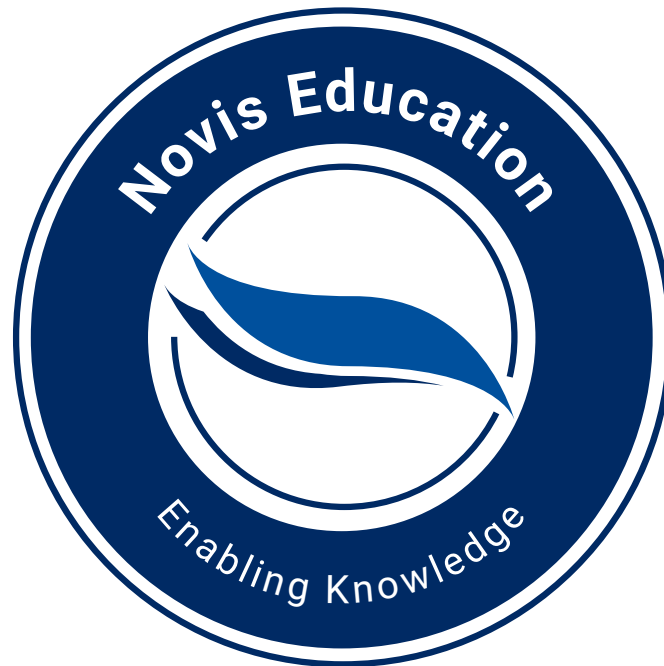




Access to water utilising Assistive Technology

February 2023



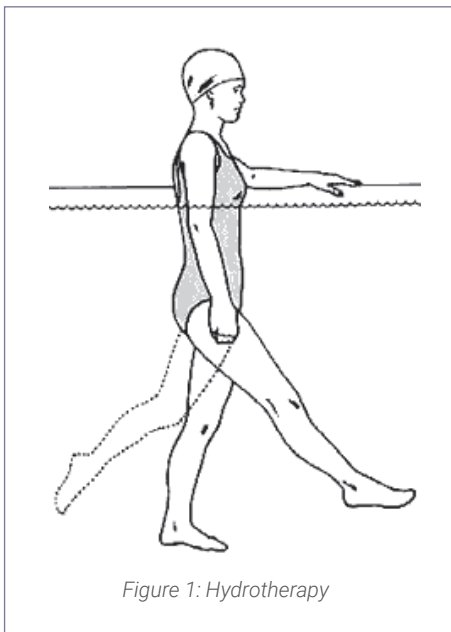
Novis Healthcare is a specialist in the design, manufacture and supply of pressure care devices, assistive technology solutions and clinical training. A strong focus on clinical outcomes including pressure injury prevention and patient handling ensures Novis provide healthcare products that exceed clinical and therapeutic expectations.

Novis utilises best practice, gold standard procedures and clinical evidence to ensure our research, innovation and design facilitate clinical excellence. Novis maintains a strong focus on delivering successful patient outcomes in acute care, long term care, rehabilitation and in the community.

INTRODUCTION

Hydrotherapy is the medicinal use of water for positive health benefits. These health benefits come from the mechanical and thermal effects of water interacting with the body. It includes the use of physical water properties to treat the symptoms of certain disease or disabilities ¹.

Hydrotherapy (Figure 1) is one of the oldest therapeutic methods for managing physical dysfunctions. It is used for the effects on body tissues of heating, cooling, debridement, pain relief, muscle relaxation, treatment of joint stiffness, psychological relaxation, and exercise ².



Water immersion offers biophysiological, physical and therapeutic benefit. The complex thermal, mechanic, and inherent mechanical forces of buoyancy, pressure, cohesion, and viscosity play a role in the effects produced on the body from Hydrotherapy. The supportive, assistive, and resistive qualities of the water make it possible for patients to begin range motion, strength, and endurance exercise ².

“Other biological benefits of immersing the body in water up to chest (or higher) include lymphatic compression, venous compression, increased central blood volume, increased cardiac volume, increased atrial pressure, increased stroke volume, increased cardiac output, increased work of breathing, increased oxygen delivery, improved dependent oedema, increased muscle blood flow, offloading of body weight, decreased joint compression with movement, increased flow to kidneys, higher pain threshold, suppression of sympathetic nervous system activity, and promotion of excretion of metabolic waste” ⁴.

Australian Physiotherapy Association reported that “evidence was documented to support aquatic Physiotherapy in the management of osteoarthritis, rheumatoid arthritis, joint arthroplasty, fibromyalgia, ankylosing spondylitis, back pain, upper- and lower-limb disorders, stroke, acquired brain injury, spinal cord injury, multiple sclerosis, Guillain Barré syndrome, post-polio syndrome, adult cerebral palsy, autism, Rett syndrome, maternal-perinatal health, post-menopausal health, osteopenia, obesity, lymphoedema, chronic obstructive pulmonary disease (COPD), heart failure and sport-specific rehabilitation” ⁵.

Accessibility of water provides a significant barrier to a person’s ability to access the range of physical, psychological and therapeutic benefits of immersion in water. However, multiple options of Assistive Technology are available and can easily improve accessibility to the large number of pools, spas and waterways that are present in Australia.

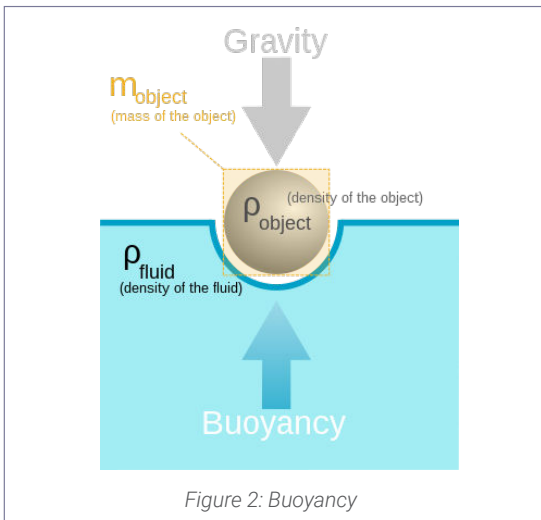
The better the access, the greater the potential for more people with disease or disability to have the same opportunities that able bodied, mobile people have accessing the multitude of benefits of water and Hydrotherapy.

HYDRODYNAMICS

Understanding the effects and the physical properties of water may assist therapists to determine benefit of access to water, determine a plan and implement Assistive Technology to meet these goals.

Buoyancy:

*"Reduces the force of gravity and provides resistance to downward movement"*⁶



Describes the upward thrust of water on an immersed or partially immersed (floating) object, equivalent to the weight of water that is displaced by the object. This coincides with the relative density of the person⁷. (Figure 2)

Buoyancy counteracts the effect of the normal pressure from gravity creating an apparent 'weightlessness'. The result being an effect of body weight being as low as 10% of its actual body weight on land¹.

The upward thrust of buoyancy can be also used as resistance against exercise⁶.

Object Density:

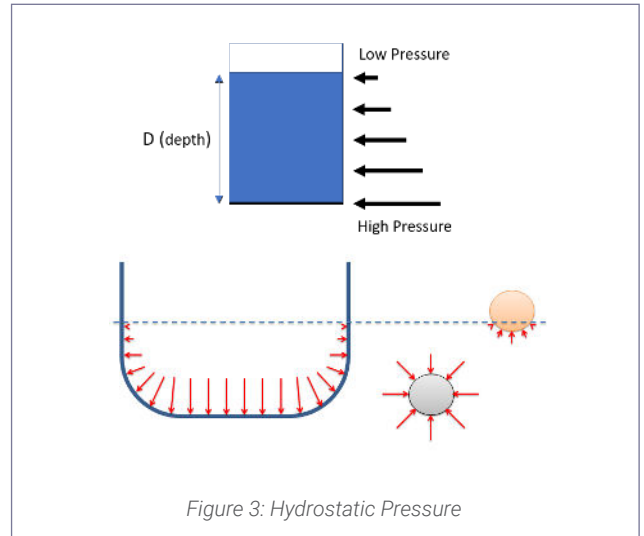
"The density of the body will impact the effect of buoyancy"

This determines how well the person will float on water as it determines the weight/mass of the patient compared with an equal volume of water.

The density of water is 1.0 compared with 0.8 for fat and 2.0 for bone, therefore, fat will float and bone will sink. The implication of this is that a lean person will need more support for buoyancy in the water than an obese patient⁷.

Hydrostatic Pressure:

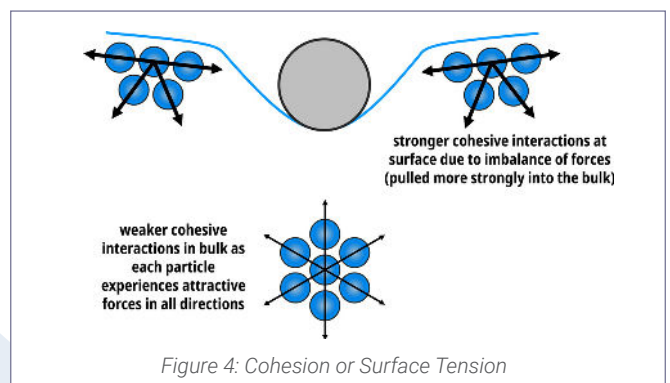
*"Hydrostatic pressure is the force exerted by water on the immersed object, the body"*⁶



As an object is submerged or partially submerged in water the pressure exerted upon it is directionally proportional to the depth and density of the water, therefore the height of the water or amount of body that is placed within the water undergoes compression⁷. Because water is denser than air, water exerts more pressure on the body. (Figure 3)

Cohesion:

*"Cohesion is the surface tension that increases the resistance of the water a body or an object entering the water"*⁶



Cohesion of the molecules within water is greater at the surface than at any given depth. This is due to the structure of particles pulling more strongly at the surface. (Figure 4)

Resistance to movement of a limb through water is greater at the water surface than beneath the water. Practically, this means that it is more difficult for a patient to break surface tension, i.e. lift a limb out of the water and re-immense, than it is to move the limb through the water at a given depth ⁷.

Viscosity:

"Viscosity creates resistance to objects or body parts moving through the water" ⁶

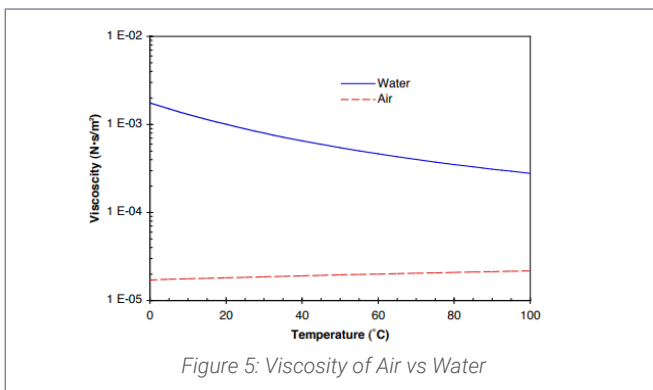


Figure 5: Viscosity of Air vs Water

Viscosity is a fluid's resistance to movement and flow which affects the amount of force that must be exerted to move a solid body part such as a limb through the fluid. Water has a higher viscosity than air and therefore creates more resistance so that moving through water requires more force than moving through air. Density of water is substantially (1000 times) greater than air ⁹. (Figure 5)

This resistance can be beneficial to people when clinically aiming to improve musculoskeletal strength or cardiovascular fitness ⁷. Resistance to movement can be varied by changing the speed of motion and by increasing water turbulence ¹⁰.

Temperature:

Temperature of the water need to be appropriate for person, their morbidities, the activity being performed and the desired goal.

Ideal temperatures will vary dependant on the Hydrotherapy goals. The Australian Physiotherapy Association recommends people with acute pain, arthritic or some neurological conditions will benefit from a pool at 34-35°C while clients involved in work-hardening and aerobic programs may prefer a cooler pool ⁵. Temperatures should be kept below 30°C if there is a propensity to increase exercise intensity.

A thermoneutral pool (in which the body neither gains nor loses temperature) may be the most appropriate for aquatic physiotherapy techniques. Thermoneutral is usually recognised as a 'window' of temperature (based on skin temperature) from 33.5-34.5°C. This temperature range can be recommended as therapeutically useful for a wide range of conditions ⁵.

However, cooler water (eg 25-30°C) will elicit other advantageous physical, biological and psychological responses from the body. It is therefore important to have a thorough assessment prior to utilising the water and a clear set of goals to determine whether a heated or cooled environment if preferential.

Immersion Depth:

"Immersion depth will impact the degree in which water properties affect the body"

The depth of immersion with vary dependant on a person's height, mass and therapeutic goals of the activity. The deeper the person is immersed into the water the greater the role of buoyancy, hydrostatic pressure and viscosity.

Partial immersion allows use of surface tension and increasing upper body weight relative to lower body weight that is submerged.

An apparent weight reduction of 83% of body weight was observed during body immersion ¹¹. As the depth of immersion is decreased, the person having more body out of the water, the effect of buoyancy, hydrostatic pressure and viscosity is also decreased. (Figure 6)

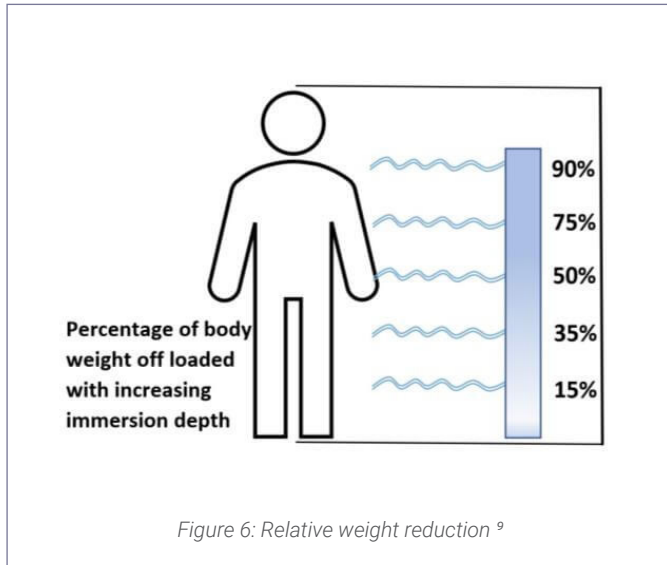


Figure 6: Relative weight reduction ⁹

HYDROTHERAPY

Passive Hydrotherapy:

In Passive Hydrotherapy, the individual is inactive and immersed in water, receiving treatment by simply being immersed, floating. A therapist can also manipulate joints, perform stretches or use massage techniques to alleviate pain or increase range of motion ⁹.

One technique known as WATSU (water and shiatsu) is a form of Passive Hydrotherapy in chest-deep thermoneutral water. It combines elements of myofascial stretching, joint mobilization, massage, and shiatsu and is reported to be used to address physical and mental symptoms ¹². Benefits have been found for the use in pain and stress related conditions ¹². In addition, fatigue and quality of life can be improved ¹³.

Floation-REST (Reduced Environmental Stimulation Therapy) reduces sensory input to the nervous system through the act of floating supine in a pool of water ¹⁴. This induces a strong reduction in anxiety and a substantial improvement in mood in anxious and depressed people ¹⁴. Following this therapy, a decrease in self-reported stress, muscle tension, pain, depression, and reduced negative affect. As well as a significant increase in serenity, relaxation, happiness, positive affect, overall well-being, energy levels, and feeling refreshed, content and peaceful ¹⁴.

Passive Hydrotherapy can form a complementary part of a holistic aquatic and land based rehabilitation program.

Active Hydrotherapy:

Exercise is associated with physical and psychological health benefits and a reduced risk of cardiovascular disease, diabetes, depression, and cancer ¹⁵. Following surgery or injury people who utilise Hydrotherapy exercises recover faster as compared to conventional therapy alone ⁶.

The characteristics and efficiency of water provides great advantage for people exercising to improve quality of life and diminishes disabilities ⁶.

Exercise in water takes the weight off joints while also providing resistance. This results in the ability to improve muscle strength, gain greater flexibility and range of motion, enhanced balance and coordination of core muscle groups to stabilise the body ⁶.

When stretching and strengthening are done in water, the properties of water relieve pain, reduce muscle spasm, increase joint range of motion, strengthen weak muscles, improve circulation, provide resistance, improves balance and coordination ^{10,16}.

SYSTEMIC RESPONSE OF HYDROTHERAPY

Cardiovascular:

Hydrotherapy improves cardiorespiratory performance ¹⁷ in multifaceted ways.

As a result of the hydrostatic and hydrodynamic effects, adrenaline in the body decreases, the heart rate decreases, and the muscles of the blood vessel walls relax, causing blood pressure to decrease ¹⁸.

During head out of water immersion, hydrostatic pressure compresses the superficial veins of the lower extremities, pelvis and abdomen, resulting in a shift of blood volume to the thorax and heart. On immersion

up to the neck the central blood volume increases by approximately 700mls. On average, heart size increases 30% and stroke volume increases 35-45% ⁵.

During swimming, the horizontal body position, hydrostatic pressure and muscular activity, can produce a higher cardiovascular load than that experienced when exercising in an upright vertical position ⁵.

Hydrotherapy is effective in treating primary varicose veins. It can be considered as an adjunct measure to compression therapy and other conservative treatments ¹⁹.

Respiratory:

As a direct result of Hydrostatic Pressure, the effect of Hydrotherapy ⁵:

- Causes increased work of inspiratory muscle contraction in chest expansion
- Causes compression of the abdomen, resulting in cephalad movement of the diaphragm, reducing space in the thoracic cavity
- Causes re-distribution of the blood flow from peripheries to the cardiothoracic space, resulting in relative central hypervolaemia
- All these factors can influence the increase in the work of breathing as well as decreasing lung volumes such as vital capacity, total lung capacity, functional residual capacity and expiratory reserve volume.

Neurological:

Hydrotherapy is used for treatment of neurological diseases, since the physical properties of water combined with physical advantages of exercise bring preventive, motor and sensory benefits.

The sensorial benefits are highlighted in those with Parkinson's Disease, since they stimulate the balance, the notion of corporal and spatial schema and the proprioception thus promoting greater functional independence ²⁰.

Musculoskeletal:

Exercising in water produces an increase in cardiac output, in the blood flow to muscles, and in the diffusion of metabolic waste products from muscle to blood, as well as a reduction in the time it takes to transport oxygen, nutrients, and hormones to fatigued muscles ⁸.

The microgravity environment allows patients to actively participate in exercise. Due to the lack of a stable position of the body in the water, the muscles are constantly activated in order to stabilise it. This makes it possible to gain strength, flexibility and balance. Hydrostatic pressure provides proprioceptive and sensory feedback that is different from that on land ³⁴.

Exercise in water takes the weight off painful joints while also providing resistance ⁶ for exercise therapy or recreation.

Balance & Falls:

People experience safety and pleasure when they participate in the restoration of movements in fluid media such as water ¹⁰.

The physical properties of water enable people to feel safe, participate in tasks that are too difficult on land, do more exercises than they would be able to do on land whilst allowing them to keep their balance ³ ensuring safety.

In water, the minimisation of 'fear of falling' can allow people to move freely, assisting in the accomplishment of physical and functional goals ²³.

Falls and fall-related injuries are a serious health concern in geriatric populations, especially with age-related deficits in postural control and during postural control challenging dual-task situations ²¹.

Balance training has been reported to be beneficial in reducing falls. However, some of these exercises have their inherent physical challenges that prevent people

from performing them effectively on land. Hydrotherapy that focuses on balance and postural perturbation based exercises in water offer a successful alternative to land based balance training ²¹.

Hydrotherapy offers a safe environment to perform balance exercises ²¹ to facilitate the training needed to minimise falls risk on land.

Aquatic exercises are beneficial for the static and dynamic balance in patients with multiple sclerosis, Parkinson's disease, and hemiplegia ²².

Gait Training:

The physical properties and comfort of warm water allow people to participate in training that may be too painful, too difficult or too fear inducing on land ². It provides a safe environment to explore movement. Water properties such as hydrostatic pressure, buoyancy, density, temperature and resistance have a positive effect. They allow the patient to exercise with balanced and coordinated movements ³⁴.

When opposed to a land-based context, trunk muscles in an aquatic environment require only around 25% of their typical tension to stabilise the trunk ⁹ making gait and other movement more achievable for those with low muscle tone.

Gait training in water increases underwater functioning of the lower limbs and gait kinematics ²². With a short period of aquatic based gait retraining, speed, length, stance/swing ratio and balance had better values compared to those solely training on land ¹⁰.

Following Spinal Cord Injury, exercise in an aquatic environment could be expected to improve functional gait characteristics out of the water ^{2,17}.

In person with Parkinson's disease, improvement in postural stability was significantly larger after Hydrotherapy ²⁴.

People with Multiple Sclerosis demonstrate a significant improvement in gait speed resulting from

implementation of a Hydrotherapy program ³⁴.

Psychological:

Hydrotherapy positively influences mood, socialisation and wellbeing ¹⁰. Improvement in overall quality of life is significantly greater when participating in water based training ²⁵.

An aquatic exercise program reduces depression and anxiety, improves functional autonomy, decreases oxidative stress ²⁶ and improves cognition ²⁷ in elderly individuals.

Hydrotherapy reduces the clinical symptoms of the nervous system diseases, reduces pain and improves quality of life. ²⁸

Fatigue:

Exercise has long been associated in a longer term benefit to fatigue levels ²⁴. Allowing someone to exercise with the advantages of water will allow the benefit of fatigue reduction to occur.

Hydrotherapy in particular can be of assistance post exercise, reducing fatigue by reducing muscle pain and accelerating recovery of fatigued muscle ²⁴.

WARM WATER HYDROTHERAPY

Water temperature in a typical Hydrotherapy pool is higher than a regular swimming pool, usually between 33°C and 36°C ²⁹.

When water temperature is within this thermoneutral range of 33.5-34.5°C ⁵, Hydrotherapy has a positive effect on pain, quality of life, condition-related disability and functional exercise capacity. Following Hydrotherapy, the perceived benefit of well-being was superior to land-based exercise protocols ³⁰.

In a reflexive response to external heat, your body initiates changes that help keep the body cool, including dilating blood vessels to increase the blood flow through them, diverting blood flow to the extremities and to the

skin's surface, opening the pores of the skin, activating sweat glands and relaxing muscles ¹.

Cardiovascular:

Immersion in thermoneutral water has been shown to be accompanied by stimulation of the cardiopulmonary arterial baroreceptors. Sympathetic nervous system activation, systemic vascular resistance and pulmonary vascular resistance are all decreased ⁵.

A considerable increase in cardiac output ²⁴, reduction in HR, and increases in systolic and diastolic biventricular functions, were observed during warm water Hydrotherapy ²⁴.

This is explained by the conduction theory, which states that heat transfer from warm water to the body causes blood vessels to dilate and muscle tension to decrease, thereby improving circulation ¹⁸ and in particular peripheral circulation ²⁴.

This increased blood flow to the extremities has important effects on your body, including more efficient oxygenation of tissues, thereby helping injuries heal faster, and more efficient removal of toxins from tissue, which helps prevent or ease injuries and increases tissue resiliency ¹.

Two main factors affecting O₂ transport during immersion are temperature and hydrostatic pressure. O₂ transport was improved above neutral temperature, because of increase in cardiac output resulting from the combined actions of hydrostatic counter pressure and body heating ²⁴.

In people with chronic heart failure, thermal vasodilatation following warm-water bathing improves cardiac function, increases left ventricular ejection fraction, improvement in flow-mediated dilation and improves exercise tolerance in association with improvement in endothelial function ²⁴.

Respiratory:

A significant decrease in vital capacity with warm

temperature occurs. Alterations in respiratory muscle function might produce variations of the pulmonary volumes as a function of water temperature ²⁴..

Neurological:

Temperature and pressure of water in aquatic or Hydrotherapy can block nociceptors by acting on thermal receptors and mechanoreceptors and exert positive effect on spinal segmental mechanisms, which is useful for alleviation of pain ^{23, 24, 31}.

Not only did the pain itself ease, but Hydrotherapy helps participants shift the focus from the constant pain that were experiencing ³.

Hydrotherapy exercises assist in faster relief from pain than conventional exercise ⁶. Pain is also not generally increased following exercise and activity is not diminishes post session ³².

Musculoskeletal:

Because warm water Hydrotherapy has a calming effect on the nervous system and helps increase blood flow to soft tissue, it helps alleviate symptoms associated with neural and muscular diseases by decreasing demands on neurons, decreasing stress in the muscles, and increasing the flow of oxygen to soft tissues, which aids in healing ¹.

Warmth and pressure of water reduce swelling and reduces load on painful joints, promoting muscle relaxation ²⁴.

People receiving Hydrotherapy have better alleviation of pain, improved function, performance for knee flexor and extensor strength, knee flexor power, and knee extensor endurance ³³.

People who take part in Hydrotherapy gain a perception that the exercises resulted in physical benefits, including pain relief and improvements in strength, flexibility and mobility ³.

Aqua-jogging without caloric restrictions in obese persons for 6 weeks was associated with reductions in waist circumference and body fat; improvement of aerobic fitness and quality of life ²⁴.

Hydrotherapy can benefit subjects with chronic lower back pain or back and leg pain ³⁶. Buoyancy, warmth, and effects of the water's turbulence foster speed recovery after surgery ¹⁰.

Hydrotherapy can provide great relief from many muscle discomforts including cramps, swelling, pain and spasticity ¹.

Spasticity:

Spasticity is a major health problem for people, including following a Spinal Cord Injury. This spasticity limits mobility and affects independence in activities of daily living and work. Spasticity may also cause pain, loss of range of motion, contractures, sleep disorders, and impair ambulation. Spasticity creates great difficulty for both the patient and the rehabilitation team ².

Spasticity is considerably improved by aquatic exercise, because patients are able to perform wider voluntary movements while immersed in water ¹⁵.

The temperature of the water is critical because excessively warm or cold temperatures may exacerbate spasticity and can also decrease the effectiveness of certain therapeutic techniques ³.

People describe feeling less stiff after Hydrotherapy and feeling more mobile and flexible ³.

Inflammation:

With muscle relaxation, a resultant reduction of stress and pressure on joints occurs, thereby alleviating pain from arthritis and rheumatism ¹.

Inflammation in surrounding muscles and connective tissue is caused by a combination of cellular reactions to injury and a build-up of fluids, when blood flow is increased, the body is able to reabsorb fluids faster and heal injury faster, helping reduce inflammation over time ¹.

Hydrotherapy treatment for those with Rheumatoid Arthritis results in beneficial effects in improving health status, reduced pain scores, substantial increase in physical activity and emotional well-being ³⁷.

Endocrine:

Warm water immersion increases the production of endorphins in the body as well. Endorphins are the body's 'pain killers' and are associated with feelings of elation or happiness. Endorphins also stimulate the immune system, alleviate pain, and help tissues heal faster ¹.

Over short durations, immersion in warm water will cause organs of the endocrine system to become less active, particularly the adrenal gland, and can decrease blood pressure. This results in a relaxed, less stressful state and helps calm the nervous system ¹.

Psychological:

The calming effects on the nervous and endocrine systems help put our bodies in a calmer state thereby relaxing us mentally. This state of heightened relaxation helps alleviate daily stress and anxiety ¹.

Once relaxed, it is likely that the person will be able to perform motor skills in a more functional way and will be able to move more freely. As a result, they will feel better adapted and happier in physical, emotional, and even spiritual terms ².

Hydrotherapy allows people to become more active and improve their quality of life as a result ²⁴.

Hydrotherapy assists people gain a sense of control over their chronic condition, gives them a sense of achievement and help in lifting general mood ³.

People with Rheumatoid Arthritis undertaking exercises in a heated pool are significantly more likely to feel much better or very much better than patients doing similar exercises on land ³².

Significant benefits on some sleep parameters, including

less time for sleep onset latency ¹ and better sleep efficiency in older adults with mild sleep impairment ³⁸.

Renal:

The sympathetic nervous system activity and systemic peripheral resistance are decreased, causing a reduction in anti-diuretic hormone thereby increasing diuresis (urine output) ⁵.

These effects may be beneficial to clients with renal disease. With immersion there is stimulation of renal blood flow. The decrease in renal sympathetic activity which in turn decreases renal vascular pressure and increases urine, sodium and potassium excretion. These effects increase with increased depth and immersion time ⁵.

COLD WATER HYDROTHERAPY

Cold Water Hydrotherapy (25-30°C) facilitates physiologic reactions such as decrease in local metabolic function, local oedema, nerve conduction velocity, muscle spasm, and increase in local anaesthetic effects ²⁴.

Cold exposure to the surface of the body produced compensatory vasodilatation in deeper vascular system resulting increased blood flow to the tissues underlying the site of exposure. This vascular reaction occurs mainly to maintain constant deep tissue temperature ²⁴.

Cold water causes the body to try and conserve heat. As a result, blood vessels in the body constrict, decreasing the amount of blood that flows through them. Blood flow is diverted from the extremities to the core of the body and to internal organs, to help keep them warmer. The pores of the skin close, sweat glands shut down, muscles tense, and some endocrine system organs, like the adrenal gland, become more active ¹.

Whole body immersion in moderately cold water is effective cooling manoeuvre for lowering body temperature and body heat content of approximately 545 kJ at the end of immersion ²⁴.

Respiratory:

Cold water immersion was associated with increase in respiratory minute volume and decrease in end tidal CO₂ partial pressure ^{24,40}.

Repeated cold water stimulations reduced frequency of respiratory infections, increased peak expiratory flow, lymphocyte counts, and expression of gamma-interferon, modulated interleukin expression, and improved quality of life in patients with chronic obstructive pulmonary disease ²⁴.

Neurological:

Cold water immersion is the most indicated, effective modality for inducing therapeutic effects associated with the reduction of motor nerve conduction ²⁴. The responses induced by cold are mainly due to increased activity of the sympathetic nervous system ^{39,43}.

Musculoskeletal:

The cooler temperature causes blood vessels to constrict and along with hydrostatic pressure can reduce the swelling and inflammation of tissue around an injury ⁸. Cold water Hydrotherapy is often used to alleviate swelling and pain ¹.

Cold immersion increases opioid tone and high metabolic rate, which could diminish fatigue by reducing muscle pain and accelerating recovery of fatigued muscle ^{24, 41,42}.

The decrease in muscle blood flow has implications for muscle metabolism during recovery from exercise. Lower blood flow in muscle in response to cold water immersion could reduce muscle protein synthesis. Cold water immersion attenuates gains in muscle strength and endurance capacity following strength training ⁴¹.

Cardiovascular:

Cold Water immersion is associated with an increase in heart rate, systolic and diastolic blood pressure ³⁹, and a

decrease in cerebral blood flow ^{24,40} which may assist in headache reduction ¹.

Cold water immersion increased metabolic rate by 350% ^{24,40}.

It is important to note that when cardiac patients are immersed in cold water, peripheral vascular resistance does not decrease as occurs with warm water immersion, and the potential for cardiac compromise is increased. Increased ventricular ectopic beats are also observed on ECG ⁵.

Spasticity:

One positive mechanism of Hydrotherapy on spasticity may be related to depressing the sensitivity of the muscle spindle and a decrease in skin sensitivity, thereby reducing gamma fibre activity. The administration of cool water leads in many cases to a sufficient relaxation in spastic muscle groups. It may be mediated by a decrease in skin sensitivity and its influence on alpha/gamma motoneuron activity ².

Immunology:

Cold exposure induced increase of leukocytes and, granulocytes, circulating levels of interleukin and natural killer cells and all their activity ²⁴. This white blood cell response demonstrates immune-stimulating effects of cold water immersion ²⁴.

Cold water therapy elicits a major effect in adaptive and innate tumour immunity. Daily brief cold-water stress could enhance antitumor immunity and improve nonlymphoid cancer survival rate ²⁴.

Endocrine:

Plasma noradrenaline and dopamine concentrations were increased by 530% and by 250% respectively, during cold water Hydrotherapy ⁴⁰. Cold temperature reduces level of serotonin in most regions of brain ²⁴.

Cold induced analgesia might be mediated by increased production of opioid peptide beta-endorphin ²⁴ and noradrenaline and to increase synaptic release of noradrenaline in the brain ⁴³.

Psychological:

Due to the high density of cold receptors in the skin, cold exposure is expected to send increased impulses from peripheral nerve endings to the brain, which could result in an anti-depressive effect ⁴³.

Cold Hydrotherapy can relieve depressive symptoms rather effectively and does not appear to have noticeable side effects or cause dependence ⁴³.

Exposure to cold water may have antipsychotic effect similar to that of electroconvulsive therapy because it could work as mild shock applied to sensory cortex. Cold stress induced analgesia occurs and suppression of psychosis related neurotransmission occurs within the mesolimbic system ²⁴.

Cold water Hydrotherapy can help alleviate mood disorders. Cold water helps a person feel more active, mentally alert and can help people cope with feelings of sadness or fatigue ¹.

Fatigue:

Reduced perception of fatigue after exercise is a principal effect ²⁴ of cold water therapy.

People with Multiple Sclerosis can increase exercise level utilising cold water Hydrotherapy, having a positive impact on fatigue ¹⁵.

There are 2 mechanisms for this effect ²¹:

- o Because MS patients are sensitive to heat and symptoms worsen in warm environments, pool water can lower body temperature and increase exercise tolerance compared to land exercise programs ²¹.

- o Water buoyancy reduces gravity and resistance to body movements and helps MS patients engage in physical activity for longer periods of time with less fatigue ²¹.

Renal:

During immersion in cooler water diuresis increased by 163% ³⁹ this has the consequence of assisting in blood pressure reduction and clearing of excessive oedema.

OCEAN WATER

Thalassotherapy is another branch of Hydrotherapy which refers to the use of seawater and seascapes for healing ⁴⁴.

The nature of immersion in sea water includes the supplementary benefits of systematic methodical exposure to sun, total or partial application of warm sea sand, and marine atmospheric climatotherapy, temperature, humidity, wind, and air pressure ⁴⁵.

Hydrotherapy in seawater is beneficial by reducing pain, improving balance, enhanced mobility and improving the functional status and overall well-being of post-stroke patients ⁴⁶. It has significant effects on muscle fatigue, muscle damage recovery and improved quality of life ⁴⁷.

There is evidence to support the notion that thalassotherapy can be beneficial to improve several diseases, especially chronic inflammatory conditions and degenerative illnesses ⁴⁸.

Mechanistic studies suggest that these benefits may be due to a combined action of different natural components ⁴⁸:

- o Highly mineralised water resulting in symptomatic improvements of osteoarthritis, back pain of rheumatic origin, fibromyalgia, psoriasis, atopic dermatitis, chronic venous insufficiency of lower limbs and other health problems
- o Marine climatic conditions, characterized by pleasing mild temperatures and sunny weather.
- o Controlled sunlight exposure, beneficial for

patients with psoriasis and to boost the body's vitamin D supply

- o Interaction with biogenic compounds released in the environment by seaweed, algae and coastal vegetation, marine aerosol inhalation, will have beneficial effects for some respiratory conditions

Seawater and thalassotherapy are general body stimulants. They act by increasing the hematopoietic (blood cell production) function, improving response capacity, and promoting positive wellbeing. They can also boost the immune system ⁴⁹.

Other benefits include, stimulation of endocrine functions, including thyroid, adrenal, parathyroid, and sexual glands improvement of blood circulation, increased sweating and an increase in red and white blood cells ⁴⁹.

Seawater contains many minerals and trace elements necessary for the cellular metabolism. The use of seawater has also been recognized as a treatment for the symptoms of multiple skin conditions ⁴⁹:

- o Dermatitis, psoriasis, eczema
- o nasopharyngitis, or the common cold
- o conjunctivitis
- o wound healing
- o excretion of toxic residue

Thalassotherapy may also help improve sleep. Sleep management found both immediate and delayed sleep benefits, including ⁴⁹:

- o Reduced daytime sleepiness
- o Improved mood and cognitive function
- o Reduced of anger, stress, and depression
- o Improved sleeping through the night
- o Positive effects on anxiety and sleep disorders

ACCESSIBILITY REQUIREMENTS

Legislation in Australia states that certain locations must not be closed to people with disabilities. According to section ²³ of the Disability Discrimination Act (1992), it is against the law for people to refuse access to public facilities to those with disabilities by prohibiting or not providing an accessible means of entry.

As such, public swimming pools must be outfitted with appropriate equipment, supplies and indicators to make sure they are open to all patrons, regardless of disability status.

A community or strata-type subdivision or development must be accessible as required under the National Construction Code 2019 (Part D3 Access for people with a disability). Many aspects of accessibility require consideration including access to an installed swimming pool. Accessible access to and into swimming pools with a total perimeter greater than 40m must be implemented. The National Construction Code 2022 ⁵⁰ specifies the requirements of accessible pool options including ramps, sloped entry, platform lifts, and sling lifters.

Accessibility compliance should take into consideration Australian Standard for Hydrotherapy Pools AS3979-2006 and Australian Standard for Design for Access and Mobility AS1428.1-2009. Local councils will have their own building requirements these standards must be followed ⁵.

ACCESSIBILITY OPTIONS

One current difficulty in accessing Hydrotherapy is the lack of available ²⁹ and accessible pools.

Many Hospital Hydrotherapy pools had to close due to lack of funding to maintain running and repairs, leading to many people being unable to access a pool who would have been able to do so previously ²⁹.

Studies indicate that people do not raise barriers to Hydrotherapy, although they do concede that public pools are not suitable for their condition ³ in part due to concerns with accessibility and inclusivity.

With reduced access to pools, it is important to recognise that Australia has the highest number of pools per capita in the world ⁵¹. 13% of houses have a pool, which translates to nearly 2.7 million Australians living in a house with a swimming pool ⁵².

Availability of local and public pools, school pools, ocean pools and apartment complex pools are also a consideration.

However, use of these available pools is reliant on appropriate access.

Options include the installation of stairs or a ramp, this being done at the point of installation. Ramps dramatically decrease the space available in the pool which can limit effective usage of the pool.

Installation of a ramp can occur at point of construction or is difficult and costly as a refurbishment. When decisions on construction or purchase of a pool a person does not necessarily take into account future known or unknown disability or reduced mobility.

POOL LIFTERS

A Pool Lifter is an Assistive Technology device that can transfer people to and from pools. Independently or dependently. The person sits on the seat, is rotated in over the pool, then lowered into the water. (Figure 7)

This accessible pool lift allows a person access to above and below-ground spas, swimming and Hydrotherapy



Figure 7: Aqua Creek Pool Lifter

pools. Both in the indoor and outdoor environment. This eliminates any need for manual handling into the pool and keeps both the person and any care givers safe.

Pool lifts can also be used to lower a person into a boat from a wharf, improving access to the range of activities that water has to offer. Figure 8)



Figure 8: Aqua Creek Pool Lifter

They are suitable for all environments including public pools, leisure centres, private homes, nursing homes and schools, where desire or requirements exist.

A swimming pool lift must be: (NCC 2022)⁵⁰

- o Capable of being operated from the swimming pool surround, within the swimming pool, and on the platform
- o Located where the water depth is not more than 1300 mm
- o Designed to withstand a weight capacity of not less than 160 kg and be capable of sustaining a static load of not less than 1.5 times the rated load.

Aqua Creek offer a wide range of lifters suitable for a range people, weight capacity, varied functionality, accommodation of different pool sides and affordability. They also offer a portable pool lift that can be conveniently stored. (Figure 9)

CEILING LIFTERS

Ceiling Lifters provide a versatile solution to access of indoor pools and spas. It allows even the most dependant people to gain access to the benefits of being in water.



Figure 9: Portable Pool Lifter

Multiple slings and stretchers can be used including low back and high back slings in mesh, amputee sling, toileting sling, bariatric sling full body sling/ soft stretcher or a firm stretcher. A mesh sling allows drainage of water when leaving the pool, reducing the resistance that the entrapped water will create. (Figures 10, 11, 12)



Figure 10: Molift Rgo Mesh Sling



Figure 11: Molift Air with Rgo High Back Sling



Figure 12: Molift Air with Firm Stretcher

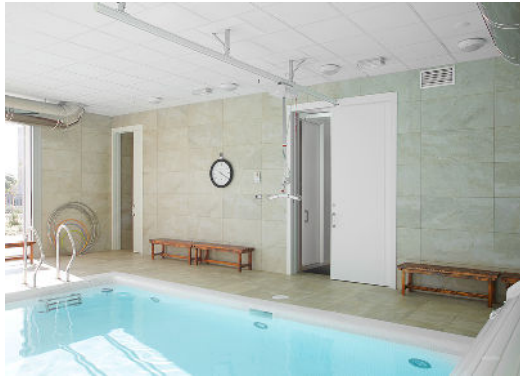


Figure 13: Straight Track

Multiple rail configurations are available including a simple straight track (Figure 13) from the pool side to move over a pool and lowered into the water. A traverse system (Also known as room covering / H track or XY) (Figure 14) can also be utilised giving a wider range of positioning options within the pool.

A Ceiling track system can be designed to go directly from the change room into the pool to minimise equipment required and reduce transfers between the two locations. (Figure 15)

Powered traverse allows the ceiling lifter to be moved in either direction at the touch of a button allowing smooth transport along the rail.

A person can remain in the sling or on a stretcher whilst immersed in the water if required, the effect of buoyancy needs to be considered as the person will tend to rise to the surface away from the sling or stretcher.

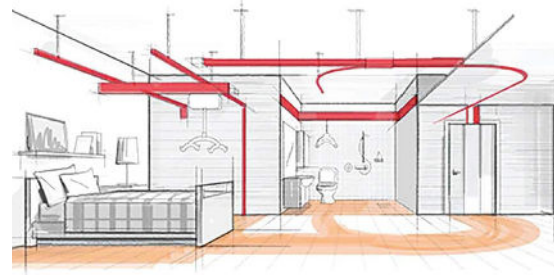


Figure 15: Track design options

A sling lift must comply with the following: (NCC 2022)⁵⁰

- o A sling lift must be located where the water depth is not more than 1300 mm.
- o the centreline of the sling must be located not less than 450 mm from the edge
- o A clear space must be provided on the swimming pool
- o A sling lift must be capable of being operated from the swimming pool surround, within the swimming pool and from the sling.
- o A sling must be designed so that it will submerge to a water depth of not less than 500 mm below the stationary water level.
- o A sling lift must be designed to withstand a weight of not less than 136 kg and be capable of sustaining a static load not less than 1.5 times the rated load.



Figure 14: Molift Air XY System

WATERWAY ACCESS

Many Assistive Technology options are available for access to beaches, lakes, rivers and dams. This equipment improves accessibility for those with disability or reduced mobility.

The key to the design is the increased surface area via larger width and depth wheels. This enables equipment to access rough terrain, unpredictable surfaces, and tolerate exposure to both pool and salt water.



Figure 16: All Terrain Rollator

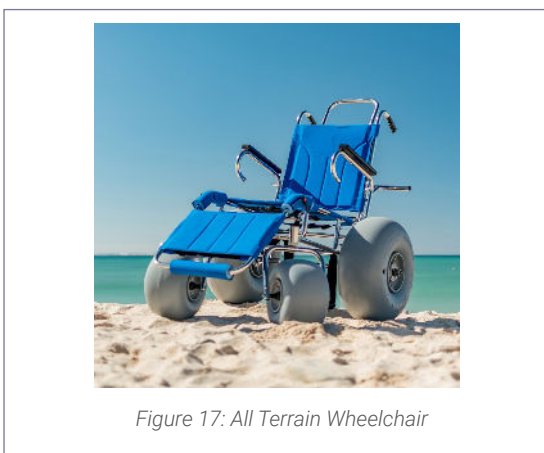


Figure 17: All Terrain Wheelchair

For those still mobile an all-terrain beach walker could be utilised, (Figure 16) or for those with more dependant needs an all-terrain wheelchair would be indicated. (Figure 17). Accessibility Wheelchairs come in multiple options. This includes level of postural support offered, materials used for comfort and affordability.

To facilitate mobility assistance in accessing water, to then providing floatation in the water an amphibious chair is an appropriate solution. It goes from beach to land without requiring any transformation. It moves smoothly on any type of surface, sand or pebbles, then facilitates access to immersion and flotation in the water in a safe and sustainable position. (Figures 18, 19)

Consideration needs to be paid to the transportability of this equipment and the method of transfer into the beach chair. A portable lifter like the Molift Smart 150 can provide an effective solution to safely transfer a person into the all-terrain or amphibious chair. (Figure 20)

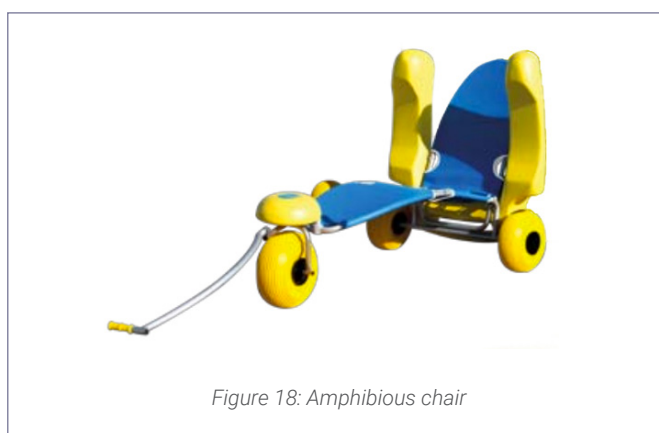


Figure 18: Amphibious chair

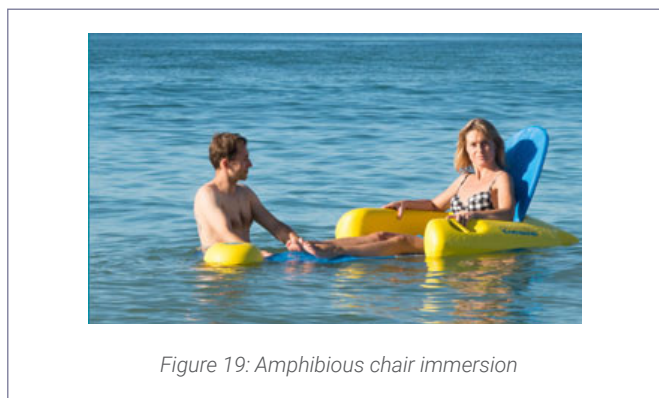


Figure 19: Amphibious chair immersion



Figure 20: Molift Smart 150

SUMMARY

The positive biological effects of immersion in water are directly related to the fundamental principles of hydrodynamics 8.

The effects and physical properties of water, such as density, hydrostatic pressure and buoyancy are highly useful resources for therapeutic benefit, when used as a counterbalance to gravity, resistance, a compressor and a thermal conductor 8.

This medium enables the stimulation of metabolic, neuromuscular 8, cardiopulmonary and other systemic reactions, with the corresponding physiological adaptations. This allows benefits to both maintain and improve physical ability, function and quality of life.

The fundamental barrier to people being unable to utilise the benefits of water, is restriction of access due to diminished ability or mobility.

By utilising Assistive Technology to access pools, spas and waterways we are able to create an inclusive environment whereby those who can most benefit from the properties of water, are able to access it without undue physical risk or negative psychosocial effect.

Hydrotherapy in all its forms are a non-invasive, non-interventional, reasonably priced, therapeutic option with few side effects. A therapeutic medium that can and should be available to the entire population.

REFERENCES

1. Bahadorfar M. A Study of Hydrotherapy and Its Health Benefits. *International Journal of Research*, 2014. 1(8)
2. Kesiktaş N, Paker N, Erdogan N, Gülsen G, Biçki D, Yılmaz H. The Use of Hydrotherapy for the Management of Spasticity. *Neurorehabilitation and Neural Repair*. 2004. 18(4)
3. Larmar P, Kersten P, Dangan J. Patient reported benefits of Hydrotherapy for arthritis. *New Zealand Journal of Physiotherapy*. 2014. 42(2): 89-93.
4. Becker, B. E. (2004). Biophysiological aspects of Hydrotherapy, In A. J. Cole, B. E. Becker (Eds.), *Comprehensive aquatic therapy* (2nd ed.),
5. Australian Physiotherapy Association - Australian guidelines for aquatic physiotherapists working in and/or managing Hydrotherapy pools (second edition) 2015
6. Sawant RS, Shind SB. Effect of Hydrotherapy Based Exercises for Chronic Nonspecific Low Back Pain. *Indian Journal of Physiotherapy and Occupational Therapy*. 2019. 13(1)
7. Calvo G. When to use Hydrotherapy. *BSAVA Congress 2018 Proceedings*
8. Torres-Ronda L, Del Alcázar XS. The Properties of Water and their Applications for Training. *J Hum Kinet*. 2014. 30(44):237-48.
9. EWAC medical
10. Giaquinto S, Ciotola E, Dall'Armi V, Margutti F. Hydrotherapy after total hip arthroplasty: A follow-up study. *Archives of Gerontology and Geriatrics*. 2010. 50(1):92-95
11. Alberton CL, Bgeginski R, Pinto SS, Nunes GN, Andrade LS, Brasil B, Domingues MR. Water-based exercises in pregnancy: Apparent weight in immersion and ground reaction force at third trimester. *Clinical Biomechanics*. 2019 67:148-152
12. Schitter AM, Fleckenstein J, Frei P, Taeymans J, Kurpiers N, Radlinger L. Applications, indications, and effects of passive Hydrotherapy WATSU (WaterShiatsu)-A systematic review and meta-analysis. *PLoS One*. 2020. 15(3):e0229705
13. Zamuner AR, Andrade CP, Arca EA, Avila MA. Impact of water therapy on pain management in patients with fibromyalgia: current perspectives. *J Pain Res*. 2019 Jul 3(12):1971-2007.
14. Feinstein JS, Khalsa SS, Yeh HW, Wohlrab C, Simmons WK, Stein MB, Paulus MP. Examining the short-term anxiolytic and antidepressant effect of Floatation-REST. *PLoS One*. 2018. 13(2):e0190292.
15. Lee, J et al. Hydrotherapy for the Treatment of Pain in People with Multiple Sclerosis: A Randomized Controlled Trial. *Evidence-Based Complementary and Alternative Medicine* 2012
16. Geytenbeek J. Evidence for effective Hydrotherapy. *Physiotherapy* 2005. 88(9): 514-529.
17. Hammill HV, Ellapen TJ, Strydom GL, Swanepoel M. The benefits of Hydrotherapy to patients with spinal cord injuries. *Sabinet African Journals* 201835.
18. Retnaningsih D, Setyawati E, Application of Hydrotherapy on the blood pressure of the elderly with hypotension: Case Study. *Jurnal Ilmu dan Teknologi Kesehatan*. 2022. 13(1)
19. Ernst E, Saradeth T, Resch KL. Hydrotherapy for Varicose Veins: A Randomized, Controlled Trial. *Phlebology*. 1992. 7(4):154-157
20. Amaral S, Cruz P, Ribeiro AM, Araújo R, Cantista P. Benefits of Hydrotherapy in Parkinson's Disease. *Serviço de Medicina Física e de Reabilitação*. 2018 1:198-199
21. Turner AJ, Chander H, Knight AC. Falls in Geriatric Populations and Hydrotherapy as an Intervention: A Brief Review. *Geriatrics*. 2018. 3(4):71.
22. Methajarunon P, Eitivipart, C, Diver, CJ, Foongchomcheay A. Systematic review of published studies on aquatic exercise for balance in patients with multiple sclerosis, Parkinson's disease, and hemiplegia. *Hong Kong Physiotherapy Journal*. 2016. 35:12-20
23. Stanciu LE, Iliescu MG, Vlădăreanu L, Ciota AE, Ionescu E-V, Mihailov CI. Evidence of Improvement of Lower Limb Functioning Using Hydrotherapy on Spinal Cord Injury Patients. *Biomedicines*. 2023. 11(2):302.
24. Mooventhan A, Nivethitha L. Scientific evidence-based effects of Hydrotherapy on various systems of the body. *N Am J Med Sci*. 2014. 6(5):199-209.
25. Busch A. Hydrotherapy improves pain, knee strength, and quality of life in women with fibromyalgia. *Australian Journal of Physiotherapy*. 2007. 53(1):64
26. D'Silva LA, Tortelli L, Motta J, Menguer L, Mariano S, Tasca G, Silveira GB, Pinho RA, Silveira PCL. Effects of aquatic exercise on mental health, functional autonomy and oxidative stress in depressed elderly individuals: A randomized clinical trial. *Clinics (Sao Paulo)*. 2019. 74:e322.
27. Kim S, Hsu FC, Groban L, Williamson J, Messier S. A pilot study of aquatic prehabilitation in adults with knee osteoarthritis undergoing total knee arthroplasty - short term outcome. *BMC Musculoskelet Disord*. 2021. 26;22(1):388
28. Itzecka J. Hydrotherapy in nervous system diseases. *Journal of Education, Health and Sport*. 2019. 9(1):55-60.
29. Vann
30. Carere A, Orr R. The impact of Hydrotherapy on a patient's perceived well-being: a critical review of the literature. *Physical Therapy Reviews*. 2016. 21(2):91-101
31. Bender T, Karagülle Z, Bálint GP, Gutenbrunner C, Bálint PV, Sukenik S. Hydrotherapy, balneotherapy, and spa treatment in pain management. *Rheumatol Int*. 2005. 25(3):220-4.
32. Eversden L, Maggs F, Nightingale P, Jobanputra P. A pragmatic randomised controlled trial of Hydrotherapy and land exercises on overall well being and quality of life in rheumatoid arthritis. *BMC Musculoskelet Disord*. 2007. 1(8):23.
33. Dias JM, Cisneros L, Dias R, Fritsch C, Gomes W, Pereira L, Santos ML, Ferreira PH. Hydrotherapy improves pain and function in older women with knee osteoarthritis: a randomized controlled trial. *Brazilian Journal of Physical Therapy*. 2017. 21(6):449-456
34. Bekiari M, Iakovidis P, Lytras D, Chatziprodromidou IP and Dimitros A. The effect of Hydrotherapy on the symptoms and functional characteristics of multiple sclerosis patients *International Journal of Physical Education, Sports and Health*. 2021. 8(2): 191-197
36. McIlveen B, Robertson VJ, A Randomised Controlled Study of the Outcome of Hydrotherapy for Subjects with Low Back or Back and Leg Pain. *Physiotherapy*. 1998. 84(1):17-26
37. Al-Q
38. Chen, L.J., Fox, K.R., Ku, P.W. et al. Effects of Aquatic Exercise on Sleep in Older Adults with Mild Sleep Impairment: a Randomized Controlled Trial. *Int.J. Behav. Med*. 20016. 23:501-506
39. Srámek P, Simecková M, Janský L, Savlíková J, Vybíral S. Human physiological responses to immersion into water of different temperatures. *Eur J Appl Physiol*. 2000. 81(5):436-42.
40. Bleakley CM, Davison GW. What is the biochemical and physiological rationale for using cold-water immersion in sports recovery? A systematic review. *Br J Sports Med*. 2010. 44(3):179-87
41. Roberts LA, Raastad T, Markworth JF, Figueiredo VC, Egner IM, Shield A, Cameron-Smith D, Coombes JS, Peake JM. Post-exercise cold water immersion attenuates acute anabolic signalling and

- long-term adaptations in muscle to strength training. *J Physiol*. 2015. 593(18):4285-301.
42. Bleakley C, McDonough S, Gardner E, Baxter GD, Hopkins JT, Davison GW. Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. *Cochrane Database Syst Rev*. 2012 Feb 15;2012(2):CD008262
43. Shevchuk NA. Adapted cold shower as a potential treatment for depression. *Med Hypotheses*. 2008. 70(5):995-1001.
44. Wardle, J. Hydrotherapy: A forgotten Australian therapeutic modality. *Australian Journal of Herbal Medicine*. 2013. 25(1): 12–17.
45. Munteanu C, Munteanu D. Thalassotherapy today. *Balneo Research Journal*. 2019 10(4):440–444
46. Morer C, Michan-Doña A, Alvarez-Badillo A, Zuluaga P, Maraver F. Evaluation of the Feasibility of a Two-Week Course of Aquatic Therapy and Thalassotherapy in a Mild Post-Stroke Population. *Int J Environ Res Public Health*. 2020. 17(21):8163.
47. Kim N-I, Kim S-J, Jang J-H, Shin W-s, Eum H-j, Kim B, Choi A, Lee S-S. Changes in Fatigue Recovery and Muscle Damage Enzymes after Deep-Sea Water Thalassotherapy. *Applied Sciences*. 2020. 10(23):8383
48. Antonelli, M.; Donelli, D. Thalassotherapy, Health Benefits of Sea Water, Climate and Marine Environment: A Narrative Review. *Environ. Sci. Proc*. 2021
49. Medworld Clinic
50. NCC 2022 Volume One - Building Code of Australia Class 2 to 9 buildings: Specification 16 Accessible water entry/exit from swimming pools
51. Caulfield K. Domestic and global surge in demand for Australian made pools. *Advanced Manufacturing Sector Leader*. January 4, 2021
52. Morgan R, Swimming pool ownership increases in Australia, Press Release. November 23, 2018

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