCI patients as measured by increases in forced vital capacity (FVC), forced expiratory reserve (FER), forced expiratory volume in 1 second (FEV1), and FEV1/FCV ratio.[6] A debilitating neurological condition that causes physical dependence, morbidity, psychological stress, and financial hardship is spinal cord injury (SCI). Its prevalence has risen from 236 to 1298 instances per million people worldwide over the past 30 years. The estimated worldwide rate of SCI ranges from Between 250,000 to 500,000 people annually . Each SCI patient's lifetime expenses above $3 million, and Canada's estimated yearly economic burden is close to $2.67 billion . Patients with lifetime disabilities can only receive supportive alleviation from the few available treatment . The main causes of inadequate knowledge and unsuccessful SCI treatment are heterogeneous elements, including complicated characteristics, a wealth of inconsistencies, and complex pathophysiologic effects after SCI . Acute SCI commonly occurs due to sudden trauma to the spine and results in fractures and vertebrae dislocation. The initial stage immediately after the injury is known as primary injury [2,4] (Figure 1a) with features of bone fragments and spinal ligament tearing. SCI is accomplished in two phases: the first phase includes the destruction of neural parenchyma, disruption of axonal network, haemorrhage and disruption of glial membrane (Figure 1a). The main determinants for SCI severity are the extent of initial destruction and duration of spinal cord compression.

A cascade of events associated with secondary injury is activated by the onset of biochemical, mechanical and physiological changes within neural tissues [7]. Although clinical manifestation suggests complete functional loss, few segments remain connected by some axons during primary SCI phase, thus reflecting incomplete and partial injury state. The main injury sets off secondary injury, which causes additional chemical and mechanical harm to the spinal tissues, raises reactive oxygen and glutamate levels, causes neuronal excitotoxicity due to excessive calcium buildup inside cells, and more. These incidents neurological dysfunction brought on by harm to the underlying proteins, phospholipids, and nucleic acids. The secondary injury phase, which lasts for a few weeks after the original damage period, represents multifaceted pathogenic processes (Figure 1b). Increased cell permeability, apoptotic signaling, ischemia, vascular damage, oedema, excitotoxicity, ionic deregulation, inflammation, lipid peroxidation, free radical formation, demyelination, Wallerian degeneration, fibroglial scarring, and cyst formation are clinical manifestations of secondary injury. Three stages of secondary damage are distinguished: acute, subacute, and chronic.

Clinical signs such vascular damage, ionic imbalance, excitotoxicity, and free radicals indicate the start of the acute secondary injury phase after the main injury phase. production, lipid peroxidation, elevated calcium influx, inflammation, oedema, and necrosis. The sub-acute secondary damage phase, which is characterized by characteristics including neuronal apoptosis, axonal demyelination, Wallerian degeneration, axonal remodelling, and glial scar formation, starts if the acute secondary injury phase continues. SCI is a debilitating illness . Although our understanding of the pathophysiology of spinal cord injuries has advanced significantly, each therapeutic approach has unique benefits and drawbacks. Meningitis, vascular injuries, developmental abnormalities, tumors or cancers, herniation, syringomyelia, and infections are among the conditions that can affect the spinalcord. degenerative diseases, transverse myelitis, and traumatic injuries (full section, hemisection, and compression). Nearly 90% of all spinal cord injuries are traumatic, and they are frequently the result of violent crimes, falls, sports injuries, and auto accidents. The patient's life may be severely impacted by them. Lesions in the cervical region cause quadriplegia, whereas injury to the lower thorax causes paraplegia. The first mechanical injury and the ensuing cascade of auto-destructive damages make up the two stages of the pathophysiology of SCI. Axonal damage, neural cell death, demyelination, disruption of the blood-spinal barrier, and extracellular matrix (ECM) degeneration are all swiftly brought on by mechanical trauma. These events set off a series of secondary injuries that intensify the inflammatory response at the lesion site and ultimately result in the formation of a cystic cavity. A secondary phase of injury, characterized by edema, ischemia, vascular dysfunction, excitotoxicity, inflammation, electrolyte changes, free radical generation, and delayed apoptotic cell death, follows the initial mechanical injury to the spinal cord. The first issue is figuring out how to stop the chain of events that is connected to the phase of subsequent spinal damage. Restoring lost connectivity and regenerating damaged spinal tissue comprise the second obstacle. SCI has a dynamic and intricate pathophysiology that involves interconnected molecular and metabolic processes . To manage one component of events or several events at once, different treatments have been developed.

Treatments that either directly or indirectly regulate and manage concurrent pathways aid in the improvement of this debilitating illness. The most effective strategies serve as the best means of overcoming SCI-related issues. Hot spring hydrotherapy is a type of physical treatment that offers a means of comfort and rehabilitation by utilizing the special therapeutic qualities of natural hot spring water, such as its temperature and mineral content, for both physical and emotional healing. It makes use of the hot spring's physical characteristics—temperature, water velocity, and buoyancy—to enhance illness symptoms and aid in CLBP patients' recuperation. It is frequently used to treat pain, lower inflammation, ease muscular tension, improve circulation, and aid in healing.[8] Hot spring hydrotherapy, which involves soaking in hot spring water, getting a hot spring jet, and working out in hot spring water, can offer a special kind of physical treatment that helps with the symptoms and functional abnormalities of conditions like persistent lower back pain.

Neural circuit integrity and remodeling are essential for spinal cord function recovery. Neural circuit dysfunction following SCI is caused by the loss of neurons and the rupture of neuronal axons. . The recovery of brain function is based on the plasticity of neural circuits. Restoring the connection with distal neurons and encouraging the regeneration and extension of the corticospinal tract (CST) are the traditional repair principles. These include lowering the production of regenerative-related inhibitors in the microenvironment during the early stages of SCI, such as chondroitin sulfate proteoglycans (CSPG) / NogoA / myelin-associated glycoprotein (MAP)/ oligodendrocyte myelin glycoprotein (OMG), and even lipid metabolites, or encouraging axon regeneration by taking advantage of the intrinsic growth ability. Spinal cord injury (SCI)-related impairments are caused by neuronal malfunction. Neurons experience mechanically induced cell death, demyelination and axon damage interfere with signal propagation, and synaptic connections are destroyed at the site of injury. Neuronal function is further disrupted by a secondary cascade of vascular, inflammatory, and metabolic events that are triggered by the first injury. Glia, such as astrocytes, fibroblasts, pericytes, Schwann cells, and microglia, are activated by these primary and subsequent damage processes. In the wounded central nervous system (CNS), endogenous pathogenic and reparative processes are based on the communication between activated glia and damaged neurons.[9]

REVIEW OF LITERATURE

Stanciu LE et al. (2023) Whether it affects elderly individuals or young people in their prime, spinal cord injury (SCI) is a terrible problem for modern civilization. Since there is presently no cure for spinal cord injuries, rehabilitation medicine is used as a therapeutic intervention to reduce secondary problems and maximize residual function. This scientific paper's primary goal is to ascertain whether there is evidence in the literature supporting the value and/or application of hydrotherapy as part of the therapeutic management of patients with spinal cord injuries. Goals include reducing the severity of pain and spasticity, maintaining or increasing range of motion, improving respiratory, cardiovascular, and metabolic status, and improving function and psychological benefits.

Lima R et al. (2022) The debilitating disorder known as spinal cord injury (SCI) impairs autonomic, sensory, and motor abilities. SCI remains a global health priority that affects thousands of people year, despite a great deal of research in recent decades. The intricate pathophysiology of SCI, which results in the point at which the body's ability to repair and regenerate is irreversibly compromised, is reflected in the dearth of viable therapeutic approaches for its patients. However, a number of studies have recently begun to reveal the complex web of mechanisms underlying SCI, which has prompted the creation of novel therapy strategies. We provide a thorough explanation of the anatomy and physiology of the spinal cord as well as the pathophysiology of SCI in this study. Furthermore, we present a summary of various molecular approaches that show encouraging promise in regulating secondary damage events that support neuroprotection or neuroregeneration. Other cutting-edge treatments, such as cell-based treatments, biomaterials, and epidural electric stimulation, are also briefly covered. In order to slow the progression of secondary damage from SCI and encourage regeneration that leads to functional recovery, a successful therapy may focus on various pathologic events.

Campo AR et al. (2022) One of the most common side effects of spinal cord injury (SCI) is neuropathic pain (NP). Pain catastrophization might result from the correlation between pain, quality of life, and functionality. Pharmacological treatment of NP patients resulting from SCI is well established, and the body of evidence supporting this practice is growing. However, because the effectiveness of nonpharmacological therapy is unclear, it is not entirely explained

Albert C. MD et al. (2020) conducted a study titled "Exercise in the Aquatic Environment for Patients With Chronic Spinal Cord Injury and Invasive Appliances: Successful Integration and Therapeutic Interventions"[7]. The objective of the study was to evaluate the interventions used in skilled aquatic therapy and to identify any clinical benefits for individuals with spinal cord injuries who use invasive appliances, including pressure injury dressings, suprapubic catheters, indwelling catheters, colostomy bags, and tracheostomy tubes.The results showed that forty-nine patients with traumatic spinal cord injuries demonstrated scores indicating statistically significant improvement in their total mobility and self-care, as measured by the Spinal Cord Independence Measure III ($P \leq 0.021$, 0.039, 0.021) scores. Forty-five patients with traumatic spinal cord injuries demonstrated significant improvement in ASIA Impairment Scale motor scores ($P \leq 0.002$), and nine patients with traumatic spinal cord injuries walked longer distances in the 6-minute walk test ($P \leq 0.011$). The Spinal Cord Independence Measure III efficiency was 0.26 per hour (95% confidence interval = 0.037–0.475). There was one reported unplanned bowel evacuation that occurred but did not prevent future therapy. All patients successfully completed a sequence of aquatic therapy.The study concluded that spinal cord injury patients with various invasive appliances can safely participate in specialized aquatic therapy without complications and seem to achieve clinically significant benefits. The authors recommend that spinal cord injury rehabilitation centers seek out and connect with opportunities for aquatic therapy within their institutions and communities.

Anjum A et al. (2020) Major motor, sensory, and autonomic dysfunctions are caused by spinal cord injury (SCI), a

debilitating neurological and pathophysiological condition. Its pathophysiology includes both acute and chronic stages, as well as a series of harmful processes such ischemia, oxidative stress, inflammation, apoptosis, and dysfunctions of the locomotor system. To combat neurodegenerative events and lessen subsequent neuronal damage, numerous treatment approaches have been put forth. In order to improve neuronal recovery and outcome, efforts have also been made to develop neuroprotective and neuro-regenerative medicines. Curative success remains elusive despite various degrees of success, most likely because of the intricate healing and protecting mechanisms involved. Therefore, it is necessary to evaluate the state of knowledge in this field in order to develop suitable treatment approaches that will enhance SCI recovery. The purpose of this review is to advance knowledge of the pathophysiology of SCI, interconnected or correlated multimolecular interactions, and different neuronal recovery strategies, such as immunomodulatory, neuroprotective, and neuro-regenerative pathways, as well as pertinent techniques.

Alizadeh A et al. (2019) Traumatic spinal cord injury (SCI) is a neurological disorder that can change a person's life and has significant financial effects on both the patient and the person providing care. The diagnosis, stability, survival rate, and general well- being of SCI patients have all improved dramatically as a result of recent developments in medical therapy of the condition. On the other hand, little has been done to improve the neurological outcomes of SCI patients through therapeutic alternatives. The intricacy of SCI pathophysiology and the variety of physiological and biochemical alterations that take place in the damaged spinal cord are the primary causes of this incremental success. In order to understand the pathophysiology of SCI and the underlying cellular and molecular mechanisms of tissue degeneration and healing in the injured spinal cord, researchers studying SCI have worked hard over the past few decades. In order to better replicate the primary and secondary injury processes of SCI, several preclinical animal and injury models have been created. We will give a thorough summary of the most recent developments in our knowledge of the pathophysiology of SCI in this review. We will also go over the neurological effects of SCI in humans as well as the experimental model systems that have been used to pinpoint the causes of SCI and create treatment plans.

Orr MB et al. (2018) Spinal cord injury (SCI) is characterized by deficits in neuronal function, and axon regeneration in the central nervous system (CNS) is frequently the focus of treatment efforts. However, in addition to intensifying SCI damage, secondary injury responses by astrocytes, microglia, pericytes, endothelial cells, Schwann cells, fibroblasts, meningeal cells, and other glia also promote endogenous repair. Glial cells and glial scar modification are the focus of SCI therapeutic research because of their significant influence on the course of SCI. Extracellular matrix (ECM) proteins, including collagen, fibronectin, laminin, and chondroitin sulfate proteoglycans (CSPGs), are deposited by cells within and surrounding the glial scar and have an impact on axon formation. This thick layer of substance.SCI treatments tackle this additional obstacle to endogenous healing. The release of glial chemokines and cytokines, followed by the activation of chemotactic cellular adhesion molecules and selectins on endothelial cells, attracts infiltrating neutrophils and monocytes to the site of damage. These peripheral immune cells are targeted for therapeutic manipulation because they, in conjunction with endogenous microglia, produce a strong inflammatory response to damage with a variety of reparative and pathogenic characteristics. In order to control SCI scarring and inflammation and enhance damage outcomes, we go over the function of glial and inflammatory cells following SCI as well as the treatment approaches that try to replace, reduce, or change their activity. Ellapen TJ et al. (2018) Sedentary lifestyles are common among patients with spinal cord injuries (PWSCI), who also face health issues and a low quality of life. Because performing the same exercises over and over again is tiresome, PWSCI dislike land- based activities, which lowers their rehabilitative compliance and has a detrimental effect on their wellbeing. Exercises and an other setting could reduce boredom and improve compliance.

Chunxiao Li et al. (2017) conducted a study titled "Effects of Aquatic Exercise on Physical Function and Fitness among People with Spinal Cord Injury"[8]. The objective of the study was to synthesize the evidence on the effects of aquatic exercise interventions on physical function and fitness among people with spinal cord injury.The results showed that eight out of 276 studies met the inclusion criteria, of which none demonstrated high research quality. Four studies assessed physical function outcomes, and four studies evaluated aerobic fitness as outcome measures. Generally, significant improvements were found for these two outcomes. Other physical or fitness outcomes, including body composition, muscular strength, and balance, were rarely reported. The study concluded that there is weak evidence supporting aquatic exercise training to improve physical function and aerobic fitness among adults with spinal cord injury. Suggestions for future research include reporting details of exercise interventions, evaluating other physical or fitness outcomes, and improving methodological quality

Andresa R. Marinho-Buzelli et al. (2014) conducted a study titled "The Effects of Aquatic Therapy on Mobility of Individuals with Neurological Diseases: A Systematic Review"[9]. The objective of the study was to summarize evidence on the effects of aquatic therapy on mobility in individuals with neurological diseases.The results showed that a total of 116 articles were obtained for full-text eligibility. Twenty studies met the specified inclusion criteria: four Randomized Controlled Trials (RCTs), four non-randomized studies, and twelve before-and-after tests. Two RCTs (30 patients with stroke in the aquatic therapy groups), three non-randomized studies, and three before-and-after studies showed “fair” evidence that aquatic therapy increases dynamic balance in participants with some neurological disorders. One RCT (seven patients with stroke in the aquatic therapy group) and two before-and-after tests (20 patients with multiple sclerosis) demonstrated “fair” evidence of improvement in gait speed after aquatic therapy. The study concluded that our synthesis showed “fair” evidence supporting the use of aquatic therapy to improve dynamic balance and gait speed in adults with certain neurological conditions.

NEED FOR STUDY: Studying the impact of hydrotherapy on functional status after spinal cord injury (SCI) is crucial for several reasons. Hydrotherapy offers a unique environment for rehabilitation, promoting buoyancy, reduced weight-bearing, and increased mobility. Understanding its effects can contribute valuable insights into developing more effective rehabilitation strategies for individuals with SCI, potentially enhancing their overall quality of life and independence.

Investigating the physiological and functional outcomes will provide evidence-based support for incorporating hydrotherapy into rehabilitation protocols for SCI patients.

AIM AND OBJECTIVES

AIM: To understand the impact of hydrotherapy to improve functional status following SCI

OBJECTIVES: To conduct a comprehensive review of exisiting literature to analyze the documented impact of hydrotherapy on functional status in individuals with spinal cord injury.

METHODOLOGY

The influence of hydrotherapy to enhance functional status following SCI was the subject of a case study and a comprehensive review that were completed. A predetermined search strategy depending on the year of discovery will be used to Research Gate, Pubmed, and Google Scholar. The terms SCI and aquatic therapy will be used as anchoring terms in different combinations in the search databases mentioned above.

SELECTION CRITERIA

Inclusion criteria

- Full text articles
- Articles with only abstract

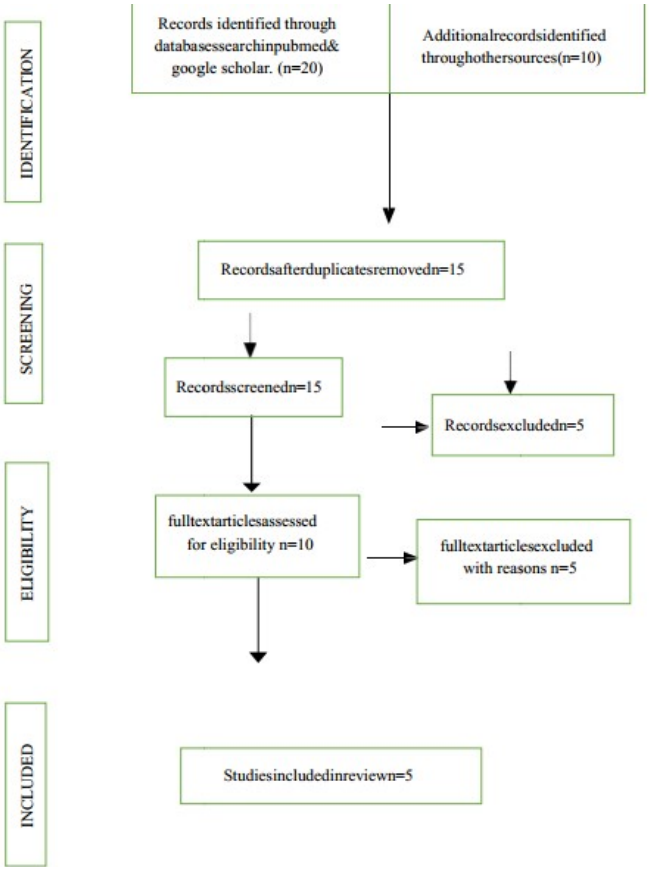
Exclusion criteria

- Studies not focusing on hydrotherapy as a primary or significant intervention.
- Articles pubished in other languages. 3.Duplicate articles should be removed

PROCEDURE

STUDY SELECTION: Several articles from PubMed, google scholar databases were reviewed the following keywords :spinal cord injury, effects of hydrotherapy in SCI , were used for studies that were completed and published in English focusing on hydrotherapy in SCI were selected. This study included patients with SCI to improve functional status.

STUDY STRATEGY: Studies were selected according to above mentioned inclusion and exclusion criteria. Narrative review on how the study was carried out, the graphic clearly specifies four phases: inclusion, eligibility, screening and identification. First records discovered through database searches n=30 are followed by records obtained through sources n = 10. after that, carefully sorting the screening proceeds n=30 with the duplicates with the exception of the exclusion n=5 .as we get further towards eligibility, were left with the final phase, which is crucial. there are a total of 5 studies that are included in the qualitative synthesis n = 5 which consisted of controlled trial, retrospective study, cross sectional study, comparative study, case control study, Experimental, crossover design.



RESULTS AND DISCUSSION

This narrative review is primarily aimed to provide an overview of the physiotherapy management used and its effect on patients with The impact of hydro therapy to improve functional status following spinal cord injury. The findings of this review had been drawn from the above summarized 5 articles, which had information on effect of physiotherapy management on SPINAL CORD INURY. According to the study conducted by Franciane R Dos Anjos the preterm newborns receiving hydrotherapy experienced a significant increase in weight gain, with improvement beginning on the second day ($p < 0.001$). This shows that by enhancing circulation, muscle tone, and lowering stress—all of which are critical for the growth of premature infants—hydrotherapy may have a good impact on weight gain. However, there was no discernible weight gain in the tactile-kinesthetic stimulation group ($p = 0.43$), suggesting that it might not be as successful in increasing weight in this population. Although bigger, blinded trials are required to validate these results and examine long-term outcomes, these findings highlight the potential advantages of hydrotherapy for preterm newborns.

Another study which was studied by Dylan J Edwards there is no discernible change in walking speed, the study demonstrated that clinical ambulation in patients with chronic incomplete spinal cord injury (iSCI) improved after 12 weeks of exoskeleton-based robotic gait training. Participants in the Ekso group were more likely to improve from home to community walking speeds, suggesting potential benefits for functional mobility. While secondary outcomes did not show significant improvements, the intervention was safe and well-tolerated.

REFERENCE	STUDY DESIGN	TITLE	INTERVENTION	RESULT
Franciane R Dos Anios et.al (2021)	Randomized Controlled Trial	Effects of hydrotherapy and tactile- kinesthetic stimulation on weight gain of preterm infants admitted in the Neonatal Intensive Care Unit	1. Hydrotherapy protocol: It involved gentle movements like trunk rotation and scapular dissociation to stimulate the body and improve posture using the upthrust force of the water. 2. Tactile kinesthetic stimulation: It involved three phases: tactile stimulation (massage) on the newborn's body with moderate pressure for five minutes, kinesthetic stimulation (flexion/extension of limbs) for five minutes, and a repeat of the tactile sequence for five minutes.	Although weight gain varied in the tactile- kinesthetic stimulation group, there was no discernible difference (p =0,43). On the other hand, it was noted that the hydrotherapy group experienced higher weight gain beginning on the second day .
Dylan J Edwards et.al (2022)	Randomized Controlled Trial	Walking improvement in chronic incomplete spinal cord injury with exoskeleton robotic	1. Ekso GT robotic gait training: 45 minutes of device training, with 300 steps per session, and 15 minutes of standard overground gait training once minimal assistance was needed. Weekly progress was assessed using the 10- meter walk test. 2. The Active Control group: A 45-minute	A total of 25 individuals completed the training (9 Ekso, 10 Active Control, 6 Passive Control). The primary endpoint, mean change in gait speed, was not statistically significant. However, the Ekso group showed the highest percentage of patients
		training (WISE)	session of jBWSTT, starting with 300 steps, and transitioned to Sm&SMd gait training once criteria were met. Sessions focused on task-specific training, intensity, and dose, with a progression strategy similar to the Efe&group. 3. Passive Control group: continued daily activities without new gait training or treatments, with evaluations at baseline, 6, and 12 weeks. After 12 weeks, they were offered Active or Active BWSTT sessions.	improving their ambulation category from home to community speed (>50%vs. 33% in Active Control, 0% in Passive Control; p < 0.05). Secondary outcomes showed no significant improvements.
Ning Bei et.al(2023)	Randomized Controlled Trial	Effect of Water Exercise Therapy on Lower Limb Function Rehabilitation in Hemiplegic Patients with the First Stroke	1. Butterfly bath rehabilitation exercise: They were informed of their treatment the day before and instructed to arrive at the spa room 15 minutes early to gradually adjust to the temperature difference between indoors and outdoors. 2. Limbs Bath Rehabilitation Nursing: Direct current electric stimulation and drug ion import in a water bath enhance proprioception, stimulate muscle contraction, and reduce limb swelling through hydrothermal effects and	Prior to treatment, there were no significant differences between the two groups on various outcome measures. After 8 weeks of treatment, significant improvements were observed in the FMA, FAC, BBS, and MBI scores. The treatment group showed greater improvements compared to the control group across these measures.
			uniform pressure therapy. 3.Rehabilitation Nursing of Walking Bath (Gait Training): Weight-bearing exercises in water promote sensory stimulation and help reduce lower limb edema, with progress monitored through walking groove markers and observation windows.	
Hongju Liu et al (2019)	Randomized Controlled Trial	Short-term effects of core stability training on the balance and ambnlation function of individuals with chronic spinal cord injury	1. Residual Extremity Muscle Strengthening Exercises (REMSE): REMSE strengthens remaining muscles using resistance or movement exercises to enhance coordination. Both groups performed them on stable or unstable surfaces to challenge muscle activation. 2. Body Weight Supported Treadmill (BWSTT) Training: BWSTT supports partial body weight during treadmill walking to improve gait and endurance. Both groups practiced walking with this reduced load. 3. Conventional Stabilizing Training (CST): CST enhances balance and core strength through stability exercises. The control group	After the 12-week intervention, the unstable group showed significant improvements in stride length, cadence, walking speed, and balance (Romberg ratio, CA, EVA, DC'DX with eyes closed) compared to the control group. These findings indicate that the intervention improved both dynamic walking and static balance, with better outcomes for the unstable group.
			used stable surfaces, while the experimental group trained on unstable surfaces for added difficulty.	
Eline Zwijgers et.al (2024)	Randomized Controlled Trial	Efficacy of Walking Adaptability Training on Walking Capacity in Ambulatory People With Motor-Incomplete Spinal Cord Injury	1 .Walking adaptability training : GRAIL svstem.incorporating treadmill,motion capture, and vrrtual reality for tasks like precision stepping and obstacle avoidance. Each 60-minute session included 20 minutes of walking tasks and balance exercises tinder a certified physiotherapist's guidance. 2.Conventionallocomotorandstrength training involved 20 minutes of treadmill training followed by lower-body strength exercises, guidedby a physiotherapist. Treadmill speedwasadjustedto each participant's ability, and strength exercises likelegpress andhip abductionwere progressively increased based on individual progress.	Six weeks after training, no significant differences were found in maximal walking speed or secondary outcomes between the walking adaptability and traditional locomotor/strength training groups. Both groups showed improvements in walking speed, functional ambulation, and balance confidence, indicating that walking adaptability training may not be more effective than traditional methods for individuals with :SCI.

These findings highlight the need for future research to refine participant criteria and consider longer training durations to achieve more substantial improvements in ambulation. According to Ning Bei emphasizes how early water exercise therapy helps stroke patients recover from their first stroke. Higher scores on the FMA, FAC, BBS, and MBI after 8 weeks of treatment demonstrated that the hydrotherapy group had significantly improved lower limb motor function, balance, and walking ability. These results imply that by offering a low-impact setting that promotes mobility and coordination, water-based workouts can improve functional recovery, especially in hemiplegic stroke patients. The extra advantage of hydrotherapy highlights its potential

as a supplemental treatment in stroke recovery, even if the control group demonstrated some improvement. The long-term effectiveness of hydrotherapy could be ascertained with the aid of more research with extended follow-up times. Hongju Liu conducted study In contrast to CST on a stable support surface (SSS), this study shows that CST on an unstable support surface (USS) improves ambulation and static balance more in people with chronic spinal cord injury (SCI). Stride length, cadence, walking speed, and static balance metrics like Romberg ratio all significantly improved for the trial group. Better functional outcomes are probably promoted by the USS condition, which increases neuromuscular activation and proprioception. For SCI patients, combining CST with other therapies such body weight supported treadmill exercise and muscle development may provide a more successful rehabilitation approach. To validate these results and look into the underlying mechanisms, more research is required.

According to Eline Zwijgers study, walking adaptability training with a virtual reality treadmill system does not improve walking capacity, functional ambulation, balance confidence, or participation in individuals with incomplete spinal cord injury (iSCI) more than traditional locomotor and strength training. While no significant differences were found between the groups, both interventions resulted in improvements in walking speed, functional ambulation, balance confidence, and participation. These findings suggest that both types of training may be beneficial for ambulatory individuals with iSCI. Future studies with larger sample sizes or extended training periods are needed to further investigate the potential benefits of walking adaptability training.

CONCLUSION

Hydrotherapy is a potentially effective rehabilitation method that can enhance cardiovascular fitness, joint mobility, muscular strength, and coordination. Additionally, it lessens stiffness and discomfort, improving general quality of life. Existing evidence supports its inclusion in SCI rehabilitation programs, despite the fact that its efficacy can vary according on the severity of the damage and the health of the individual. Hydrotherapy continues to be a useful treatment for enhancing functional results and accelerating rehabilitation in SCI patients, despite obstacles including accessibility and the requirement for further extensive research.

REFERENCES

1. Recio AC, Kubrova E, Stiens SA. Exercise in the Aquatic Environment for Patients With Chronic Spinal Cord Injury and Invasive Appliances: Successful Integration and Therapeutic Interventions. American Journal of Physical Medicine & Rehabilitation. 2020 Feb 1;99(2):109-15.
2. Recio AC, Stiens SA, Kubrova E. Aquatic-Based therapy in spinal cord injury rehabilitation: effective yet underutilized. Current Physical Medicine and Rehabilitation Reports. 2017 Sep;5:108-12.
3. Hammill HV, Ellapen TJ, Strydom GL, Swanepoel M. The benefits of hydrotherapy to patients with spinal cord injuries. African journal of disability. 2018 Jan 1;7(1):1-8.
4. Ahuja CS, Wilson JR, Nori S, Kotter M, Druschel C, Curt A, Fehlings MG. Traumatic spinal cord injury. Nature reviews Disease primers. 2017 Apr 27;3(1):1-21.
5. Bailey DG. The Effect of Aquatic Therapy on Patients with a Complete Spinal Cord Injury in the In-Patient Rehabilitation Setting. University of North Texas Health Science Center at Fort Worth; 2018.
6. De Morand A. Pratique de la rééducation neurologique. Elsevier Health Sciences; 2022 May 18.
7. Evidence of Improvement of Lower Limb Functioning Using Hydrotherapy on Spinal Cord Injury Patients Biomedicines 2023
8. Kim S, Kwon SH, Kam TI, Panicker N, Karuppagounder SS, Lee S, Lee JH, Kim WR, Kook M, Foss CA, Shen C. Transneuronal propagation of pathologic α-synuclein from the gut to the brain models Parkinson's disease. Neuron. 2019 Aug 21;103(4):627-41.
9. Stanciu LE, Iliescu MG, Vlădăreanu L, Ciota AE, Ionescu EV, Mihailov CI. Evidence of Improvement of Lower Limb Functioning Using Hydrotherapy on Spinal Cord Injury Patients. Biomedicines. 2023 Jan 21;11(2):302. doi: 10.3390/biomedicines11020302. PMID: 36830837; PMCID: PMC9953065
10. Campo AR, Pacichana-Quinayáz SG, Bonilla-Escobar FJ, Leiva-Pemberthy LM, Tovar-Sánchez MA, Hernández-Orobio OM, Arango-Hoyos GP, Mujanovic A. Effectiveness of Hydrotherapy on Neuropathic Pain and Pain Catastrophization in Patients With Spinal Cord Injury: Protocol for a Pilot Trial Study. JMIR Res Protoc. 2022 Apr 29;11(4):e37255. doi: 10.2196/37255. PMID: 35486436; PMCID: PMC9107053.
11. Stanciu LE, Iliescu MG, Vlădăreanu L, Ciota AE, Ionescu EV, Mihailov CI. Evidence of Improvement of Lower Limb Functioning Using Hydrotherapy on Spinal Cord Injury Patients. Biomedicines. 2023 Jan 21;11(2):302. doi: 10.3390/biomedicines11020302. PMID: 36830837; PMCID: PMC9953065.
12. Anjum A, Yazid MD, Fauzi Daud M, Idris J, Ng AMH, Selvi Naicker A, Ismail OHR, Athi Kumar RK, Lokanathan Y. Spinal Cord Injury: Pathophysiology, Multimolecular Interactions, and Underlying Recovery Mechanisms. Int J Mol Sci. 2020 Oct 13;21(20):7533. doi: 10.3390/ijms21207533. PMID: 33066029; PMCID: PMC7589539.
13. Chen Y, Tang Y, Vogel L, DeVivo M. Causes of spinal cord injury. Topics in spinal cord injury rehabilitation. 2013 Jan 1;19(1):1-8..
14. Eli I, Lerner DP, Ghogawala Z. Acute Traumatic Spinal Cord Injury. Neurol Clin. 2021 May;39(2):471-488. doi: 10.1016/j.ncl.2021.02.004. Epub 2021 Mar
15. PMID: 33896529.
16. McDonald JW, Sadowsky C. Spinal-cord injury. Lancet. 2002 Feb 2;359(9304):417-25. doi: 10.1016/S0140-6736(02)07603-1. PMID: 11844532.

17. Tamburella F, Scivoletto G, Cosentino E, Molinari M. Walking in water and on land after an incomplete spinal cord injury. Am J Phys Med Rehabil. 2013 Oct;92(10 Suppl 2):e4-15. doi: 10.1097/PHM.0b013e3182a1e6c3. PMID: 24052028.

18. Karimi S, Derakhshan M, Tondro A. The effect of aquatherapy on pain intensity and performance in patients with osteoarthritis. J Family Med Prim Care. 2024 May;13(5):1793-1796. doi: 10.4103/jfmpc.jfmpc_1088_23. Epub 2024 May 24. PMID: 38948627; PMCID: PMC11213425.

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