

# ICEBAT

UK

The international brain wave

*BOOK OF ABSTRACTS*

**21<sup>st</sup>, 22<sup>nd</sup> and 23<sup>rd</sup> June 2024**  
**University of Winchester, UK**

In association with

**ATACP**

Aquatic Therapy Association of Chartered Physiotherapists



## **INTRODUCTION**

The 2024 International Conference on Evidence Based Aquatic Therapy (ICEBAT) UK entitled “The International Brain Wave” organised by the Aquatic Therapy Association of Chartered Physiotherapists (ATACP) in close cooperation with the International Association Aquatic Therapy Faculty (IATF) 21<sup>st</sup> June to 23<sup>rd</sup> June 2024 in Winchester, UK.

“The International Brain Wave” title refers to the significant effects aquatic therapy has on brain function, as well as the wave of knowledge that the conference aims to evoke.

The conference includes presentations, posters and pool practicals presented by invited international speakers from the aquatic therapy field. It aims to be a peer reviewed conference focusing on scientific evidence-based aquatic therapy. Aquatic therapy research has increased enormously in recent years and clearly supports the health benefits in various patient groups.

## **DISCLAIMER**

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## **REFERENCE**

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**CONTENTS**

**KEYNOTE LECTURES** ..... 1

    K1: LIFESTYLE & CHRONIC PAIN: OPPORTUNITIES FOR AQUATIC THERAPY 1

    K2: WATER IMMERSION FOR PROMOTING SENSORIMOTOR  
    NEUROPLASTICITY ..... 2

    K3: ARTIFICIAL INTELLIGENCE IN AQUATIC EXERCISE..... 3

    K4: AQUATIC EXERCISE THERAPY: SPOTLIGHT ON PEOPLE WITH LOW  
    BACK PAIN AND ON FALLS PREVENTION ..... 3

    K5: AQUATIC THERAPY FOR PARKINSON’S DISEASE: INTERNATIONAL  
    EVIDENCE BASED GUIDELINES..... 4

    K7: ENERGY USAGE AND SAVINGS IN A HYDROTHERAPY POOL..... 5

    K8: CLINICAL QI SHUI: A COORDINATIVE AND MYOFASCIAL AQUATIC  
    THERAPY CONCEPT..... 6

**POOL SESSIONS** ..... 8

    POOL 1 – K6: BEYOND GUIDELINES AND BIOMECHANICS, TO EMPOWERING  
    PEOPLE WITH HIP AND KNEE OSTEOARTHRITIS TO MOVE, FOR OPTIMAL  
    OUTCOMES IN AQUATIC THERAPY..... 8

    POOL 2 – K9: FROM MOLECULE AND CELL TO BEHAVIORAL CHANGE:  
    THERAPEUTIC EFFECTS AND CLINICAL APPLICATIONS OF AQUATIC  
    EXERCISE..... 9

    POOL 3: AQUATIC GAMIFICATION: MOVE AND THINK..... 11

    POOL 4 – K10: AQUATIC PHYSIOTHERAPY IN CLINICAL PRACTICE ..... 13

    POOL 5: AQUAQISHUI..... 13

**ORAL PRESENTATIONS**..... 15

    O1: CONSIDERATIONS FOR AQUATIC HIGH INTENSITY INTERVAL TRAINING  
    TO IMPROVE EXERCISE CAPACITY IN ADULTS WITH RHEUMATIC  
    MUSCULOSKELETAL DISEASES- THE AQUAHIGH RANDOMISED  
    CONTROLLED TRIAL ..... 15

    O2: THE EFFECT OF AI CHI ON EXECUTIVE FUNCTIONS, PREFRONTAL  
    ACTIVATION, AND AUTONOMIC NERVOUS SYSTEM IN HEALTHY ELDERLY 16

    O3: STROKE TOOLKIT FOR AQUATIC REHABILITATION AND RECREATION  
    THERAPY (STARRT): THE PROCESS OF A PARTICIPATORY DESIGN..... 17

O4: COMPARISON OF AQUATIC PHYSICAL THERAPY PROTOCOLS IN THE GAIT OF CHILDREN WITH CEREBRAL PALSY: RANDOMIZED AND BLINDED CONTROL TRIAL .....	18
O5: EFFECT OF WATER- AND LAND-BASED EXERCISE ON LUNG FUNCTION IN CHILDREN WITH POST COVID-19 CONDITION: A RANDOMIZED CONTROLLED TRIAL .....	19
O6: ACUTE EFFECT OF MODERATE-INTENSITY AQUATIC TREADMILL EXERCISE ON COGNITIVE FUNCTION AND CEREBRAL BLOOD FLOW FOR HEALTHY ELDERLY: A RANDOMIZED CONTROLLED TRIAL .....	22
O7: DEVELOPMENT OF AN AQUATIC OBSERVATION INSTRUMENT FOR CHILDREN WITH ASD: RELIABILITY AND VALIDITY .....	20
O8: THE ACUTE EFFECT OF AN AQUA-PILATES FITNESS CLASS USING FLOATING EXERCISE MATS ON STATIC BALANCE PARAMETERS .....	23
O9: IMPORTANCE OF AQUATIC EXERCISE IN A COMMUNITY BASED MUSCULOSKELETAL WELLNESS SOLUTION.....	24
O10: EFFECT OF AQUATIC THERAPY ON CARDIO-RESPIRATORY ENDURANCE AND QUALITY OF LIFE IN ADOLESCENT AND YOUNG ADULTS CEREBRAL PALSY .....	25
<b>POSTER PRESENTATIONS</b> .....	27
P1: THE PHYSICAL FITNESS COMPARISON BETWEEN WATER-BASED AEROBIC EXERCISES AND OTHER AQUATIC INTERVENTIONS IN OLDER ADULTS: A META-ANALYSES.....	27
P2: PILOTING QUANTIFICATION AND ANALYSIS OF AQUATIC RESISTANCE TRAINING.....	28
P3: LONG-TERM ADAPTATIONS OF A COMBINED SWIMMING AND AQUATIC THERAPY INTERVENTION IN AN ADULT PERSON WITH HIGH-FUNCTIONING AUTISM: A CASE STUDY.....	29
P4: CAN AQUATIC EXERCISE IMPROVE BRAIN FUNCTION IN DISABLED PERSONS? A PRIMARY QUANTITATIVE RESEARCH.....	30
P6: RESEARCH METHODOLOGY: OUTCOMES FOLLOWING AQUATIC THERAPY IN THE REHABILITATION OF STROKE PATIENTS.....	31
P7: AQUATIC THERAPY IN CONGENITAL MALFORMATION DURING THE USE OF EXTERNAL FIXATOR FOR BONE LENGTHENING: IS IT POSSIBLE? .....	32
P9: CASE REPORT: HYDROTHERAPY REHABILITATION OF A POST COVID-19 PATIENT WITH MUSCLE WEAKNESS .....	34

P10: AQUATIC BASED THERAPY INTERVENTIONS FOR CHILDREN WITH AUTISM SPECTRUM DISORDER - A MIXED METHODS SYSTEMATIC REVIEW .....	34
P11: IMPACT OF KEY PERFORMANCE INDICATOR ON EFFICIENCY IN AN AQUATIC THERAPY FACILITY AS QUALITY PERFORMANCE METRIC – AN EXPERIENCE FROM QRI.....	36
P12: COMPARISON OF ENERGY EXPENDITURE OF INDIVIDUALS WITH DUCHENNE MUSCULAR DYSTROPHY IN THE SITTING POSTURE ON THE GROUND AND IN WATER.....	37
P13: LEARNING AQUATIC SKILLS? STAY BALANCED.....	39
P14: THE POWER OF WATER – OPTIMISING WATER AND EXERCISE FOR VASCULAR HEALTH .....	40
P15: IMPLEMENTATION CONSIDERATIONS OF AQUATIC THERAPY POST-STROKE: A QUALITATIVE STUDY .....	41
P16: THE ACUTE EFFECT OF THE BAD RAGAZ RING METHOD ON LATERAL FLEXION PATTERN ON THE INDENTION PARAMETERS OF THE THORACOLUMBAR REGION .....	42
P17: USING THE FITT PRINCIPLE TO INFORM AQUATIC THERAPY PRACTICE AFTER STROKE: A SCOPING REVIEW.....	43
P18: FEASIBILITY OF AQUATIC THERAPY FOR BALANCE IN SPINAL CORD INJURY PATIENTS WITH LESS THAN 6 MONTHS POST- INJURY .....	44
P19: ACUTE EFFECT OF RESISTIVE AQUATIC HIGH INTENSITY INTERVAL TRAINING AND AQUATIC HIGH-INTENSITY INTERVAL TRAINING ON METABOLIC COSTS AND PERCEIVED EFFORT IN ACTIVE ADULTS .....	46
P20: DUAL MEDIA KINEMATIC ANALYSIS FOR SHOULDER MOVEMENT ON DEEP WATER EXERCISES .....	48
P21: INFLUENCE OF AQUATIC THERAPY ON FUNCTIONAL ABILITIES POST SUB-ACUTE PONTINE STROKE - A CASE STUDY.....	49
P22: EFFECTS OF DETRAINING AND TRAINING ON BALANCE PERFORMANCE, STRENGTH, AND PAIN IN OLDER ADULT USERS OF AQUATIC PHYSIOTHERAPY .....	50
P23: THE EFFECTIVENESS OF AQUATIC EXERCISES ON FUNCTIONAL MOBILITY AND MOTOR IMPAIRMENTS IN PATIENTS WITH PARKINSON'S DISEASE: A SYSTEMATIC REVIEW.....	51
P24: DEVELOPMENT AND FEASIBILITY OF A SWIMMING PROGRAMME AS A REHABILITATION MODALITY FOR PEOPLE WITH CHRONIC LOW BACK PAIN: A MIXED METHODS PROJECT .....	52

## KEYNOTE LECTURES

### K1: LIFESTYLE & CHRONIC PAIN: OPPORTUNITIES FOR AQUATIC THERAPY

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Chronic pain has a tremendous personal and socioeconomic impact. Lifestyle factors such as physical (in)activity, sedentary behaviour, stress, poor sleep, unhealthy diet and smoking are associated with chronic pain severity and sustainment<sup>1-5</sup>. This applies to all age categories, i.e., chronic pain across the lifespan. Yet current treatment options often do not, or only partly address the many lifestyle factors associated with chronic pain<sup>6</sup>, or attempt to address them in a standard format rather than providing an individually tailored multimodal lifestyle intervention<sup>1,7,8</sup>. Therefore, the lecture will use the available evidence on (multimodal) lifestyle interventions targeting physical (in)activity, stress, sleep and nutritional factors, specifically, from a clinical point of view and with emphasis on integrating aquatic therapy into the multimodal approach for chronic pain. First, advice is provided on how to design a personalized multimodal lifestyle approach for a specific patient. Subsequently, best-evidence recommendations on how to integrate physical (in)activity, stress, sleep and nutritional factors as treatment targets into a personalized multimodal lifestyle approach are outlined. Evidence supporting such a personalized multimodal lifestyle approach is growing, but further studies are needed.

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## **K2: WATER IMMERSION FOR PROMOTING SENSORIMOTOR NEUROPLASTICITY**

Daisuke Sato

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Water immersion (WI) causes several physiological adjustments, including changes in respiratory, circulatory, and metabolic functions. Nevertheless, the influence on neural activity in the brain during WI remains ambiguous, primarily due to the experimental challenges inherent in aquatic environments. Despite these limitations, our research team has overcome these challenges by devoting 15 years to water immersion neuroscientific research. Our studies have primarily examined neural dynamics within the somatosensory and motor-related cortical regions. This presentation will cover two main themes.

The first topic explores the balance between excitatory and inhibitory neural activity in the sensorimotor cortex and its role in regulating neural plasticity. Earlier findings indicated a marked increase in excitatory neural activity during water immersion. Also, recent studies suggest a concurrent reduction in inhibitory neural activity, which may have potential applications in the rehabilitation regimen for patients with somatosensory deficits. In addition, our study revealed changes in the balance of neural activity in the motor cortex. Specifically, WI appears to reduce only somatosensory input-induced inhibitory activity, as measured by short-range afferent inhibition, without affecting intracortical activity. Taken together, these studies demonstrate the ability of WI to modulate somatosensory-related neural activity and suggest that SAI is transiently enhanced after WI, which is a mechanism potentially beneficial for neuroplasticity.

The second theme is the development of novel aquatic neuromodulation techniques using water flow stimulation for sensory-motor adaptation. We developed a novel device for this purpose and observed that water flow stimulation selectively reduces inhibitory neural activity in the motor cortex. Our latest investigations evaluate whether water flow stimulation could alter sensorimotor adaptation by inducing disinhibition in the primary motor cortex. Previous studies have shown that the M1 is not involved in motor skill acquisition during sensorimotor adaptation (Baraduc et al., 2004; Richardson et al., 2006). However, evidence exists that M1 modulates motor memory retention (Richardson et al., 2006; Hadipour-Niktarash et al., 2007; Hamel et al., 2017; Ohashi et al., 2019). Based on these results, we hypothesized that whole-hand WF induces M1 disinhibition, facilitating motor memory retention. As results, prior WF stimulation did not affect skill acquisition in line with our hypothesis. This could be explained by the somatosensory experience accompanying the increased excitability in S1, which is necessary for skill acquisition during the early stages of ML. Consistent with the process of skill acquisition, memory retention 24 h after skill acquisition did not exhibit any change by WF stimulation, contradicting our initial assumption that WF stimulation can augment memory retention during sensorimotor adaptation phases. Considering these results, WF stimulation did not modulate skill acquisition or motor memory retention during sensorimotor adaptation, whereas this intervention attenuated intracortical inhibition.

### **K3: ARTIFICIAL INTELLIGENCE IN AQUATIC EXERCISE**

Ben Waller

University of Reykjavik, Sports Science department, Iceland, Good Boost Wellness, Bristol, UK

The presentation explores the transformative role of different types of artificial intelligence (AI) in aquatic-based rehabilitation, from initial assessment to the quantification of treatment load and movement quality. By harnessing innovative methods such as natural language processing (NLP) through chat bots and virtual assistants and movement analysis through computer vision, practitioners can optimise the evaluation to gather invaluable insights from patient interactions, streamlining the overall rehabilitation experience.

The integration of AI technologies to quantify aquatic exercise, particularly markerless motion capture and convolutional neural networks for signal processing, offers unprecedented capabilities for analysing aquatic exercise movements with precision and efficiency, enabling clinicians to tailor treatment plans with greater accuracy. Furthermore, the keynote delves into the utilization of supervised and unsupervised machine learning techniques, particularly in signal processing, to extract meaningful patterns and trends from vast datasets accumulated during aquatic rehabilitation sessions. Real life examples with their theory and practice will be presented and discussed during the presentation.

### **K4: AQUATIC EXERCISE THERAPY: SPOTLIGHT ON PEOPLE WITH LOW BACK PAIN AND ON FALLS PREVENTION**

Stelios S.G. Psycharakis

The University of Edinburgh, UK

**Keywords:** Aquatic Physiotherapy; Musculoskeletal; Biomechanics, Older Adults, Geriatrics.

**INTRODUCTION:** This presentation explores two common problems: a) chronic low back pain (CLBP) and b) falls in older adults. Low back pain is the most prevalent musculoskeletal disorder, affects people of all ages, places a massive burden on global health and has a high economic cost<sup>1,2</sup>. Falls are a major problem in older adults, with one-third of people aged 65 years or over falling every year<sup>3</sup>. This presentation discusses recent and ongoing research projects on aquatic and land exercise, focusing on: a) muscle activity, pain and exertion for people with and without CLBP and b) falls prevention for older adults.

**METHODS:** For the CLBP research, two groups of participants (40 in total), with and without CLBP, performed 26 exercises in the water and on land. The outcome measures were muscle activity of core and gluteal muscles, pain, perceived exertion and exercise intensity.

For the falls prevention research, two groups of participants (100 in total) are undertaking a 16-week intervention programme, one group in the water and one on land. This is a feasibility study, designed to inform subsequent large scale randomised controlled trials. The primary outcomes are based on the feasibility and acceptability of the trial. A range of secondary outcomes are also explored, such as: falls, postural stability, strength, functional tests, balance confidence, health economics and quality of life.

**RESULTS:** For the CLBP research, there were no significant differences between the CLBP and control group in any outcome variables. For the between-environment comparison, pain levels were generally lower in the water, and pain was reported more than twice as frequently on land. Muscle activity was not different between environments in 66% of the cases (higher on land in 29% and in



the water in 5% of comparisons). Exertion was balanced, sometimes higher in the water, sometimes on land, and other times not different between environments. Heart rate was higher on land. Finally, between-exercise comparisons in the aquatic environment provided some interesting insights to inform exercise selection when aiming for increased activity of particular muscle groups.

The falls prevention research is current and the interventions were not completed at the time of submitting this abstract. Some preliminary data on aspects such as recruitment, retention, adherence, adverse effects and acceptability, will be discussed during the presentation.

**DISCUSSION:** People with mild-to-moderate CLBP have similar exercise responses to healthy controls. Aquatic exercise produced sufficient muscle activation, intensity, and exertion, and should not be assumed to be less strenuous or less effective in activating trunk and pelvic muscles than exercise on land. Pain occurrence and intensity of aquatic exercises are very low, and lower than similar exercises on land, with most aquatic exercises being completely pain free. Data from these studies can be used to inform design and prescription of rehabilitation programs and interventions, with one such study about to start at the University of Edinburgh.

Early evidence from the falls prevention research suggest that the aquatic programme has high recruitment and acceptability, satisfactory retention and low adverse effects.

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## **K5: AQUATIC THERAPY FOR PARKINSON'S DISEASE: INTERNATIONAL EVIDENCE BASED GUIDELINES**

Louise Carroll

School of Allied Health, Faculty of Education and Health Sciences, Aging Research Centre, Health Research Institute, University of Limerick, Limerick, Ireland

**BACKGROUND:** Parkinson's disease (PD) is a chronic progressive neurodegenerative disorder, which is estimated to affect over six million people globally. Aquatic physiotherapy is quickly gaining popularity as one type of structured physical activity used to target specific motor and non-motor impairments associated with PD. Research has shown that aquatic therapy may improve, balance, gait, mobility disability, and health related quality of life in people with mild to moderate Parkinson's disease. However, there is an unmet need for agreed, evidence-based and pragmatic aquatic therapy practice guidelines. Therefore, being able to apply aquatic research evidence within clinical practice can be challenging for healthcare professionals delivering aquatic therapy in the management of Parkinson's disease.

**AIMS:** First, to synthesise the available research literature on the effectiveness of aquatic therapy for PD compared to other land-based interventions and to examine the optimum aquatic therapy prescription and dosage. Second, to explore the thoughts and opinions of people with PD with experience of aquatic therapy and those with no prior experience of aquatic therapy engagement. Thirdly, to create international evidence-based aquatic therapy guidelines for people with PD based on the four pillars of evidence-based practice, research evidence, clinical expertise, patient values and context.

**METHODS:** This was a mixed methods research project completed between 2017 and 2022. A systematic review and meta-analysis was initially completed to establish the totality of the research evidence and the certainty of evidence for key outcomes of interest (gait, motor disability, balance, mobility, falls, mood, cognitive function, and health related quality of life) based on 14 randomised controlled trials involving 272 participants living with PD (Hoehn & Yahr I-IV)<sup>1</sup>. A mixture of focus groups and interviews were conducted with people with PD in Ireland (n= 24) and Australia (n=10) to explore factors influencing access to, participation in, and long-term adherence to community-based aquatic therapy<sup>2</sup>. The information gathered from the two studies was then used, along with input from a Parkinson's panel of experts, to gain consensus by applying a 3-step modified Delphi process with more than 45 international practice and research experts from around the globe<sup>3</sup>.

**RESULTS:** Findings from the meta-analysis<sup>1</sup> suggest that there are low levels of evidence that aquatic therapy may yield small improvements in mobility over land-based physiotherapy and very low to moderate quality of evidence that aquatic therapy has comparable effects to land-based interventions for motor disability, balance and quality of life in people with PD. Qualitative study findings<sup>2</sup> highlight the importance of access to individually tailored, community based aquatic programs with opportunities for socialisation and group comradery. Furthermore, people living with PD regarded aquatic therapy as being beneficial for their overall health and wellbeing. The final published guidelines and accompanying infographic<sup>3</sup> provide preliminary evidence for the optimal dosage, content, safety, and delivery of aquatic programs for people with mild to advanced PD.

**DISCUSSION:** It is anticipated that the internationally agreed aquatic therapy guidelines may be used to assist clinical decision-making for prescribing aquatic therapy, to help standardise aquatic therapy research and practice, and to increase patient safety and outcomes for people with PD. In addition, the patient informed guideline's infographic, published in an easily accessible format, can further enhance the impact of this research.

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## **K7: ENERGY USAGE AND SAVINGS IN A HYDROTHERAPY POOL**

Ian Ogilvie

A Chartered Health and Safety practitioner that specialises in the Leisure Industry with a particular passion for swimming pools. Pool Water Treatment Advisory Group Vice Chair, Royal Lifesaving Society Consultant and British Standards Institute committee member for swimming pools.

With a passion for mathematics, nearly three years ago a colleague set Ian a challenge to try and predict the energy cost and carbon footprint of a swimming pool and pool plant room. He will guide you through the project and lessons learned throughout the program. Locally to Ian a small hydrotherapy swimming pool he has assisted with over the years for a charity for

neurological clients set him a challenge. Try to lower the energy costs and carbon footprint to ensure the long-term viability to the centre.

Let Ian share with you the potential opportunities to reduce the costs of running a swimming pool and maintaining water quality for the patients and hydrotherapists. Exploring energy saving items such as:

- Variable Speed Drives (VSD's)
- Heating ventilation and air condition (HVAC)
- Swimming pool covers links to the Building Management Systems (BMS)
- Heat exchanger jackets
- Filtration heat loss

## **K8: CLINICAL QI SHUI: A COORDINATIVE AND MYOFASCIAL AQUATIC THERAPY CONCEPT**

Urs N. Gamper, Félix Castellanos, Anne Bommer, Johan Lambeck

Association IATF, Vilters, Switzerland

**INTRODUCTION:** Like many allied health applications worldwide, aquatic therapy is subject to constant change. One of the greatest challenges in the future will be to use the available financial resources efficiently and for the benefit of both patients and the financing society. The demographic development of the population is a constant that must be taken seriously. According to the report, Demographic Outlook for the European Union 2019, the European Union expects the age pyramid to change into a T-shape - the over-85s will show a huge growth rate. Within IATF, consideration has been given to developing evidence-based aquatic therapy programs to protect the ageing population from falls, loss of mobility and loss of autonomy. Ai Chi is probably the most studied aquatic therapy method in this respect. It has been shown to be effective in terms of balance, pain, walking and quality of life, but whether it also prevents falls has never been studied. When Ai Chi is compared with the evidence content of current fall prevention programs, significant deficiencies are found in terms of agility, strength, speed, use of hydromechanical forces, exercising under small bases of support and exercising with dual tasks.

**METHODS:** Wu Qin Xi is an ancient Chinese gymnastics method based on the 5-animal system for general health. A group of IATF instructors and a specialist in traditional Chinese martial arts have developed a program for groups that can be performed in water and is based on the five animals. Great emphasis was placed on the implementation of strength components, the movement of the body's center of gravity in the frontal and sagittal planes, spinal mobility and plyometric activities with jumps, which is practically impossible for this age group outside the water. Arm activities outside the water incorporate metacentric effects into the exercises, which places increased demands on balance behavior.

**RESULTS:** The Qi Shui exercise program was developed, which includes 20 exercises and meets the requirements of mandatory content for fall prevention programs. By implementing additional therapeutic principles for the treatment of clinically relevant functional disorders, the standard program is given clinical-therapeutic impulses, which should make the program more efficient regarding the target groups. We are convinced that the inclusion of fascial tissue in the training and exercise program will provide an additional benefit in maintaining autonomy for the elderly population. The therapeutic adaptation was termed Clinical Qi Shui.

**DISCUSSION:** Clinical Qi Shui is new and has not yet been researched for its effectiveness. In addition to programs, algorithms will be needed to match the right people to the right therapies.

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## POOL SESSIONS

### POOL 1 – K6: BEYOND GUIDELINES AND BIOMECHANICS, TO EMPOWERING PEOPLE WITH HIP AND KNEE OSTEOARTHRITIS TO MOVE, FOR OPTIMAL OUTCOMES IN AQUATIC THERAPY.

Heywood, S.

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**Keywords:** osteoarthritis, aquatic exercise, empowerment

Exercise, along with education, are first line components of all higher quality international guidelines in the management of people with hip and knee osteoarthritis (1). This involves selection of a variety of kinds of exercise including aerobic, lower limb strengthening, neuromuscular, flexibility and balance training with consideration of the impairments or functional limitations of the individual (1). There are variable recommendations relate to aquatic exercise for people with hip and knee osteoarthritis, but it is most often supported (1). This divergence of opinion on aquatic exercise is a concern, potentially reflecting a poor understanding of the environment and the evidence base.

Aquatic exercise is widely used in musculoskeletal conditions (2). There may be a lack of specificity and progression of resistance in aquatic strengthening programs for people with hip and knee osteoarthritis. Variable effectiveness of aquatic exercise in improving lower limb strength in people with musculoskeletal disease may relate to insufficient resistance, limited progression of load, and vague use of hydrostatic and hydrodynamic principles (3). More targeted prescription of aquatic exercise and greater resistance in programs can be achieved using shallower depths with single leg, closed kinetic chain exercise, and increasing drag resistance with faster speeds of movement, including plyometric exercise (3). Broader consideration of pain, function, and quality of life outcomes, assists to look beyond strengthening exercise, to the potential of cardiovascular exercise, joint control and balance training.

Off-loading of weight bearing with exercise in water due to buoyancy may be enabling for people with joint pain and weakness and this provides a unique opportunity to maximise outcomes. Exploring the experiences and insights of aquatic physiotherapists with expertise in managing knee osteoarthritis can inform clinical reasoning frameworks (4). Psychosocial aspects of aquatic exercise may be empowering. This includes recognising previous unsuccessful exercise experiences, creating enjoyable exercise with less pain and greater achievement and social connectedness. A focus on participation, function, graded increases in load and higher intensity exercise will build physical capacity. Maximising opportunities for learning (including pain, flare management, load, exercise) may also be important to build self-efficacy. The water was described by experienced clinicians as a positive environment for education on pain, fear, loading and pacing (and an option in a flare/heightened symptoms). Embodied learning with experiences shaping perception of exercise and capability, may influence behaviour, and could be tapped in to further.

Qualitative studies of patient experience indicate that there are valuable psychological effects of aquatic exercise for people with joint pain. Both self-efficacy and confidence with exercise can be improved alongside mood, improved physical capability and enjoyment of social

interactions as well as increasing the opportunity to exercise successfully (5,6). Combining both experienced clinicians clinical reasoning insights with the experience of people with hip and knee osteoarthritis with exercise, both on land and in water, is the way forward to maximise healthcare outcomes and long-term adherence to exercise.

In addition to considering people's experience and understanding of exercise, their perceptions of arthritis, their joint health and the trajectory of their condition is also important. There is value in adapting communication approaches with people and how osteoarthritis is discussed. This shift in communication moves towards the whole-person, avoiding mechanical analogies, focussed on what people can do, backed up with resources, and with a coaching focus (7). Highlighting participation and active, strong bodies, rather than the joint as broken or suffering from "wear and tear", builds skills and can be empowering (7).

A move from a biomechanical focus, but still informed by the opportunities of the environment, towards the user experience, therapist communication and embodied learning, represents a more contemporary approach to aquatic therapy. Informed clinical reasoning to achieve optimal outcomes for people with hip and knee osteoarthritis includes a deep understanding of the aquatic environment, but beyond this, an expanded focus on an empowering approach to build psychosocial capacity alongside physical capability.

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#### **POOL 2 – K9: FROM MOLECULE AND CELL TO BEHAVIORAL CHANGE: THERAPEUTIC EFFECTS AND CLINICAL APPLICATIONS OF AQUATIC EXERCISE.**

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**Keywords:** cerebral blood flow, neuroprotection, neuronal plasticity, autonomic nervous system.

**INTRODUCTION:** Vertical immersion induces various physiological responses in the brain: a) Cerebral vascularization; b) Cortical activity (somatosensory and motor); c) Executive functions; d) Production of neuroprotective factors (neurotrophins); and e) Motor learning and neuroplasticity. However, long-term primary cortical excitability is not achieved solely through immersion, as it involves low-intensity inputs. Aquatic exercise can induce beneficial long-term structural and functional adaptations in cerebral vascular function and brain health.

**METHODS:** We propose an aquatic exercise program with sequenced exercises and active recovery moments. This program is designed to enhance psychomotor learning through skill retention, supported by increased post-program recovery due to the parasympathetic nervous system.

### **RESULTS AND DISCUSSION:**

**Immersion and Exercise Theory:** The combination of immersion and aquatic exercise disrupts body homeostasis and self-regulation, catalyzing structural and functional adaptations in the brain. These adaptations include angiogenesis, increased cerebral blood flow (CBF), improvements in dendritic density, and white matter integrity (Burley et al, 2016).

**Mechanisms and Therapeutic Strategies:** Underlying mechanisms for cerebral vascular adaptations involve shear stress induced by hydrostatic pressure and water temperature. These factors contribute to neurovascular coupling, enhancing executive functions and learning (Weaber et al, 2021).

**Vascular Effects of Immersion:** Immersion positively affects the nervous system through changes in heart rate variability (HRV) and neuroinflammation (Hashimoto & Okamoto, 2019). Alterations in neurotransmitters such as serotonin and acetylcholine are also observed (Sato et al, 2020).

**Learning and Plasticity:** Recent research suggests that water immersion before rehabilitation can promote neuronal plasticity induction and improve motor memory consolidation (Sato et al, 2020).

**Regulation of Cerebral Blood Flow (CBF):** Proper CBF regulation is vital for survival and optimal brain function. Immersion and aquatic exercise can increase CBF, leading to significant functional consequences (Becker, 2020; Burtscher et al, 2021).

**Autonomic Nervous System:** Changes in parasympathetic nerve conduction following immersion, enhanced by active rest after programmed exercise, are associated with improved cognitive performance (Sato et al, 2017).

**CONCLUSIONS:** Aquatic therapy offers a unique hemodynamic profile, especially beneficial for patients with reduced capacities. Episodic and recurrent increases in blood flow and shear stress are potent stimuli for endothelial function improvement and arterial remodeling. Aquatic exercise is ideal for patients with physical limitations, providing accessible intensity to stimulate cerebrovascular adaptations. Clinical populations can benefit from aquatic therapy, enhancing brain health and quality of life.

**CLINICAL APPLICATIONS:** Various clinical applications stand out, focusing on primary prevention (neuroprotection and health promotion) and the treatment of diverse neurovascular diseases at secondary prevention (early intervention and risk factor management) and tertiary prevention (rehabilitation/recovery and long-term management).

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### POOL 3: AQUATIC GAMIFICATION: MOVE AND THINK

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Aquatic gamification (or serious gaming in water) is a relatively recent motor-cognitive therapy, based on the emerging notion that movement in water is neuroprotective and important for brain integrity, brain vasculature health and brain plasticity. Movement intensity, e.g., is relevant as a basis for neuroplastic changes in the brain areas related to executive and motor control functions due to neurovascular and vasculo-neuronal coupling. At comparable physiological intensities, brain blood flow is higher in water than on land. Higher flow velocities increase the immune-metabolic activity of endothelial cells, supporting plasticity processes.

Moving is combined with thinking, i.e., using executive functions. Executive functions are important in (re)learning of motor skills and the planning of tasks. These are cognitive processes, necessary for non-routine (movement) control to attain chosen goals. Various publications have shown the very positive effects of environmental enrichment and – intensive – movement in water on executive functions with clinically relevant effects of playful moving with (an)aerobic components (Sato 2014, Kang 2015).

Human beings play, independent of age. Contents, intentions, and goals change with age, but there are common features between young adults and elderly that play. These features are also important for the – neurologically – impaired person, which was nicely underlined by Krakauer (2018). Elements of playful moving are: challenging, problem-solving, attention-taking, enjoyment and fun, social interaction, experiencing success and also exertion. Playful moving coincides with *environmental enrichment*, known to attenuate neuroinflammation and improve executive functions (Kentner, 2019). Neuroinflammation is a chronic low-grade inflammation of the nervous system that can occur in a variety of neurodegenerative – and metabolic diseases.



Underlying mechanisms might be neurophysiological, circulatory, and immunological changes in the brain. These have been well documented, showing (temperature dependent) changes in cerebral blood flow during immersion (Parfitt 2017, Carter 2023), changes in corticospinal excitability (Sato 2020, Le Cong 2022), increases in growth factors like the Brain Derived Neurotrophic Factor (Bansi 2013), or modification of the expression of pro- and anti-inflammatory cytokines (Pochmann 2018): all aspects of neuroprotective mechanisms.

Water is a great environment to combine all elements, especially when possibilities to move on land are limited because, e.g., of fall risk: playful movement and focusing on postural control (during e.g. agility) in water is THE alternative (Shariat 2023). Executive functions are used in relation to, e.g., obstacle negotiation, reaching to the limits of stability, reacting to unexpected perturbations, using double-tasks, etc.

Summarizing in one sentence: the added immuno-metabolic effects of (intensive) exercise in water opens a door to include cognitive elements – especially executive functions - during motor control in complex situations. These situations often have an equilibrium component and might be difficult to achieve on land when working with patients with increased fall risk.

During the congress workshop, participants will experience playful movement to activate executive functions for adults (related to fall prevention) at certain cardiac intensities.

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#### **POOL 4 – K10: AQUATIC PHYSIOTHERAPY IN CLINICAL PRACTICE**

Pattman JA

Aquatic Physiotherapy Specialist and consultant, Chartered Physiotherapist MCSP, HCPC ATACP Tutor, ATACP committee and Education Committee member

A Practical demonstration and video treatments and case studies to provide ideas for clinical practice in different neurological presentations

Following ATACP guidelines, utilising clinical expertise, research, and patient driven goals, Jacqueline will guide participants through an in-pool assessment and treatment programme of a screened unfamiliar patient in the hydrotherapy pool.

Sharing knowledge and practical skills providing clinical reasoning through the process.

Any question can be brought to the panel discussion

The video case studies will show a variety of patients in their clinical journey including neurological paediatrics, Spinal cord Injury and Acquired brain Injury. The interventions include the Halliwick concept, Water Specific Therapy, and the Bad Ragaz Ring Method plus the foundation essentials of utilising buoyancy, drag, balance and gait strategies

Outcome measures include SMARTTER goals, SWIM outcome measure, HR monitoring

#### **POOL 5: AQUAQISHUI**

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**INTRODUCTION:** Exercise has generally positive effects on physical and mental health and is recommended worldwide from childhood to old age. The WHO recommends a variety of physical activity that includes several components, reference

Activities in the pool offer several advantages over those on land, which are often important for older people - less pain from mechanical problems, no risk of falling, improved strength

reserve due to less weight bearing, etc. There are several choreographies for active health programs in the water, such as Ai Chi, Aquapilates or various others, which generally fall under the synonym aquafitness. In terms of the needs of older people, some programmes are not well customized. Ai Chi is, given the existing research, in 2021 compiled in a scoping review. (Dunlap et al) Nevertheless, some important elements are not included, e.g. plyometric muscle power or shoulder elevation above 90°.

**METHOD:** Aqua Qi Shui was developed under the initiative of the International Aquatic Therapy Faculty (IATF) and a specialist in traditional Chinese martial arts. Aqua Qi Shui was originally designed for the ageing Chinese population to meet their needs in an aquatic environment. It should not only find acceptance among the population of China, but also in other countries.

Aqua Qi Shui is based on Wu Qin Xi, an ancient Chinese gymnastics method based on the system of the Game of the 5 Animals, which promotes general health. On the basis of the Wu Qin Xi movement forms of these 5 animals (tiger, monkey, deer, bear and crane), a choreography of movement exercises in water was developed, which does justice to the ageing population and should lead to better autonomy, quality of life and health in old age.

**RESULT:** A program of 20 exercise sequences was created that improves mobility, strength, coordination, balance and agility.

## ORAL PRESENTATIONS

### O1: CONSIDERATIONS FOR AQUATIC HIGH INTENSITY INTERVAL TRAINING TO IMPROVE EXERCISE CAPACITY IN ADULTS WITH RHEUMATIC MUSCULOSKELETAL DISEASES- THE AQUAHIGH RANDOMISED CONTROLLED TRIAL

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**Keywords:** Aquatic therapy, AHIT, Clinical considerations

**INTRODUCTION:** People living with Rheumatic Musculoskeletal Diseases (RMDs) face common challenges in exercise therapy, including pain and fatigue and aquatic exercise may have a potential to overcome some barriers to land-based exercise. The purpose of this study is to examine the immediate and 6-month effects of a three-month aquatic high intensity interval training (AHIT) compared with aquatic moderate intensity continuous training (AMICT). Comparing AHIT to AMICT, is needed to fully understand its impact on exercise capacity on a broader population with RMDs.

**METHODS** Members of the Norwegian Rheumatic Association (NRF) in Norway were recruited as participants and were randomly assigned to either AHIT or AMICT. Both groups received exercise twice weekly for 12 weeks supervised by people from local NRFs groups. The AHIT program consisted of four intervals of four minutes at high intensity (Borg Rating of Perceived Exertion 14-18) of exercises activating large muscles in the lower and upper limbs. Intervals were interrupted by 2-3 minutes bouts of light recovery exercises. The AMICT group exercised continuously with moderate intensity (Borg scale 12-13). The primary outcome measure was exercise capacity (VO<sub>2</sub>peak), assessed using an indirect maximal test on a treadmill involving walking uphill until exhaustion, according to a modified Balke protocol. A linear mixed model for repeated measures (intention-to-treat analysis) was used to estimate the mean difference with 95% confidence interval in outcomes: exercise capacity, and secondary outcomes of interest: physical activity, perceived disease activity, pain, lower extremity strength, the ability to participate in social roles and activities, fatigue, and quality of life.

**RESULTS:** 89 participants (with osteoarthritis, rheumatoid arthritis, fibromyalgia and axial spondyloarthritis) were eligible and randomised to AHIT (n= 44) or AMICT (n=45). A total of 66 participants (74%) completed the intervention and assessments at 3 months and 50 participants at 6 months. Six participants (14%) in the AHIT group and twelve participants (27%) in the AMICT groups dropped out prior to the post-intervention assessment (3-months). At follow up at six months, nine (26%) in AHIT and six (19%) in AMICT dropped out. Mean age 62 (SD 13) years, and 93% were female. The AHIT group had 28 of 45 participants completing 80% of sessions ( $\geq 17/24$ ), while the AMICT group had 21 of 44 participants completing 80%. No significant difference in completed sessions was found ( $p = .25$ ). AHIT had a mean Borg intensity of 15.1 (SD 2), considered "somewhat hard" to "very hard," while AMICT had 12.7 (SD 2), corresponding to "fairly light" to "somewhat hard" ( $p < .001$ ). In AHIT, 35% exercised at lower intensity than protocol, while 14% in AMICT trained at a higher intensity (Borg >15). No adverse events were reported. The observed between group difference in

VO<sub>2</sub>peak was 1.91 mL kg<sup>-1</sup> min<sup>-1</sup> (95% CI .045 to 3.769) in favour of the AHIIT group (p = .045) at 3 months. For secondary outcomes AMICT was equally valuable. At 6 months, the between group difference was not maintained (1.06 mL kg<sup>-1</sup> min<sup>-1</sup> (95% CI 1.05 to 3.17)).

**CONCLUSIONS:** Exercise capacity increased in participants with RMD following 3 months group based AHIIT. For secondary outcomes AMICT was equally valuable. The intervention was well tolerated with no adverse events suggesting that people with RMDs were capable of successfully completing a 12-week AHIIT program applied and integrated into existing organizations in volunteer settings within the municipality. Clinical considerations for the implementation of AHIIT could review the number of sessions per week, the use of volunteers as exercise leaders, and the main aims of the aquatic program to design the most effective intervention.

## **O2: THE EFFECT OF AI CHI ON EXECUTIVE FUNCTIONS, PREFRONTAL ACTIVATION, AND AUTONOMIC NERVOUS SYSTEM IN HEALTHY ELDERLY**

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**Keywords:** Ai Chi, Executive function, Prefrontal cortex, Heart rate variability, Elderly

**INTRODUCTION:** Executive function (EF), a high-level cognitive function declining with age, is found to be associated with increased prefrontal cortex (PFC) activation and decreased vagal tone indicated by heart rate variability (HRV). Aerobic exercise is one of the most well-established exercises to improve EF along with the modulation of PFC activation and HRV. However, aerobic training is often a challenge to elderly with musculoskeletal issues in lower extremity. Ai Chi, a low-impact aquatic exercise, combining effect of water immersion which increases cerebral blood flow and movement characteristics of Tai Chi and Qigong which modulates HRV, might be a beneficial alternative to improve EF in older adults.

**METHODS:** Thirty-seven healthy elderly, aged between 65 and 80, were enrolled and received 24 sessions of 60-minute exercise training in eight weeks. Twenty-four participants received Ai Chi training and thirteen undertook treadmill training. The EF performance, PFC activation and HRV were assessed in pre- and post-test. EF was evaluated by trail making test (TMT) and digit span test. PFC activation using functional near-infrared spectroscopy (fNIRS) and HRV using ECG were simultaneously recorded during Stroop color word test with congruent condition (SCWT-c), incongruent condition (SCWT-ic), and category fluency test (CFT). The HRV indices included R-R interval (RRi), root mean square of successive differences (RMSSD), and the proportion of NN50 divided by total number of NNs (pNN50).

**RESULTS AND DISCUSSION:** Participants in Ai Chi group (mean age: 69.8 y/o) showed significantly greater intra-group improvement in TMT-B after 8 weeks of training while treadmill group (mean age: 71.1 y/o) did not show such change. PFC activation only showed a trend of decrease during SCWT-ic task in Ai Chi group. The resting RMSSD increased after Ai Chi intervention but not after treadmill training, possibly indicating the elevation of vagal tone. Ai Chi exerted potential effects on improving EF while attenuating compensatory PFC activation, as well as increasing the resting vagal tone, which was found to be positively correlated with EF performances. Although there was no inter-group difference, the intra-group changes showed that Ai Chi had similar or potentially larger effects as aerobic training, which was found in literature effective to improve executive function and modulate brain activity and HRV. It is

important to have different possibility of exercise, especially in people with older age, because many elderly were limited by degenerative disorders and not able to perform vigorous exercise. Ai Chi, though with low level of impact and yet high level of mindfulness, is a possible option for improving EF in older people. Hawkes et al. (2014) also found that Tai Chi practitioners (although not particularly Ai Chi) or meditation plus exercise might perform better executive function than aerobic exercise practitioners. The results in our study should be interpreted with care because only intra-group difference was detected. The training period of our study was only eight weeks, which was slightly shorter than the suggested time for elderly exercise.

**CONCLUSION:** Eight weeks of Ai Chi training might be a beneficial alternative for healthy elderly to improve EF with potentially decreased PFC activation, and enhancement of resting vagal tone. However, the significant difference was only in intra-group comparison. A study with larger sample size and possibly longer intervention period was suggested. EF performance and the physiological modulation is also affected by the presence of cognitive impairment, and therefore, the implication of further study could address whether older people with and without cognitive impairment show different results after receiving Ai Chi or aerobic exercise.

### **O3: STROKE TOOLKIT FOR AQUATIC REHABILITATION AND RECREATION THERAPY (STARRT): THE PROCESS OF A PARTICIPATORY DESIGN**

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Keywords: toolkit, user-centred design, cerebrovascular disorders, aquatic exercise

**INTRODUCTION:** Aquatic therapy (AT) is beneficial to body functions and activities of people who experienced a stroke, as shown by a number of quantitative intervention studies.<sup>1</sup> However, a recent qualitative study identified a lack of AT knowledge by both clients and healthcare providers that may prevent the use of AT in clinical practice.<sup>2</sup> The present study aimed to co-design the evidence-based Stroke Toolkit for Aquatic Rehabilitation and Recreation Therapy ([www.starrt.net](http://www.starrt.net)) to address this knowledge gap in AT and to facilitate AT uptake by aquatic and recreation therapists, and persons who experienced a stroke.

**METHODS:** We used a participatory design approach,<sup>3</sup> which considered the end-user experience from conceptualization to prototyping of the toolkit. The four phases used to co-design the STARRT were: 1. A scoping review on implementation considerations of aquatic therapy post-stroke; 2. Qualitative interviews to elucidate clients' and providers' experiences (N=23) with AT to inform phase three; 3. A co-design approach with a multidisciplinary group of stakeholders (N=19) using exploration, discovery and prototyping phases; and 4. Final prototyping of toolkit in a larger group of stroke stakeholders from across Canada. The STARRT was disseminated nationally using the International Association for Public Participation (IAP2) framework.

**RESULTS AND DISCUSSION:** Our co-design team (N=10) in consultation with the consumer advisory team (N=9) envisioned the STARRT toolkit as an education guide (e.g. to inform users about benefits of AT post-stroke) and an information guide (e.g. to guide users on how and where to access AT, explaining risks and safety considerations). The prototyping of the toolkit with national stakeholders identified relevant and necessary updates for the STARRT and empowered both clients and AT providers to use STARRT in their clinical practice.

**CONCLUSION:** STARRT was developed as a toolkit to optimize the use of aquatic therapy and recreation post-stroke. Clients who experienced a stroke and AT providers alike will find an education and information guide to facilitate the application of AT to support stroke recovery in Canada.

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#### O4: COMPARISON OF AQUATIC PHYSICAL THERAPY PROTOCOLS IN THE GAIT OF CHILDREN WITH CEREBRAL PALSY: RANDOMIZED AND BLINDED CONTROL TRIAL

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**Keywords:** Aquatic Exercise; Balance; Walk.

**INTRODUCTION:** The main motor disabilities of children with cerebral palsy (CP) are atypical movement patterns, deficits in maintaining posture and balance that interfere with gait performance. Two aquatic therapy protocols demonstrated positive effects on trunk control and balance (Kakhata AM, *et al.*, 2019; Oliveira LMM, *et al.*, 2015). The main objective was to verify and compare the effects of these two aquatic exercise protocols on the gait of children with CP, in addition to verifying and comparing the effects on balance, trunk control, mobility, risk of falls and quality of life and gait.

**METHODS:** Randomized and blind control trial, following the recommendations of the CONSORT, registered in the ReBEC and approved by the research ethics committee of the Association for Assistance to Disabled Children. Type I error of 5%, type II error of 20% and power of 80% were assumed, with an assumption of a difference of 50% between the groups at the end of the interventions and an effect size of Cohen's *d* of 1.60, for the calculation sample. A sample of 8 individuals in each group was required. Children with diparetic spastic CP levels II and III in the GMFCS between 6 and 8 years of both sexes were included. Exclusion criteria: non-collaborative children, unable to understand or carry out the activities proposed in the initial assessment due to musculoskeletal deformities or cognitive changes, musculoskeletal disorders, who presented episodes of uncontrolled seizures, underwent orthopedic or neurological surgeries less than 12 months ago and neuromuscular blockades for less than 6 months. Eligible children were randomized and allocated into the of aquatic balance exercises (ABG) and aquatic trunk exercise group (ATG), stratified by GMFCS. The

children performed the six-minute walk test (6MWT), Timed Up and Go (TUG), Dynamic Gait Index (DGI), Pediatric Balance Scale (PBS), Trunk Control Measurement Scale (TCMS), quality of life questionnaire and parents measured their perception of gait quality using the Visual Analogue Scale (VAS). The energy expenditure index (EEI) and average gait speed (GS) were calculated. The protocols consisted of 16 aquatic therapy sessions, lasting 35 minutes, twice a week, with water at 35°, depth in the xiphoid process or floating. The Shapiro-Wilk test analyzed the distribution. The unpaired Student's t test or the Mann-Whitney test compared the groups. The paired Student's t test or the Wilcoxon test compared the moments. Cohen's *d* effect size calculated the amplitude of the differences.

**RESULTS:** The majority were female (75%) and classified as level II (62.5%) on the GMFCS. After the intervention, an improvement was observed in most outcomes in both groups, except for the time in TUG, for ATG, and for EEI in both groups. The ABG was statistically significantly better than the TG in the 6MWT and GS after the intervention ( $P = 0.04$ ) (Cohen's  $d = 1.09$ ).

**DISCUSSION:** There are no robust RTCs on the effects of aquatic therapy on gait in children with CP. In the systematic review by Roostaei et al. (2017), eleven studies on gross motor function were reviewed, with only 2 RCTs and studies with low internal validity. The present study was based on Oliveira et al. (2015) and Kakihata et al. (2019). Considering the effects of immersion and the proposed exercises, it was possible to verify that the protocols improved the outcomes studied for this population and that ABG was superior to ATG in the gait performance test. Some AGB exercises were more similar to gait activities, so this factor may have influenced this difference, as described in the literature (Skriverer K, et al., 2020) which describes the importance of task-oriented training.

**CONCLUSION:** Aquatic therapy protocols were effective for most outcomes and ABG were better for gait performance.

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#### **O5: EFFECT OF WATER- AND LAND-BASED EXERCISE ON LUNG FUNCTION IN CHILDREN WITH POST COVID-19 CONDITION: A RANDOMIZED CONTROLLED TRIAL**

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**Keywords:** aquatic therapy; long COVID; child



**INTRODUCTION:** Children and adolescents may have persistent abnormalities in lung imaging and function, cardiorespiratory symptoms, fatigue, and decreased functional capacity between three to 12 months after COVID-19 infection.

The aim of this study was to assess the effect of water- and land-based exercise on lung function in children with post COVID-19 condition.

**METHODS:** Children age 10-12 years with post COVID-19 condition were randomly assigned into one of three groups - water-based exercise, land-based exercise or control (no intervention). The intervention lasted 8 weeks, 2 times per week for 45 minutes.

The pulmonary outcomes of this study were the changes in lung function from baseline to immediately after the 8-week intervention. Pulmonary function tests were performed using the portable Lungtest Handy (MES LLC, Cracow, Poland). Parameters measured included forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), vital capacity (VC).

**RESULTS:** An increase in all spirometric parameters expressed as % predicted values was observed in the active groups (AQUA and LAND). After the intervention there was a significant difference ( $p < 0.01$ ) in absolute FEV1 values between the two exercise groups compared to the control group, in which post-intervention values were lower than in other groups. After the intervention, a shift in the severity of obstruction towards normal values was observed, however, there were new cases from the control group with restrictive disorders.

**CONCLUSIONS:** The study showed that lung function of children with post COVID-19 condition can be improved with exercise training and aquatic setting appears to be more favorable than land.

## **O6: ACUTE EFFECT OF MODERATE-INTENSITY AQUATIC TREADMILL EXERCISE ON COGNITIVE FUNCTION AND CEREBRAL BLOOD FLOW FOR HEALTHY ELDERLY: A RANDOMIZED CONTROLLED TRIAL**

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**Keywords:** Cerebral blood flow, Aquatic therapy, Geriatrics

**INTRODUCTION:** Resting cerebral blood flow diminished in ageing and in several neurodegenerative diseases. This study aims to compare the effect of a single session of moderate-intensity aquatic treadmill exercise (ATM) on cerebral blood flow (CBF) and cognitive function in healthy elderly to moderate-intensity land-based treadmill exercise (LTM).

**METHODS:** This is a randomized controlled trial study. Twenty-eight participants aged 60-80 were randomly assigned to either ATM group (N = 14) or LTM group (N = 14). Both groups underwent incremental tests to determine the individualized speed of moderate intensity [65% maximal oxygen uptake ( $VO_{2max}$ )], followed by a 20-minute exercise session on the respective treadmill. Cognitive function and cerebral blood flow were assessed before and after the

exercise. The outcome measures used in this study were the Digit Symbol Substitution Test (DSST) and the Digit Span Test (DST) to assess cognitive performance, and the mean middle cerebral artery blood velocity ( $MCAV_{mean}$ ) to evaluate CBF.

**RESULTS:** The DSST demonstrated a statistically significant improvement within both the ATM [ $\beta \pm SE$ :  $-13.643 \pm 2.407$ , 95% CI:  $-18.749$ ,  $-8.537$ ] and LTM [ $\beta \pm SE$ :  $-19.25 \pm 3.66$ , 95% CI:  $-26.424$ ,  $-12.076$ ] groups, indicating clinical significance in both groups. Both ATM and LTM groups exhibited post-exercise improvements within their respective groups for forward Digit Span Test (FDST) [ATM  $\beta \pm SE$ :  $-0.143 \pm 0.362$ , 95% CI:  $-0.92$ ,  $0.634$ ; LTM  $\beta \pm SE$ :  $-0.286 \pm 0.37$ , 95% CI:  $-1.078$ ,  $0.506$ ] and backward Digit Span Test (BDST) (ATM  $\beta \pm SE$ :  $-1.741 \pm 5.377$ , 95% CI:  $-13.27$ ,  $9.792$ ; LTM  $\beta \pm SE$ :  $-6.729 \pm 5.370$ , 95% CI:  $-4.788$ ,  $18.24$ ), although these improvements did not reach statistical significance. In terms of  $MCAV_{mean}$ , there is a higher improvement of CBF in ATM group [ $\beta \pm SE$ :  $-138.669 \pm 67.9217$ , 95% CI:  $-288.164$ ,  $10.826$ ] than LTM group [ $\beta \pm SE$ :  $-9.305 \pm 70.076$ , 95% CI:  $-153.617$ ,  $135.007$ ], though the group-trial interaction effect is not statistically significant [ $\beta \pm SE$ :  $0.3773 \pm 4.480$ , 95% CI:  $-8.769$ ,  $9.524$ ].

**DISCUSSION:** The evidence indicated beneficial effects of moderate-intensity ATM and LTM on cognitive function and CBF in elderly, specifically ATM can significantly enhance DSST performance. This suggests that a single session of exercise can enhance certain aspects of cognitive function in healthy elderly with normal cognitive function. Both ATM and LTM groups demonstrate clinically and statistically significant improvement in DSST. A prior study compared the effects of six months combined treatment of water-based cognitive training (Brain Gym®) and aquatic aerobic exercise on cognitive function in healthy women using Symbol Digit Modalities Test (SDMT). One group performed water-based cognitive training followed by fitness training and the other group followed the same program in reverse order. The SDMT performance improvement of the former and later group were 7.10% and 4.45% respectively. Our study provides evidence to support the choice of exercise parameter for clinicians in the future, clinicians may consider the implementation of aquatic exercise with a moderate intensity for 20 minutes for cognitive preservation.

**CONCLUSION:** A single bout of moderate-intensity ATM and LTM can enhance cognitive function and CBF in healthy older adults, suggesting their potential as preventive strategies against age-related declines.

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## **O7: DEVELOPMENT OF AN AQUATIC OBSERVATION INSTRUMENT FOR CHILDREN WITH ASD: RELIABILITY AND VALIDITY**

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Keywords: Observation, Aquatic Therapy, Swimming, Autism Spectrum Disorders

**INTRODUCTION:** This study aimed to develop an observation instrument for assessing water-related motor skills in Children with Autism Spectrum Disorders (WOT-ASD) and to evaluate its reliability and validity. In addition to disorders in social communication and interaction, and repetitive behaviors, 80% of children with autism spectrum disorders are at risk for motor impairments. Aquatic interventions offer good opportunities to practice, experience, discover, and develop motor skills. To tailor training and therapy to the needs of the children, it is important to get insight into their movement behavior. Therefore an observation instrument is needed. The five-stage model for developing and validating a systematic observation instrument was used (Brewer & Jones, 2002; Roberts & Fairclough, 2012).

**METHOD AND RESULTS:** In the first two stages, the new instrument (WOT-ASD) was developed based on the researcher's mastery of the existing instrument Water Orientation Test Align 2 (WOTA-2) (Tirosh et al., 2011), which is based on the Halliwick ten-point program (Lambeck, 2015). In stage 2 the less suitable items of the WOTA-2 were omitted and the other items were specifically operationalized based on the observed motor behavior. In stage 3 the content validity was established based on feedback from six experts in the field of aquatic therapy and/or swim education, resulting in an instrument with 25 items in four subscales. In stage 4 the interobserver reliability and internal consistency were determined by observations in 31 children, resulting in perfect agreement for all items, ICC > .81 and good for two items, ICC > .80. Cronbach's Alpha showed excellent reliability with, > .91 for 23 items and good reliability for the other two > .8. Scalability in stage 5 (n= 36) was established via Mokken Scala Analyses. Results of this stage showed strong scalability per item and subscale  $H \geq .5$ .

**CONCLUSION:** The new observation instrument (WOT-ASD) is reliable and valid for observing and evaluating the water-related motor skills of children with ASD and may provide direction for child-centred guidance and treatment.

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## O8: THE ACUTE EFFECT OF AN AQUA-PILATES FITNESS CLASS USING FLOATING EXERCISE MATS ON STATIC BALANCE PARAMETERS

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**Keywords:** postural control, Centre of Pressure, sensory reweighting, proprioception.

**INTRODUCTION:** An exercise method gaining popularity in recent years is the aquatic physical fitness training using floating mats in the pool. This was found to be an effective method for the improvement of strength, balance, and postural control [1]. The use of floating aids in an aquatic environment is suggested to enhance proprioception in rehabilitation [2] and exercise [3] programmes. However, there is a lack of evidence in the literature about the acute effects of exercising on floating mats. The purpose of the study was to examine the acute effect of a single aquatic floating fitness class on the balance parameters of adult individuals with typical health.

**METHODS:** Ten aquatic fitness instructors (6 females;  $28.7 \pm 8.9$  yrs,  $1.71 \pm 0.07$  m,  $69.5 \pm 12.6$  kg) with no apparent health problems and experience on floating exercise mats performed a 35-min aquatic floating fitness class comprised of Aqua-Pilates based activities which were executed on BEboard floating exercise mats (BECO-Beermann GmbH & Co. KG, Bad Salzuflen, Germany). The perceived intensity of the programme was 5.3 based on a 10-point Borg visual analogue scale. The pre- and post-intervention assessments of static balance (normal bipedal stance) with open and closed eyes (duration: 20 s) were conducted on a stable ground outside the pool using the K-Force Plates v.2 dynamometers (Kinvent Biomecanique, Montpellier, France; sampling frequency: 75 Hz). The main effect and the interaction of “time” (pre- vs. post-measurement) and “vision” (open vs. closed eyes) were examined with  $2 \times 2$  ANOVA and Friedman’s test using the SPSS v.29 software (IBM Corp., Armonk, NY, USA), with the level of significance set at  $\alpha = .05$ .

**RESULTS:** The post-intervention measurements revealed significantly ( $p < .05$ ) lower total Center of Pressure (CoP) displacement and Root-Mean-Square (RMS) amplitude in the medio-lateral direction in the closed eyes test compared to the pre-test (Table 1).

**DISCUSSION:** Past research found that long-term exercising on floating mats improved static balance in females [1]. Participants seemed to rely more on vision rather than proprioception in the post-intervention measurement as shown by the significant time  $\times$  vision interaction for the total CoP amplitude in the medio-lateral direction. This suggests a change in the sensory reweighting strategy [4], since exercising on the floating mats caused less reliable proprioceptive inputs.

Table 1: Pre- and post-intervention comparisons for the Center of Pressure parameters ( $n = 10$ ).

Measurement Eyes	pre-intervention		post-intervention		comparison
	open	closed	open	closed	
A/P <sub>RMS</sub> (mm)	$2.8 \pm 1.5$	$3.6 \pm 1.2$	$4.0 \pm 2.1$	$4.3 \pm 1.6$	$p > .05$
A/P <sub>total</sub> (mm)	$12.3 \pm 5.2$	$17.8 \pm 6.6$	$17.0 \pm 6.3$	$19.6 \pm 6.3$	$p < .05$ : pre (open vs. closed).
M/L <sub>RMS</sub> (mm)	$2.3 \pm 1.9$	$1.0 \pm 0.8$	$0.6 \pm 0.2$	$1.3 \pm 1.2$	

M/L <sub>total</sub> (mm)	9.6 ± 7.6	5.3 ± 4.5	3.1 ± 0.9	6.8 ± 5.8	<i>p</i> < .05: pre (open vs. closed), eyes open (pre vs. post), time × vision (interaction).
CoP <sub>total</sub> (mm)	96.3 ± 51.8	137.5 ± 89.1	97.7 ± 7.4	114.3 ± 58.5	<i>p</i> > .05
CoP <sub>RMS</sub> (mm <sup>2</sup> )	71.8 ± 70.3	51.0 ± 60.1	18.2 ± 12.6	71.9 ± 93.4	<i>p</i> > .05

**CONCLUSION:** The Aqua-Pilates fitness class using floating exercise mats provoked an acute sensorimotor re-organization and may contribute to the achievement of exercise and rehabilitation programmes goals. Further research is required to study the effectiveness of this exercise modality and the involved neuromuscular mechanisms after a long-term intervention.

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### O9: IMPORTANCE OF AQUATIC EXERCISE IN A COMMUNITY BASED MUSCULOSKELETAL WELLNESS SOLUTION

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**Keywords:** Digital Health, Musculoskeletal, Aquatic Exercise

**INTRODUCTION:** The COVID pandemic created a Goldilocks effect where the surgical and treatment waiting lists for people with musculoskeletal condition increased while digital health and wellness solutions for these (and other) populations exponentially increased. Exercise, either water or land-based have been shown to be effective for people with musculoskeletal (MSK) conditions. This study is a clinical audit of a community service providing water- and land-based exercise solutions for people with MSK. These solutions were delivered through three digital platforms either in a leisure center, or a home as either an aquatic- or land-based exercise systems. Participants were free to choose the environment and frequency of their attendance as well as training location. The purpose of this study was to audit the service and describe feasibility metrics of the solution.

**METHODS:** Data collected using one of the three services in the digital ecosystem between May 2021 to December 2023 were extracted. Inclusion criteria were completion of at least one exercise session in any service or environment, age >18 years old and agreed data sharing terms and conditions. Participant flow and characteristics, Pain (visual analogue scale (VAS) 0-100), function (Patient Specific Complaint, (PSC)) (0-100) and global change scores were measured. Physical activity was measured with the International Physical Activity Questionnaire (IPAQ). Data extraction and processing was monitored by an external expert and the study approved by Exeter University's ethical board prior to data processing. Social value was calculated using the 4Global social value calculator based on age and gender.

**RESULTS:** The service was provided in 136 leisure centers by end of the year 2023 with 90% of participants using this service. In total 4429 participants were who registered into the system were female 3515 (79.4%), 21.5% ethnicity other than white, average age 58.7±15.3 years old and 44.2% had a sedentary lifestyle. Knee (33.3%) was the most common body location affected by an MSK condition. Baseline average pain (0-100) was 43.3±23.4 and 83.3% were chronic > 3 months duration. 74.2% report at least one comorbidity. 33.5% are in the lower third quartile for deprivation. In total 40995 session were completed (91.5% water-based exercise) were completed and 88.8% participants chose water-based exercise as their first session environment. Average number of completed sessions per user was 9.3. The service created an estimated £583 of social value per participant (Estimated £2,6m during the audit). 33.8% and 38.6% reached a minimal important detectable change (MCID) of 15% change in pain by 4- and 6-weeks respectively. Difficulty in functioning (PSC) decreased significantly with mean changes of -11.6 [95% CI -13.6, -9.6] and -9.1 [95% CI -11.2, -6.9] at 4- and 6-weeks follow-up respectively.

**DISCUSSION:** The wellness service attracted a heterogenous population of people with a wide range of MSK conditions, symptoms from a diverse back ground. This is representative of the population of the United Kingdom with except of a higher proportion of participants being female. The clinically important changes in pain and function along with the social value created can be considered primary a result of the participation in aquatic exercise given the high proportion of users choosing aquatic exercise as their seemingly exercise modality of preference.

**CONCLUSION:** Group water-based exercises with personalization of exercise using a digital solution appears to be a feasible solution to reduce load on local and national service at breaking point. A wellness solution delivered in leisure centers has positive effects on function and has potential to support health systems with the burden of MSK conditions.

## **O10: EFFECT OF AQUATIC THERAPY ON CARDIO-RESPIRATORY ENDURANCE AND QUALITY OF LIFE IN ADOLESCENT AND YOUNG ADULTS CEREBRAL Palsy**

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**Keywords:** hydrotherapy, aerobic endurance, functional capacity, plyometric, recreation, swimming

**INTRODUCTION:** Children with cerebral palsy have inadequate physical activity due to biomechanical restrictions, neuro-motor and musculoskeletal impairments. This leads to low peak oxygen uptake increasing fatigue levels and further leading to reduction in cardio-respiratory endurance. Aquatic therapy provides an optimal environment to exercise aerobically in comparison to land-based training.

**METHODS:** A case series of 3 subjects with spastic cerebral palsy(GMFCS level I-II) aged 15-26 years, was performed. These subjects underwent 12 aqua therapy sessions at a clinical setup for 40 minutes, 2 times in a week for 6 weeks, total 12 sessions. Outcome measures used were 6 MWT ( 6 Minute Walk Test), PEFR( Peak Expiratory Flow Rate), SF-36 ( 36 items-Short Form Survey) and the clients were assessed on day 1, week 3 and week 6.

**RESULTS:** Case 1 showed changes from baseline score to post aqua sessions in PEFR from 100 to 150 to 170, in 6 MWT from 60M to 70M to 80M and SF- 36 was not measured.

Case 2 showed changes from 70 to 90 to 100 in PEFR whereas 6MWT showed changes from 80M to 120M to 140M and SF-36 from 323.74 to 479.83.

Case 3 showed changes in PEFR from 100 to 120 and to 180, 6MWT showed changes from 200M to 240M to 320M.

**DISCUSSION:** In our study we found that, there is an increase in the 6 MWT and PEFR which may be due to the cardio-respiratory adaptations after aquatic intervention. This study aligns with Fragala Pinkham et al. which states that aquatic therapy helps to improve the gross motor functions and walking endurance thereby improving cardiovascular endurance which can be reasoned by the ability of the child to exercise at high intensity and ability to move freely in the water. Aquatic environment provides a medium in which children with CP can perform activities with less joint stress and, hence attain higher aerobic training intensity as compared to land. Also, exercise in water can be fun, novel and interesting for children, motivating them to exercise for longer duration. Both higher intensity and longer duration may have led to the improvement in cardiovascular endurance. The quality of life also may be improved due to overall increase in the ability to perform movements and also the recreational factor of aquatic therapy plays a boon in improving the endurance of the children.

**CONCLUSION:** The study concludes that aquatic therapy may be used to improve the cardiorespiratory endurance and improve the fatigue levels of the young adults with cerebral palsy.

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## POSTER PRESENTATIONS

### P1: THE PHYSICAL FITNESS COMPARISON BETWEEN WATER-BASED AEROBIC EXERCISES AND OTHER AQUATIC INTERVENTIONS IN OLDER ADULTS: A META-ANALYSES

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**Keywords:** Aquatic therapy, aging, functional capacity

**INTRODUCTION:** Water-based exercises are used as an alternative to traditional land-based physical activities, capitalizing on the advantages offered by the physical properties of water. Although systematic reviews have demonstrated the effects of aquatic exercise programs combining aerobic, strength, stretching and/or balance exercises in the older population, the benefits derived exclusively from aerobic exercises in this environment on various components of physical fitness still need to be elucidated in the literature. Therefore, this study aimed to systematically investigate the effects of water-based aerobic exercises compared to other aquatic interventions on the physical fitness of older adults.

**METHODS:** The study was registered in PROSPERO (CRD42022330641). PubMed, LILACS, and EMBASE were searched on April 28, 2022. Eligibility criteria included randomized and non-randomized trials focusing on water-based aerobic exercise interventions in older adults (age  $\geq 60$  y), with outcomes related to cardiorespiratory fitness, muscle strength, flexibility, and balance. Meta-analyses were conducted to compare outcomes between aerobic and combined exercise programs. Standardized mean differences (SMD) with 95% confidence intervals (CI) were calculated, and statistical heterogeneity was assessed using the chi-square and inconsistency ( $I^2$ ) tests. Methodological quality was evaluated using the TESTEX 15-point Scale.

**RESULTS:** After the initial search, 1571 records underwent screening, resulting in 40 assessments for eligibility. Ultimately, six studies were included in this review, aiming to compare water-based aerobic exercises with other aquatic interventions. Of these, five studies implemented combined (aerobic and strength) exercises, while one focused solely on strength exercises, all compared to aerobic exercise alone. Consequently, meta-analyses were conducted to compare aerobic and combined exercise programs. Among the included studies, three assessed cardiorespiratory capacity, with pooled results indicating that aerobic exercises yielded more significant improvements than combined exercises (SMD: 0.58; 95% CI 0.15 to 1.01), with non-significant heterogeneity ( $p = 0.20$ ;  $I^2 = 36\%$ ). Three studies evaluated lower limb muscle strength (SMD: -0.04; 95% CI -0.38 to 0.30;  $p = 0.57$ ;  $I^2 = 0\%$ ), and three studies measured dynamic balance (SMD = 0.17; 95% CI -0.18 to 0.51;  $p = 0.86$ ;  $I^2 = 0\%$ ), with pooled results indicating no significant differences between aerobic and combined exercises for these outcomes. However, there were insufficient studies to conduct meta-analyses for static balance and flexibility outcomes. The quality of the included studies ranged from 6 to 13 points on the TESTEX scale.

**DISCUSSION:** The findings show the clinical benefits of water-based aerobic exercise programs, as they effectively improved various components of physical fitness in older adults. Notably, these programs demonstrated particular efficacy in enhancing cardiorespiratory fitness, a key predictor of all-cause mortality and cardiovascular events in healthy individuals. Moreover, this type of intervention aligns with established guidelines for older adults,



emphasizing exercise programs targeting cardiorespiratory capacity, muscle strength, and balance.

**CONCLUSION:** Water-based aerobic exercises proved superior to combined aerobic and strength exercises in enhancing cardiorespiratory fitness after 12 to 28 weeks of intervention while demonstrating comparable improvements in lower limb muscle strength and dynamic balance.

**Funding:** CAPES and CNPq, Brazil

## **P2: PILOTING QUANTIFICATION AND ANALYSIS OF AQUATIC RESISTANCE TRAINING**

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**Keywords:** Aquatic resistance training, Aquatic therapy, Machine learning, Movement quantification

**INTRODUCTION:** Aquatic resistance training is a modality to perform strength and rehabilitation exercises within an environment which offers reduced joint loading for land-based training. We present a machine learning (ML) enabled system for identifying exercise sets based on inertial measurement unit (IMU) recordings from aquatic resistance training sessions. Moreover, the system quantifies the number of repetitions in a set. We also present the ability to quantify the work done during a given exercise for single joint exercises through signal processing of the IMU data.

**METHODS:** Pilot data from 15 volunteers to train and validate the ML model was collected at Reykjavik University, Iceland. Participants took part in guided exercise sessions while wearing IMU sensors on each limb for several core exercises of relevance to both strength and rehabilitation training. These exercises included knee, hip, and shoulder extension-flexion as well as other common training drills. Subsequently, the IMU signals were labelled and fed into the ML model to identify a range of bilateral, unilateral, and composite exercises. The model performs this movement quantification across the entire exercise session, segments the session to exercises and reports the number of repetitions completed by the user per exercise. For single-joint exercises, we also report the amount of work done.

**RESULTS:** The resultant ML model has the capability to detect and quantify a range of exercises based on IMU signals. The initial model was developed using movements which were performed by participants in the presence of a trainer at the poolside to ensure movement quality. IMU signals from sensors mounted on each limb were used to classify movements during the exercise session. The number of repetitions was subsequently calculated on a per-exercise basis. For single joint exercises, further analysis was then performed to gain additional insights regarding the performance of the participant. The radius of gyration of the single joint exercise was calculated by numerical optimisation. Using this information, the mean resultant magnitude angular velocity of the repetition can be deduced, and the force required to move the limb through the water at a given linear velocity (i.e. the amount of work done per repetition) can be calculated.

**CONCLUSION:** The developed proof of concept approach is a significant step towards enabling aquatic exercise prescription monitoring by offering a feasible method for tracking exercise and repetition completion along with the work done by a single joint. The approach is also applicable to performance evaluation, for example during injury rehabilitation.

### **P3: LONG-TERM ADAPTATIONS OF A COMBINED SWIMMING AND AQUATIC THERAPY INTERVENTION IN AN ADULT PERSON WITH HIGH-FUNCTIONING AUTISM: A CASE STUDY**

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**Keywords:** autism spectrum disorder, pervasive developmental disorders, balance, strength.

**INTRODUCTION:** Individuals with the features of autism but without intellectual disabilities, that usually present average or high performance on intelligence tests, are nowadays diagnosed as High Functioning Autism (HFA). Individuals with HFA present low level of motor skills, namely difficulties in gross and fine mobility. They also have difficulties in motor control, that discourage them from being involved in physical activities. This results in fewer opportunities for social interaction that consequently lead to impairments in communication and motor development. There is not much evidence available about the effects of regular swimming exercise and/or aquatic therapy on health promotion in adults with HFA. The aim of the present case study was to describe an aquatic intervention and monitor changes with a 6-month combined aquatic therapy and swimming intervention applied to a young adult individual with HFA.

**METHODS:** An adult male (22 yrs old; independent walker and regular swimmer without undergoing other exercise or therapy program) diagnosed with HFA and pronounced significant kyphoscoliosis participated in a combined 6-month swimming and aquatic therapy program (two sessions/week, 60 min each), conducted in a private pool (length: 25 m, depth: 1.7 m, water temperature: 27-28 °C). Each session comprised of six 10 min segments. The intensity for each segment was amplified by increasing resistance using aquatic exercise tools. The pre- and post-intervention assessments consisted of physical fitness, flexibility, balance, functional ability, coordination psychomotor tests, and radio-diagnostic evaluation.

**RESULTS:** The post-intervention assessments showed improvements in the standing long jump (+100%), grip force measured with the Kinvent K-Grip dynamometer (+71.7%), bend arm hang test (+123.1%), the physiological parameters in the 6 min walk test (+180m; +10.2%), as well as a decrease in the Cobb angle of the thoraco-lumbar scoliosis (from 55° to 45°) compared with the initial measurements. On the opposite, decrements in the sit-up (-12%) and sit-and-reach test (-6.3%) were observed. Finally, inconclusive results in the plate-tapping test, the side-bending test, and the Romberg balance test were found, mainly due to lateral differences.

**DISCUSSION:** In this case study, the intervention assisted the participant to gain relatively good coordination of the limbs. After the intervention, a positive development in terms of rotation in the trunk, coordination, and enhanced muscular endurance of the upper limbs despite the reduced mobility of the shoulder blades was observed. Thus, the aim to improve motor performance by incorporating motor coordination in the arm functions via movement planning [1] was partly achieved. The inconclusive outcomes could be attributed to the cerebellum differences in people with autism compared to the typical population [2], with the cerebellum being responsible for sensorimotor coordination, hypotonia, dysmetria, increased postural instability, and poor coordination.

**CONCLUSION:** The applied combined swimming and aquatic therapy intervention for a person on the autism spectrum offers benefits in physical fitness. Conclusively, there is a great need for further research on this topic examining a larger adult population.

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#### **P4: CAN AQUATIC EXERCISE IMPROVE BRAIN FUNCTION IN DISABLED PERSONS? A PRIMARY QUANTITATIVE RESEARCH**

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Greece

**Keywords:** Swimming, Aquatic therapy, Disability

**INTRODUCTION:** Aquatic exercise provides a low-impact workout that promotes increased blood flow and oxygenation to the brain. It has been suggested to be beneficial for the brain function of disabled persons. Additionally, aquatic exercise has proved to improve mobility and cognitive function. The purpose was to investigate the effect of aquatic exercise on brain function of disabled persons.

**METHODS:** The conducted primary research was quantitative, and it was based on a structured questionnaire, which included questions of 5-point Likert scale and closed ended questions. Moreover, the questionnaire was based on the framework for health of the WHO's International Classification of Functioning, Disability and Health (ICF). The research sample consisted of disabled persons (n=26) who participate in aquatic training to "Poseidonio" swimming pool, which belongs to the general secretariat of sports and has an Olympic-sized pool. The research included individuals with cerebral palsy, multiple sclerosis, autism, muscular dystrophy, spinal cord injuries and other disabilities, which were congenital (n=15) or acquired (n=11). Convenience sampling was used, and the research data were personally collected by the researcher. SPSS (v.23) was used for the statistical analysis. Descriptive statistics and multiple Pearson correlation tests, independent samples t-tests and Anova were conducted.

**RESULTS and DISCUSSION:** The results showed that none of the brain and/or cognitive functions of the people with disabilities worsened after they started aquatic exercising. The mean values in the total of 22 brain/cognitive functions examined, ranged between 3.77-4.74 out of 5.00, meaning that they improved to an almost absolute extent (since the mean values 3.77-4.74 are very close to the excellent score of 5.00), after aquatic exercising, in people with disabilities. Moreover, motor function (M= 4.94/5.00, p-value<0.01), muscle power (M=

4.88/5.00, p-value=0.04), and interpersonal relationships (M= 4.62/5.00, p-value= 0.03) were more improved in disabled persons that participated in aquatic exercise more frequently. Digestion (Pearson= 0.48, p-value=0.02), metabolism (Pearson= 0.42, p-value=0.04), self-care (Pearson= 0.57, p-value<0.01), and muscle power (Pearson= 0.42, p-value=0.03) were more improved in older disabled persons, and balance (M= 4.88, p-value0.03) was more improved in women. Self-care was less improved in the individuals with Angelman Syndrome (M=3.00/5.00), while spasticity was significantly improved in the most types (87,5%) of Plegia Paralysis (M= 4.43/5.00). Furthermore, some environmental external factors were also examined, such as the insufficiency of public transportation, parking places and city's infrastructure for disabled persons, the local residents' familiarity with disabled persons, the support that they receive from their family / friends, and the frequency of aquatic exercising is not statistically significantly affected.

**CONCLUSION:** The study indicated beneficial effects of aquatic exercise on all the 22 brain/cognitive functions examined. More benefits were indicated in the older disabled individuals and in the ones that visited the swimming pool more frequently. Disabled persons are proposed to engage in aquatic exercise, between 3-5 times a week, in order for them to mostly benefit by it.

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P5: Withdrawn

#### P6: RESEARCH METHODOLOGY: OUTCOMES FOLLOWING AQUATIC THERAPY IN THE REHABILITATION OF STROKE PATIENTS

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**Keywords:** Aquatic therapy, Stroke rehabilitation, Balance, Postural control

**INTRODUCTION:** Studies of the use of hydrotherapy are diverse in relation to the methods used, the amount of treatment, the number of exercise sessions and the functional tests used to measure the effects of hydrotherapy in balance exercises for the control of posture after a

stroke. This research is proposed with the aim of identifying the therapeutic effects of hydrotherapy using instrumental and laboratory examination methods (Veldema and Janson 2022). To develop our research methodology we conducted a systematic and selective review of the existing literature on the topic.

**METHODS:** A systematic selective literature review was conducted by searching the Web of Science Core Collection, the Web of Science Medline, Academic Search Complete and PubMed using the search terms 'hydrotherapy', 'aquatic therapy', 'waterbased exercises', 'water-based therapy', 'water-specific therapy', 'stroke rehabilitation' and 'balance'. 175 items were found out of which 24 were retained after filtering out duplicates, systematic reviews and irrelevant items. Both RCT and non-RCT studies were included. Our review focused on the range of functional testing and instrument-based examination methods in relation to balance and postural control after a stroke. The types of tests, the frequency of their use and the presence or absence of instrument-based examination were searched for in the items selected by the above search criteria.

**RESULTS:** In 15 cases only functional tests of balancing ability were used. 9 studies used instrumental measurements of stabilometry or gait analysis to assess static and dynamic balance. Studies of the association between functional and biomechanical changes still appear to be under-represented. In the few available publications the results were not consistent. Eyvaz et al (2018) found a higher but not significant level of improvement after aquatherapy in the balance index while the BBS scores improved significantly in the control group. Park & Roh (2011) found significant improvement in the aquatherapy group with open and closed eyes and also in the control group with open eyes, but no functional tests were carried out.

**DISCUSSION:** Assessment methods should include functional status specific testing complemented by a movement analysis system to monitor the subtle biomechanical changes involved in functional improvement in order to identify the factors leading to changes in functional status.

**CONCLUSION:** We propose a research methodology which includes both functional and instrumental examinations. Proposed selected functional tests are: BBS, TUG Test, 2-MWT and Modified FRT both before and after 10 aquatic therapy treatment sessions. We also propose the use of instrumental examinations (DIERS Pedoscan and Romberg test) before and after the first and the last treatment sessions. The associations between the outcomes of the functional and instrumental assessments will be analysed and the preliminary results of applying this methodology will be presented.

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#### **P7: AQUATIC THERAPY IN CONGENITAL MALFORMATION DURING THE USE OF EXTERNAL FIXATOR FOR BONE LENGTHENING: IS IT POSSIBLE?**

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**Keywords:** Hydrotherapy; Rehabilitation; Aquatic exercise.

**INTRODUCTION:** Congenital malformations are structural or functional anomalies resulting from errors in morphogenesis and can result in a decrease in the size of the limbs. The main treatment for this condition is bone lengthening with an external fixator (EF). During the use of EF some adverse effects are expected, therefore physical therapy treatment is necessary for some alterations. One of the modalities used is aquatic physiotherapy, which promotes specific benefits due to the different terrestrial environment, facilitating weight bearing on the lower limbs, analgesia, and increased range of movement. The literature about this approach in this population is still scarce, so the aim of this study is to describe the rehabilitation of participants with congenital malformations (CMF) during the use of external fixator (EF) in aquatic therapy (AT) and to analyze the association between diagnosis, EF type and location with rehabilitation process outcomes, surgical intervention, and adverse effects.

**METHODS:** This retrospective study included 29 medical records from which personal and rehabilitation data were collected, related to diagnosis, sex, age, type and location of EF, objective of surgery, adverse events, surgical interventions, rehabilitation time in AT, physiotherapeutic objectives, and results of the rehabilitation process in AT. The AT used was described and the symmetry of the characterization data was analyzed using the Shapiro-Wilk test and presented as mean and standard deviation, considering a 95% confidence interval and 5% significance. Categorical data were presented as percentages and the association between outcome variables was analyzed using Pearson's Chi-square test. The primary outcome of this study was to describe AT treatment data and the secondary outcome was to verify the association between the variables.

**RESULTS:** The mean age of the participants was  $12.1 \pm 3,9$  years, with a predominance of boys and hemimelia cases, and underwent AT for  $6,8 \pm 3,6$  months. Each session was 35 min, twice a week. The most used EF was circular, located in the femur, and the main objective of surgery was bone lengthening. The most recurrent adverse effect was infection and 76% completed AT. There was no association between the variables analyzed.

**DISCUSSION:** The objective of this study was to discuss the rehabilitation process of these patients, analyzing their main outcomes and complications in recent years at the institution . There is no description in the literature of the treatment of this population in AT. In the study by Bhavé et al, 2016, the authors mention that AT is part of the treatment process, but without data on session and treatment time, treatment outcomes or complications. The current study demonstrates which functional objectives were chosen for patients and the percentage of treatment success. Furthermore, it demonstrates that there was no association between the variables studied. These data are important for the development of clinical studies on AT for people with CMF and EF.

**CONCLUSION:** It was possible to describe CMF rehabilitation with EF in AT. There was no association between the variables analyzed.

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## **P9: CASE REPORT: HYDROTHERAPY REHABILITATION OF A POST COVID-19 PATIENT WITH MUSCLE WEAKNESS**

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**Keywords:** Infection control, Intensive Care Unit, Physical Therapy

**INTRODUCTION:** The primary purpose of this case report was to examine the effects of hydrotherapy on a patient recovered from COVID-19 with ICU-acquired muscle weakness, in the absence of any cross-infection.

**METHODS:** The patient was a 29-year-old male, BMI 38.6 kg/m<sup>2</sup>, smoker three cigarettes per day, diagnosed with COVID-19 on 14<sup>th</sup> April 2020, hospitalized and intubated in the Corona Critical Care Unit until 10<sup>th</sup> May 2020. Following extubation and subsequently diagnosed with ICU-acquired muscle weakness, he tested negative for COVID-19 according to the polymerase chain reaction test. In rehabilitation he received four low to medium dose hydrotherapy sessions that included active exercises to lower limbs and gait training in warm water (31°C-35°C) to improve muscle strength in a non- or low--weight-bearing capacity. A standard land-based physical therapy program was also provided concurrently to the patient.

**RESULTS:** Following 2 weeks of rehabilitation that included four hydrotherapy sessions in addition to standard care, the patient was discharged home and able to walk outdoors independently for at least 30 minutes.

Day	Muscle Strength (MMT)	Pain (VAS)	Ambulation
1	Lower Extremities 2-3/5	Plantar fasciitis 8/10	20m indoors with 4-wheeled walker
14	Lower extremities 3+-5/5	hypo aesthesia	30 minutes outdoors independent

**CLINICAL IMPLICATIONS:** Hydrotherapy can be a useful modality in the rehabilitation of ICU-acquired muscle weakness developed following hospitalization in intensive care.

**CAVEAT:** The hydrotherapy complex at Sheba Medical Center remained open during the corona virus pandemic. Treatment took place during the corona virus pandemic; aside from the inclusion of specific personal protective equipment and social distancing (2 m), no additional requirements were necessary to our standard pool hygiene and no adverse infections were reported.

## **P10: AQUATIC BASED THERAPY INTERVENTIONS FOR CHILDREN WITH AUTISM SPECTRUM DISORDER - A MIXED METHODS SYSTEMATIC REVIEW**

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**Keywords:** functional skills, social interaction, behavioral skills, aquatics

**INTRODUCTION:** Over the years aquatic-based interventions have proven to be effective for children with neurodevelopmental disorders (Naumann et al., 2021). Owing to the multiple therapeutic properties of the water, it complements the sensory and motor needs of children with ASD. In addition, the aquatic environment encourages interaction and participation (Mortimer et al, 2014). There are a few systematic reviews published on this topic but their methodology lack robustness. Moreover, none of the reviews have included qualitative studies in their data set.

In light of this, the study takes a pragmatic approach, and the aims of this study are: to determine the effectiveness of aquatic based therapy in children with ASD and to also explore experiences and perceptions of them and their parents regarding its effect on the children's functional, social and behavioural skills by integrating and synthesising data from quantitative, qualitative, and mixed methods studies.

**METHODS:** This review followed a convergent segregated approach, as per the Joanna Briggs Institute's (JBI) methodological guidance to conduct a mixed methods systematic review (Stern et al., 2020). The literature search was carried out across various databases like PUB MED, AMED, SCIENCE DIRECT, PEDRO etc to retrieve relevant studies from 2015 to 2023. The data included the functional, behavioural and social skills of children undergoing aquatic therapy. The Quantitative and Qualitative data was synthesized independently and then integrated.

**RESULTS & DISCUSSION:** Searches across 12 databases revealed 564 studies. Among these 25 articles including 17 quantitative, 4 qualitative and 4 mixed methods studies met the eligibility criteria and were included in the review. The studies included children with ASD (n= 332) between the ages of 3 to 18 years. The studies varied in their type of aquatic intervention and their outcome measures. Due to heterogenous nature of the quantitative studies, a narrative synthesis was performed. The findings of included studies showed that aquatic based interventions had a significant impact ( $p<0.05$ ) on sensorimotor, aquatic skills, social interaction, and behavioural characteristics of children with ASD. The qualitative findings showed that the parents perceived aquatic therapy as a beneficial, feasible and a valid intervention. They believed that it facilitated their children's safety in water, improved their sleep and performance in their daily activities, reduced their problematic behaviour, assisted them in being socially active and made them happy. Both the qualitative and quantitative findings showed that aquatic therapy is an effective intervention, which can improve functional, social and behavioural skills.

**CONCLUSION:** This mixed methods systematic review deepens the understanding of the effectiveness of different aquatic-based approaches for children with ASD. Moreover, the therapeutic properties of water, coupled with the neuroplasticity aspect of motor learning and enhancement of daily functions, demonstrated across the studies, forms the fundamental parts of aquatic rehabilitation. Therefore, aquatic therapy should be included with other conventional interventions, as it not only provides a holistic approach to rehabilitation for children with ASD, but is also perceived positively by both children with ASD and their parents.

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#### P11: IMPACT OF KEY PERFORMANCE INDICATOR ON EFFICIENCY IN AN AQUATIC THERAPY FACILITY AS QUALITY PERFORMANCE METRIC – AN EXPERIENCE FROM QRI.

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Qatar Rehabilitation Institute.

**Keywords:** Key performance indicator (KPI), Efficiency, Aquatic therapy, Quality.

**INTRODUCTION:** Key performance indicators (KPI) are commonly used in businesses to measure progress and monitor operations on quantifiable metrics. Adaptation of measurable metrics in the health care sector has improved health care service delivery. Aquatic facilities use extensive resources to manage its operations. It is imperative that the resources are used efficiently to deliver aquatic services that results in a higher turnover of patients to the facility facilitating optimal and sustainable operations. Monitoring no shows and waiting time can ensure aquatic facilities are utilized to their complete potential. Little or no data is available enumerating the impact of KPI's in aquatic therapy facilities. This study illustrates the use of KPI's in influencing operational efficiency.

**METHODS:** The study design is a quasi-experimental design. There was no randomization and no control group. The objective of the study was to improve operational efficiency. The patient referrals to aquatic therapy were monitored through a centralized database through MS teams. No shows and waiting time were identified as KPI's of the facility. The data of both the parameters was recorded for analysis and interpretation. A Plan Do Study Act (PDSA) model was adopted to make a change and observe the outcome. The intervention to reduce the No shows was - to send SMS text messages of their scheduled appointments with dates and time, every patient is given the possibilities to miss two sessions due to unforeseen circumstances, but they will receive a text message about their no show and a disclaimer that if they miss another session, it requires them to get a re-referral from the physician. Besides the text message, they receive a phone call from the attending therapist to understand the possible reasons for missing the session. Therapist reiterates the importance of not missing an appointment. Regular timely follow up with patients and supporting them with telephonic consultation were undertaken to reduce the number of no shows. The impact of change was measured by the identified KPI and was correlated with the productivity of the facility, by measuring the number of visits the facility was able to document by the end of each month and annually.

**RESULTS:** The no show rate reduced to a total of less than 20% in a span of two years, the waiting time reduced to less than 15 days for priority patients. This was accepted as an optimal

time for the volume of references received to the appointment given. This demonstrated a shift in the quality of aquatic therapy services being delivered to the patients. The facility utilization achieved maximum productivity.

**DISCUSSION:** Identifying a performance indicator, measuring it using a strategic data collection process, analyzing the data, implementing improvement measures, and reviewing the outcome can have high impact on the efficiency of an Aquatic facility. The measures implemented following the PDSA model were effective in reducing the no shows and the waiting time for patients. Identifying Key performance indicators allows a facility to make focused improvement on specific parameters there by improving facility efficiency. The quality of aquatic therapy services in this study is from the perspective of providing early access to care for patients. The study is part of a bigger project in an attempt at implementing clinical governance in aquatic therapy.

**CONCLUSION:** Applying performance metrics for various quantitative measures has a positive impact on the efficiency of operations in aquatic therapy facilities. This facilitates better access to care, as one of the markers of quality of aquatic therapy services rendered to the patients. There are other parameters that can be identified as KPI from pillars of clinical governance, that are yet to be monitored in Aquatic therapy facilities.

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#### P12: COMPARISON OF ENERGY EXPENDITURE OF INDIVIDUALS WITH DUCHENNE MUSCULAR DYSTROPHY IN THE SITTING POSTURE ON THE GROUND AND IN WATER

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**Keywords:** Aquatic therapy; Oxygen consumption; Neuromuscular disease.

**INTRODUCTION:** Duchenne Muscular Dystrophy (DMD) is one of the most frequent childhood dystrophies, affecting cardiopulmonary functions and walking ability. One of the main symptoms of this disease is fatigue, which is caused by altered muscle metabolism related to energy expenditure (EE). Aquatic physical therapy is a therapeutic modality that facilitates the maintenance of this posture because of immersion on the body. This cross-sectional observational study aimed to compare the EE on the ground and water of individuals with DMD through oxygen consumption ( $VO_2$ ) in the maintenance of sitting posture.

**METHODS:** Children with DMD, aged over 7 years, who were able to remain seated without support on their trunk for 20 minutes and who collaborated with the study assessments were included. The interval between assessments was 7 days and the order of assessments was randomized. The sample was 16 individuals and were in a sitting position on the ground and in the water for 20 minutes, with a depth of the xiphoid process and in water at 34° and the evaluations were performed with a portable metabolic analysis system K5 COSMED® - Italy, which is the gold standard in the analysis of EE in rest or activity. The variables  $SpO_2$ , heart rate (HR), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), forced vital capacity (FVC), respiratory quotient (RQ), and  $VO_2$  were compared. Data symmetry was analyzed using the Shapiro-Wilk test and comparisons were made using the Wilcoxon test for asymmetric distributions and the paired student t test for symmetric distributions. The significance adopted was  $p < 0.05$ .

**RESULTS:** No difference was found between medians and quartiles of RQ when comparing the two environments. The same was observed for  $VO_2$  /Kg values on the ground (6,99 mL/min/kg) and in water (7,34 mL/min/kg) ( $p = 0,95$ ). The data from this study demonstrate that the EE of individuals with DMD did not change when maintaining a sitting posture on the two environments.

**DISCUSSION:** This study provides initial data to determine EE through oxygen consumption in the pool in individuals with DMD. Aquatic physical therapy is described in the literature as a therapeutic modality to treat these individuals (Lima AAR et al, 2020). This study may serve as a starting point for the indication of seated aquatic physical therapy in the rehabilitation processes. Considering all the findings of this study, maintaining sitting posture in the pool is safe and the aquatic physical therapy can be an approach for patients with DMD. There is no greater EE in this environment. The findings of this study may contribute to further research to arrive at better answers in relation to the EE of individuals with DMD in water during exercise.

**CONCLUSION:** There is no greater EE in this environment. The findings of this study may contribute to further research to arrive at better answers in relation to the EE of individuals with DMD in water during exercise.

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## **P13: LEARNING AQUATIC SKILLS? STAY BALANCED.**

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**Keywords:** Aquatic Skills, Swimming, Balance, Autism Spectrum Disorders

**INTRODUCTION:** Several studies have found that children with Autism Spectrum Disorders (ASD) have less well-developed motor skills compared to typically developing children (1-3). This study aimed to investigate whether the lower quality of motor skills also extends to water-related balance skills. These skills are very important for learning to swim. Balance control is necessary to get grip and feel safe in the aquatic context (4). The hypothesis is that typically developed (TD) children have better balance skills than children with ASD, affecting the aquatic skills necessary for water orientation.

**METHOD:** In this cross-sectional study, we compare land- and water-related balance skills of children with and without ASD in the 'water orientation phase' of swimming education. Participants were recruited from commercial swim class providers, swim clubs and through special education school swim programs. A convenient sample of children (n=84) between 5 and 10 years old with ASD (n=7) and without ASD (n=77), all without water safety certificates, have been assessed for their land-related balance skills with the Movement ABC-2 and for the water-related balance skills with the Water Orientation Test for ASD (Wot-ASD). The data were analyzed with the non-parametric Mann-Whitney U test.

**RESULTS:** Descriptive statistics indicates differences in age and gender diversion between the groups. The mean age of children with ASD is 7,6 years (sd 1,89), the mean age TD children is 6,1 (sd 1,57). The division between boys and girls in the ASD group is 6:1 in the TD group 38:39.

On total balance, dynamic balance and static balance significant differences were found, respectively  $\alpha$  is .001, .001 and .018 in favor of the TD group. No significant differences were found on any of the Wot-ASD subscales or total scale.

**DISCUSSION:** Power analysis indicated that at least 30 children with ASD should have participated for a reliable outcome. Most TD children receive their water safety certificate between 5 and 7 years. The higher mean age of the participants with ASD may be associated with more experience time in aquatic contexts, explaining that no significant difference in aquatic skills was found between these groups.

**CONCLUSION:** The first results show differences in land-related balance skills and not in water-related balance skills. A larger group of participants with ASD is needed for a more reliable comparison.

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## **P14: THE POWER OF WATER – OPTIMISING WATER AND EXERCISE FOR VASCULAR HEALTH**

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**INTRODUCTION:** Exercise and water immersion practices are two non-pharmacological interventions that can enhance and maintain vascular health (1). These two approaches can be used in isolation but can also be combined to elicit a cumulative benefit – which superior effect can be seen in the cerebral and peripheral vasculature (2, 3). From previous studies assessing haemodynamic changes in aquatic treadmill exercise, it is also evident that heart rate is lower at any given intensity compared to its dry-land equivalent; related to an increase in hydrostatic pressure. Therefore, given these findings, heart rate can be modulated by altering water immersion depth, with greater heart rate revealed at a shallower level (2). This means that heart rate, and by proxy working intensity, can be manipulated by water treadmill exercise to enable development of clinical high-intensity interval exercise. This mode of exercise can develop similar outcomes in a more time-efficient manner and stimulate greater enjoyment than traditional exercise structures (4) but remains infantile in an aquatic treadmill context. Thus, this study aims to compare both water immersion and exercise in isolation, both in combination ‘traditionally’ and in a clinical interval exercise framework, whilst also assessing the feasibility of the latter modality.

**METHODS:** Participants: Males and females aged between 18 and 40 years – menstrual cycle screened and controlled. Interventions: Randomised cross-over comparing passive water immersion (level: iliac crest), land treadmill exercise, aquatic treadmill exercise (iliac crest) and depth-modified aquatic treadmill exercise (iliac crest and xiphoid process interspersed). Exercise conditions performed for 40 minutes (with warm-up and cool-down) at a consistent, constant treadmill belt speed and water-based conditions embrace a neutral water temperature. Assessments will be taken pre-intervention and up to one hour following intervention cessation. A 24-hour follow up session will evaluate maintenance of acute changes over this period. Outcomes: Brain blood velocity (middle cerebral artery), brachial artery endothelial function (flow mediated dilation)\*, brain blood vessel reactivity (internal carotid artery response to changes in inspired gas)\*, blood pressure\*, plasma volume\*, neurotrophic factors (BDNF, VEGF, IGF-1)\* end-tidal carbon dioxide and cardiac function. \*These measures will also be assessed 24 hours after the initial intervention.

**RESULTS, DISCUSSION AND CONCLUSION:** As this study is part of an MSc by Research degree, what is presented in this abstract is the study proposal with the study currently being conducted. Expected results: Aquatic treadmill exercise will acutely improve brain blood velocity and vessel reactivity, neurotrophic factor expression, peripheral endothelial function, plasma (blood) volume and cardiac function compared to water immersion and exercise in isolation. It is also expected that blood pressure will decline further with greater preservation up to 24 hours after the protocol. Furthermore, the depth-modified aquatic treadmill exercise will induce additional acute improvements than the standard aquatic treadmill activity.

**Discussion and implications:** The current study will further the literature surrounding the greater benefits of combining water and exercise compared to each intervention in isolation and assess some outcomes which have to date not been explored in the aquatic treadmill exercise context. Additionally, the investigation will evaluate the feasibility of changing water depth to modulate exercise intensity and thus explore the potential to create a clinical high-intensity interval exercise-like protocol. Consequently, this newly proposed exercise modality could be developed further to enable individuals with mobility limitations to complete clinical interval exercise whilst not modifying gait speed or intensifying cardiovascular strain.

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### P15: IMPLEMENTATION CONSIDERATIONS OF AQUATIC THERAPY POST-STROKE: A QUALITATIVE STUDY

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**Keywords:** aquatic exercise, cerebrovascular disorders, implementation, qualitative

**INTRODUCTION:** The effectiveness of aquatic therapy (AT) has been extensively investigated showing positive effects on balance, mobility, muscle strength, aerobic capacity, function and quality of life in individuals who have experienced a stroke.<sup>1</sup> However, effectiveness-focused intervention studies lack essential implementation considerations for the practice of AT post-stroke, such as barriers to AT implementation and patients' needs. Therefore, we aimed to explore the implementation constructs of AT derived from qualitative interviews of persons with stroke experience and AT providers while using AT across the care continuum.

**METHODS:** We employed a deductive content analysis approach to the data we collected from semi-structured interviews. Interviews were conducted by phone or Zoom, with 23 participants (14 AT providers and 9 persons who experienced a stroke). The Consolidated Framework for Implementation Research (CFIR)<sup>2</sup> constructs were used to code our qualitative data. The Consolidated Criteria for Reporting Qualitative Research (COREQ)<sup>3</sup> was used to guide the reporting of the present study.

**RESULTS AND DISCUSSION:** Our interview data mapped onto 5 *CFIR main constructs* and 20 *CFIR organizing constructs*. Under the *Evidence Strength & Quality* subtheme (9 codes), the multidimensional benefits of AT were identified by all 23 participants, which included: the gains in walking and balance functions, "freedom of movement", the decrease in pain and hypertonicity, and the perception of feeling more secure in the water was reported. AT was also seen as an excellent medium for socialization and peer support, especially during group therapy. In the *Complexity* subtheme (7 codes), the implementation of AT in the subacute phase of stroke was seen as a barrier for lacking available skilled personnel to provide AT. In the *External policy and Incentives* (7 codes), the bundle of care, i.e. the current system of

stroke funding in Canada, does not include AT as best practice which hinders AT implementation. A perceived barrier related to *Patient Needs & Resources* (12 codes) was a lack of patient education, which is essential to optimize therapy. The cost of the intervention, the expenses around transportation, staffing and setting maintenance were also discussed as barriers within this domain. *Readiness to Implementation* (4 codes) was identified by participants' comments on the lack of best practices and the need for more specific practice guidelines for AT.

**CONCLUSION:** CFIR was useful to elucidate important implementation considerations of AT post-stroke that should be considered when designing AT interventions in the stroke care continuum, such as the complexity to implement AT in early phases of recovery and the lack of knowledge and information. AT knowledge and training are needed to AT best practices implementation for persons who experienced a stroke.

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#### **P16: THE ACUTE EFFECT OF THE BAD RAGAZ RING METHOD ON LATERAL FLEXION PATTERN ON THE INDENTION PARAMETERS OF THE THORACOLUMBAR REGION**

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**Keywords:** aquatic therapy, myofascial tissue stiffness, indentometry, tissue properties.

**INTRODUCTION:** Indentometry, namely the measurement of the mechanical properties of the myofascial tissue caused by the application of a compressive force to the underlying structures, is a recently developed non-invasive, low cost, and reliable method to evaluate tissue stiffness [1]. Among the contemporary topics included in the Bad Ragaz Ring Method (BRRM) is the exploitation of the smooth variable contractions to stimulate the tensegrity of intramuscular fascia and thus effecting fascia resilience. The purpose of the study was to examine the acute effect of a single bout of the BRRM lateral flexion pattern on the indentation parameters of the myofascial tissues at the thoracolumbar fascia region of young adult individuals with typical health against the changes made after the performance of lateral flexions executed from a standing position outside the pool.

**METHODS:** Eleven non-physical active physiotherapists and occupational therapists (7 females;  $21.5 \pm 2.3$  yrs,  $1.69 \pm 0.10$  m,  $77.1 \pm 16.8$  kg,  $26.8 \pm 3.2$  kg/m<sup>2</sup>), with no apparent health problems, were examined. The indentation parameters (applied compressive force, myofascial stiffness, and the indentation depth where the maximal myofascial stiffness occurred) were evaluated using the IndentoPro v03.04-067 indentometer (Chemnitz University of Technology, Chemnitz, Germany), set to measure at a maximal indentation of 10

mm. The average values of three measurements (5 s apart) conducted 7 cm bilaterally of the 3<sup>rd</sup> lumbar spinus process were analysed. The measures were conducted before (PRE) and after the execution of 10 lateral torso flexions from a bipedal stance (SLF) and 10 repetitions of the lateral flexion pattern (ATLF) provided by an experienced BRRM aquatic therapist. The interventions were conducted in a random counterbalanced order, with a 30-min interval. The ATFL were executed in a heated pool (32.5 °C), using typical BRRM equipment. Differences among PRE, SLF, and ATFL were tested with one-way ANOVA and Scheffe post hoc test after Bonferroni corrections, using the SPSS v.29 software (IBM Corp., Armonk, NY, USA).

**RESULTS:** The indention depth where the maximal myofascial stiffness occurred was significantly ( $F = 6.850$ ,  $p = .004$ ,  $\eta^2 = .314$ ) lower in ATLF ( $7.0 \pm 0.6$  mm) compared to PRE ( $7.9 \pm 0.8$  mm) and SLF ( $7.9 \pm 0.6$  mm). Force ( $8.5 \pm 3.7$  N,  $10.4 \pm 5.9$  N,  $6.8 \pm 3.4$  N for PRE, SLF, and ATLF, respectively) and myofascial stiffness ( $1.06 \pm 0.41$  N/mm,  $1.29 \pm 0.68$  N/mm,  $0.95 \pm 0.43$  N/mm for PRE, SLF, and ATLF, respectively) were not significantly different ( $p > .05$ ) among the testing conditions, with the relative percentage change for the latter being 2.0% between PRE and ATLF.

**DISCUSSION:** Although statistically insignificant, lower values in the examined indention parameters of the thoracolumbar fascia region were observed after the BRRM. Such trend of acute effect on the myofascial tissue stiffness is suggested to be adequate to have an impact on the nervous-system related mechanisms such as proprioception and coordination [2].

**CONCLUSION:** Further research is required to examine if the effects found in the present study can be also observed in long-term interventions, as well as the possible effect of the immersion in the water on the indention parameters of the myofascial tissues at the thoracolumbar fascia region.

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## P17: USING THE FITT PRINCIPLE TO INFORM AQUATIC THERAPY PRACTICE AFTER STROKE: A SCOPING REVIEW

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**Keywords:** aquatic exercise, cerebrovascular disorders, implementation, ICF,

**INTRODUCTION:** Aquatic therapy (AT) has shown to be an effective approach for the recovery of balance, mobility, muscle strength, aerobic capacity, function and quality of life in individuals post- stroke.<sup>1,2</sup> FITT (frequency, intensity, time and type) describes dosage and progression which is essential for AT providers to determine how effective aquatic therapy is in stroke recovery, while using the categories of the ICF allows us to translate knowledge efficiently. Existing systematic reviews on AT post-stroke have neglected to provide a more specific discussion of the intervention dose (intensity per session) or the dosage (dose x number of sessions) using FITT. Balance retraining is variable and there exists balance intensity scales.



Immersion improves blood flow therefore there is an opportunity to measure the intensity of mental work/task load. Studies do not describe their outcome measures using the International Classification of Functioning, Disability and Health (ICF). In this scoping review, we aim to report and interpret the AT interventions using FITT and the outcome measures using ICF in randomized controlled trials (RCTs) to inform AT clinical practice post-stroke.

**METHODS:** The PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines were used. Eligible RCTs evaluating AT post-stroke, identified from five databases (MEDLINE, EMBASE, PsycINFO, Cochrane Central Register of Controlled Trials, and CINAHL), were assessed by two independent reviewers. The 2<sup>nd</sup> version of Risk of Bias (ROB) was used to assess internal validity. Outcome measures were classified using the ICF framework. Intervention parameters were categorized based on the FITT principle.

**RESULTS AND DISCUSSION:** Thirty-eight RCTs were included, with over 90% of post-stroke participants in the chronic phase of recovery. Physiotherapists were the majority of professionals providing AT interventions which focused on walking, balance, stretching and endurance. Balance and gait, ICF classification d220 and d450, were the predominant outcomes, whereas only 3 studies measured sensory function and pain, ICF B298. AT interventions included Ai Chi, Halliwick, Bad Ragaz Ring Method, underwater treadmill, dynamic balance, aerobic and strengthening exercises and were described in frequency, type and time. Over 30% of the studies did not report intensity and parameters were reps/sets, %HR, RPE. There were no measures of balance intensity or mental intensity. Only 25% of studies presented low risk of bias in 4 out of 5 domains of ROB2.

**CONCLUSION:** Recent research recommends exercising at higher intensities for all conditions, but we lack the parameters based on existing post-stroke research. Intensity was poorly reported and measured in physical intensity only. Thus, there is the opportunity to measure, more holistically, the benefits of aquatic therapy by measuring the mental intensity of AT interventions. Also the use of 'Balance Intensity Scales' that reflect functional demands with graduated intensity, could enhance AT outcomes measure analysis while based in ICF concepts.

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#### P18: FEASIBILITY OF AQUATIC THERAPY FOR BALANCE IN SPINAL CORD INJURY PATIENTS WITH LESS THAN 6 MONTHS POST- INJURY

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**Keywords:** Aquatic therapy, Spinal Cord Injury, balance functional outcomes.

**INTRODUCTION:** Spinal cord injury is defined as any change in the spinal cord that may produce alterations in movement, sensation or autonomic function below the level of injury<sup>1</sup>. Aquatic therapy has been used in clinical practice for the treatment of spinal cord injury, despite the limited scientific evidence available<sup>2,3</sup>. However, there is a scarcity of studies evaluating its feasibility in balance, especially in the early stages of injury<sup>4</sup>. The objective of this study was to assess the feasibility of implementing an aquatic therapy program for incomplete spinal cord injuries with less than 6 months of post- injury to improve balance."

**METHODS:** The protocol was conducted at the National Spinal Cord Injury Hospital in Toledo, Spain. The sampling was consecutive from the waiting list of the hydrotherapy service. Individuals were included with incomplete spinal cord injury with levels between T1 and L5, with  $\leq 6$  months post injury since the injury and a prescription for aquatic therapy. The intervention was 18 sessions, 3 days per week, with a duration of 40 minutes per session with a pool depth of 1.20m. Exercise intensity was monitored using the Rating of Perceived Effort (RPE) scale The intervention was water-based exercises incorporating Water Specific Therapy<sup>5</sup> (RPE 10–11), clinical Ai-chi<sup>6</sup> (RPE 8–9) and aerobic exercise at 60% of max heart rate (RPE 13–15),<sup>7</sup> as an additional to the usual physical treatment program at the center. The outcomes measurements in the study were assessed program compliance, occurrence of adverse events, difficulties encountered by physiotherapists in implementing the intervention, self-perceived improvement in balance and lower limb strength, assessed with a Likert-type scale where the patient provides a score from “-1” to “+4” points (-1= worsening and +4= substantial improvement). The secondary outcomes were the Berg Balance Scale (BBS), Time Up and Go (TUG), and a posturography study: Romberg area with eyes open (EO), eyes closed (EC), foam with eyes open (FOEO) and foam with eyes closed (FOEC). The evaluation was conducted at the beginning and at the end of the intervention. All statistical analyses were performed by intention-to-treat, assigning the worst possible value to dropouts. Statistical significance was set at  $p < 0.05$ .

**RESULTS:** Twelve individuals with incomplete spinal cord injury were included in the study. Posturography was performed on 6 of them. 83% of the individuals completed the 18 sessions. Two individuals dropped out due to reasons unrelated to this trial. No adverse effects were reported from the program. Physiotherapists noted difficulty in achieving the prescribed effort level and maintaining standing at the beginning of the program in four individuals. The individuals perceived moderate ( $n=5$ ) and substantial ( $n=5$ ). It improved in lower limb strength and moderate ( $n=2$ ) and substantial improvement ( $n=6$ ) in balance. The mean and standard deviation post-score was in the BBS, pre:  $25.83 \pm 17.02$ ; post:  $33.67 \pm 17.98$  ( $p = 0.02$ ) and they improved 8 points; TUG, pre:  $37.30 \pm 25.48$ , post:  $30.77 \pm 25.03$  ( $p = 0.11$ ). It improved by an average of 6 seconds, but statistical significance was not reached, Two individuals couldn't perform the TUG at the start of the intervention due to an inability to maintain upright posture, but they were able to do so in the post-test. In posturography, EO, pre:  $478.67 \pm 533.70$ , post:  $341.10 \pm 253.52$  ( $p=0.11$ ); EC, pre:  $478.67 \pm 533.70$ , post:  $341.11 \pm 253.52$  ( $p=0.60$ ); FOEO, pre  $229.47 \pm 142.64$ , post:  $229.70 \pm 172.81$  ( $p=0.90$ ); FOEC, pre:  $605.13 \pm 411.69$ , post:  $814.93 \pm 782.40$  ( $p= 0.68$ ). the area EO decreased in 4 out of 6 individuals; in EC, FOEO, and FOEC decreased in 3 out of 6.

**DISCUSSION:** The compliance and adherence to the program were satisfactory, with no adverse effects. The difficulties observed by physiotherapists were addressed by using handrail to maintain balance and/or ankle weights to maintain a standing position. Individuals' satisfaction was linked to the adaptations made by physiotherapists for each individual. The improvements observed in the BBS exceeded the 5 points of Minimal Clinically Important Difference<sup>8</sup>, indicating a clinically relevant improvement. The individuals who showed improvement in BBS results were the same ones who demonstrated improvements in the posturography study.

**CONCLUSION:** The results obtained in this pilot study support the feasibility of this aquatic therapy intervention, although individual adaptations aimed at maintaining standing during the intervention are necessary. Furthermore, these preliminary data suggest that it could be beneficial in improving balance in individuals with spinal cord injury with less than 6 months post-injury. Randomized clinical trials are needed to determine the actual effectiveness of this intervention.

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#### **P19: ACUTE EFFECT OF RESISTIVE AQUATIC HIGH INTENSITY INTERVAL TRAINING AND AQUATIC HIGH-INTENSITY INTERVAL TRAINING ON METABOLIC COSTS AND PERCEIVED EFFORT IN ACTIVE ADULTS**

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**Keywords:** aquatic training, health, performance, fitness

**INTRODUCTION:** The effects of Aquatic High-Intensity Interval Training (AHIIT) and resistive AHIIT (RAHIIT) to improve metabolic health are not yet known. The objective of this study was to compare the metabolic responses and perceived effort in young healthy adults in a single session of AHIIT and RAHIIT.

**METHODS:** Twenty healthy subjects (9 females, 11 males) performed a stationary running in the water (experimental groups - AHIIT and RAHIIT) at a matched exercise intensity. The exercise included 10 x 1-minute bouts of stationary running at 90% maximum heart rate (HR<sub>max</sub>) separated by 1-minute active recovery. We applied aquatic resistance exercise with the use of devices that increase the drag force: Resistive HIIT was performed by wearing resistance boots to increase the surface area of the lower limbs. The aquatic resistive exercises must perform the movement with the resistive boots at a pace predetermined as a function of the desired number of repetitions at the desired level of effort. The metabolic and cardiorespiratory outcomes included resting energy expenditure (REE), and respiratory exchange ratio (RER) as primary outcomes, mean oxygen consumption (VO<sub>2</sub>mean), mean heart rate (HR mean), maximal oxygen consumption (VO<sub>2</sub> max), maximal heart rate (HR max), total energy expenditure (TEE), and rating of perceived exertion (RPE) are secondary outcomes. A paired t-test was used to compare the dependent variables and cadences. The level of correlations between metabolic variables was checked by Pearson's linear correlation.

**RESULTS:** The mean ages of participants in the AHIIT-DWR and LHIIT groups were 66.33 ± 4.99 and 65.68 ± 6.19 years, respectively. There were significant differences on pre and post REE within both AHIIT and RAHIIT groups (p<0.01) respectively. The subjective RPE was statistically significant (p<0.01) in the RAHIIT group when compared to AHIIT group. A moderate correlation found on RER and RPE in RAHIIT (r= 0.534). There were no significant differences between both groups in terms of HR max, HR mean, VO<sub>2</sub> max and TEE (p=0.578, p=0.615, p=0.449, p=0.782).

**DISCUSSION:** Both AHIIT and RAHIIT result in significant differences in RPE, while showing no significant differences in other metabolic and cardiorespiratory responses such as HR max, HR mean, VO<sub>2</sub>max, and TEE. Since lower exertion level was perceived in AHIIT compared to RAHIIT at the same exercise intensity, AHIIT can be preferred as a training program to enhance participants' exercise compliance and overall health. This finding also suggests that instead of progressing subjects with a resistive component in a water-based environment, the focus could be on monitoring subjects' RPE and maintaining appropriate heart rates during AHIIT.

**CONCLUSION:** RAHIIT provides comparable health benefits of metabolic outcomes with AHIIT. The addition of a resistive component to AHIIT can yield comparable results to using water's drag force as the sole medium for resistance in AHIIT. AHIIT still offers cardiometabolic benefits when compared to RAHIIT.

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## **P20: DUAL MEDIA KINEMATIC ANALYSIS FOR SHOULDER MOVEMENT ON DEEP WATER EXERCISES**

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**Keywords:** aquatic exercises; upper limb abduction; under water; above water.

**INTRODUCTION:** It is common that physiotherapists' decisions are based on their practical knowledge through analysing the patients' responses to different activities. Physiotherapists usually choose deep-water movements to achieve improvement of trunk activity, which may offer an option to better motor control of the limbs (Kanitz et al., 2015). The use of a sensitive smoothness measure (S. Balasubramanian, Melendez-Calderon, & Burdet, 2012), related with time spent, range of motion in the maximum speed performance of the exercises, looking for the changes in movement, including the intermittency, can give new understanding of aquatic movements.

**OBJECTIVE:** The aim of our study was to compare the performance of shoulder movements supported by different buoyancy devices usually used for deep-water activities.

**METHODS:** A sample of 10 healthy right-handed and experienced participants (five men and five women, age 30.1±9.4 years, BMI 21.8±2.8), in deep water pool, performed shoulder abduction at maximum speed in three conditions: no aided buoyancy, pool noodle and buoyancy belt. Movements of the endpoint of the third finger of both right and left arm were captured using the Qualisys System. The variables were range of motion (ROM), maximum angle, angular velocity and linear velocity, which were used to calculate the coefficient of smoothness. T-test for repeated measures or Wilcoxon Test by SPSS version 24.0 (SPSS Inc., Chicago, IL, USA) with  $\alpha = 0.05$ .

**RESULTS and DISCUSSION:** Results for range of motion and peak velocity indicate that buoyancy belt was significant for shoulder abduction resulting in a significant range of motion between dominant and non-dominant upper limbs for the different phases of movements above and below water. Smoothness coefficient using the spectral arc length metric (SPARC) have a normative score around -1.6 in dryland tasks. Our study obtained a lower mean value for this variable during shoulder abduction in the frontal plane for the dominant upper limb with the pool noodle (-1.77±0.20).

**CONCLUSION:** Through the comparison of dominant with non-dominant upper limbs, we can suggest the range of motion and smoothness was related to aided buoyancy. This findings could be related to stability, as pointed out in the differences between the pool noodle and the buoyancy belt.

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**P21: INFLUENCE OF AQUATIC THERAPY ON FUNCTIONAL ABILITIES POST SUB-ACUTE PONTINE STROKE - A CASE STUDY**

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**Keywords:** hemiparesis, aquatic exercise, strengthening, activities of daily living.

**INTRODUCTION:** Pons is the foremost operating part of the brain with various nuclei and tracts. 5- 10% of intracerebral haemorrhage cause pontine stroke with 48.1 % mortality and remaining have poor prognosis. It causes disruption in major functioning and mobility. <sup>(1)</sup> Aquatic therapy may have additional rehabilitative potential due to the physical properties and it may be an adjunct to land therapy. <sup>(2)</sup>

**METHODS:** Participant aged 74 years with sub-acute left sided hemiplegia. The client presented with upper limb strength deficit, grip strength affection, loss of balance, impaired gait and affection of truncal strength and proprioception causing a lot of dependency on the caregivers for ADL's. The sessions consisted of aquatic therapy for 40 min, 3 days/ week and land-based therapy for 1 hour, 3 days/week. The aquatic therapy consisted of Halliwick techniques, Bad-Ragaz ring method, Water specific therapy, Ai Chi and the physiotherapy sessions included neuromuscular re-education, functional training, strengthening, gait training. Game-based mobility trainer and ADL trainer were also used. The protocol was carried out for 24 sessions each. Outcome measures used were Stroke impact scale-16, Bergs Balance Scale and Barthel Index. The assessment was done on day 1 and post 48 sessions (2 months).

**RESULTS:** There was a significant change in client's functional abilities and had improved on his ADL's. The stroke impact scale-16 showed a change from 32 to 61. Berg's balance showed a significant change from 5 to 39. Increase in balance score indicates that there was an improvement in sitting and standing balance. Barthel Index showed a change from 55 to 95. The client improved on his dressing, grooming and transfer skills. No adverse effects were observed during the interventions.

**DISCUSSION:** In this case study aquatic therapy worked as an adjunct to maximise the benefits of land based therapy. According to Tripp et al that Halliwick therapy may enhance motor relearning which may have resulted in improved BBS suggesting improvement in postural control and balance. <sup>(3)</sup> BRRM technique works on improving the muscle activation which may have helped our client in improving the functional movements and overall increased his ADL activity. <sup>(4)</sup>

**CONCLUSION:** Aquatic therapy demonstrated beneficial changes in functional independence and may be considered as an adjunct treatment approach for patient's suffering a sub-acute pontine stroke. Further studies with more participants can be considered.

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**P22: EFFECTS OF DETRAINING AND TRAINING ON BALANCE PERFORMANCE, STRENGTH, AND PAIN IN OLDER ADULT USERS OF AQUATIC PHYSIOTHERAPY**

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**Keywords:** efficacy; long-term; aquatic intervention; outcomes.

**INTRODUCTION:** Aquatic physiotherapy (AP) research needs to provide deeper knowledge about the effects of detraining and training on balance, strength and functional reach related to upper limb disability. Avelar et al. (2018) shows significant improvements on balance through AP. Some recent clinical evidence from Adsett J. et al. (2017) showed improvements in functional tests, studied using different strategies in patients suffering from chronic pathologies, influencing quality of life (QoL). What happen on functional performance?

**OBJECTIVE:** The aim of this study was to analyse the effects of detraining (two months) and training (six weeks) in aquatic therapy programs on the functional outcomes of older adults with upper limb disability.

**METHODS:** A aquatic physiotherapy program (APP) in a sports pool. All participants with self-reported shoulder and hand disability with positive scores were assessed for functional and perceptual (with biofeedback) test outcomes after the intervention. Participants into two groups: complete follow-up (CFU) and partial follow-up (PFU). Measured time-points were: M1 (at the end of the APP), M2 (at the start of the APP) and M3 (after six weeks of APP performance). The variables used were the results of the visual analogic scale (VAS), step test (ST), functional reach test (FRT) and global balance standing test (GBST). Normal distribution of the variables was shown by repeated measures ANOVA.

**RESULTS and DISCUSSION:** The baselines of the CPU and PFU groups showed no significant differences ( $p>0.05$ ). The CFU group showed loss as detraining effects after summer stoppage with significance only for ST. For training program outcomes gives gains for

all variables in both groups, with significance for ST and GBST in CPU group. Comparison of training on time effect and clinically changing effects showed gains for all variables except ST for PFU. Some studies confirmed a negative impact of the lack of training in fitness and QoL. On other hand, our training program got validity by evidence. Our minor sample is a limitation.

**CONCLUSION:** The study suggests that PT has impact on the balance and pain symptoms of older adults with upper limb disability. Through the detraining effects, we can question the lower impact of activities of daily living in summer stoppage.

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**P23: THE EFFECTIVENESS OF AQUATIC EXERCISES ON FUNCTIONAL MOBILITY AND MOTOR IMPAIRMENTS IN PATIENTS WITH PARKINSON'S DISEASE: A SYSTEMATIC REVIEW.**

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**Keywords:** Aquatic therapy, Parkinson's disease, functional mobility, motor impairment.

**INTRODUCTION:** Parkinson's disease, a neurodegenerative disorder, is characterized by motor impairments and reduced functional mobility. While aquatic exercises have shown promise as a therapeutic intervention, their effectiveness remains uncertain. This systematic review aims to evaluate the impact of aquatic exercises on functional mobility and motor impairments in PD patients, focusing on studies published after 2017. It builds upon previous systematic reviews, including Pinto et al., 2019, by providing updated insights. Unlike recent reviews covering broader PD variables, this review specifically examines the outcomes of functional mobility and motor impairments following aquatic exercise interventions.

**METHODS:** A comprehensive search strategy was employed across multiple databases, including MEDLINE, SCOPUS, PEDro, CINAHL, and Cochrane until 27 October 2023. Research papers with a focus on the outcomes of functional mobility and/or motor impairments in PD patients undergoing active therapeutic aquatic exercises were included. Randomized controlled trials and quasi-experimental studies were assessed for methodological quality using the PEDro scale and JBI checklist, respectively.

**RESULTS:** The initial electronic search identified 223 research papers, from which 162 records were screened after the removal of duplicates. Among these, 6 records met the inclusion criteria, and data was extracted for analysis. The methodological quality of the evidence was high, with PEDro scores of 7 for three studies and 6 for the fourth study. Additionally, the two quasi-experimental studies were appraised as high quality, with scores of 7/9 and 9/9 according to the JBI critical appraisal checklist. The total sample size across the 6 studies was 181 patients, with a predominance of male participants and a small sample size in each study. The intervention durations ranged from 4 to 16 weeks, with session frequencies varying from



2 to 5 times per week. Most studies, maintained therapy pool temperatures between 30 to 34 degrees Celsius, considered optimal for facilitating movement in patients with PD.

**DISCUSSION and CONCLUSION:** Therapeutic aquatic exercises appear to improve functional mobility in PD patients, with no significant changes in motor impairments. Further standardized and long-term research is needed to establish their most effective application. Future studies should address the limitations identified in this review and consider the economic implications of aquatic therapy.

**CLINICAL IMPLICATIONS:** Clinicians should consider aquatic therapy with Parkinson's patients as a safe intervention to improve functional mobility as well as reduce risk of falls. Practical considerations such as specialized pool settings and warm water can make aquatic therapy costly and less accessible. The argument to include aquatic therapy as a subject in the curriculum is recommended for future.

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#### **P24: DEVELOPMENT AND FEASIBILITY OF A SWIMMING PROGRAMME AS A REHABILITATION MODALITY FOR PEOPLE WITH CHRONIC LOW BACK PAIN: A MIXED METHODS PROJECT**

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**Keywords:** Chronic Low Back Pain, Rehabilitation, Swimming

**INTRODUCTION:** Chronic low back pain (CLBP) is a complex multidimensional condition impacting physical activity, function, quality of life and health. Swimming is often advised by health professionals to people with CLBP<sup>1</sup>, there are however several uncertainties and limited research supporting this recommendation.<sup>2,3</sup> Unlike other forms of exercise recommended for CLBP, swimming is a more complex skill to learn and master<sup>4</sup>. There are currently no published frameworks or guidelines for using swimming as a rehabilitation modality for people with CLBP. This mixed methods multiphase project aimed to develop and test the feasibility of a swimming programme as a rehabilitation modality for people with CLBP.

**METHODS:** In the first phase of the project exploratory research was undertaken to understand common determinants impacting swimming uptake and engagement and to explore the experience of people who use swimming to manage CLBP. The findings from these studies were combined with data collected from people with CLBP, physiotherapists and swimming professionals in a modified Delphi study, leading to the development of a swimming programme. All aspects of the programme were considered, including the setup, pre-programme information, delivery, teaching approaches, session brief, warmup, cooldown, core aquatic skills, swimming strokes and strategies to enable regular swimming. The final study evaluated the feasibility of the newly developed swimming programme as a rehabilitation modality and the trial procedures.

**RESULTS:** The consensus amongst stakeholders in the Delphi study was that the programme could be delivered jointly by a physiotherapist and swimming professional. The programme would include the teaching of core aquatic skills and front crawl, backstroke, and breaststroke. The sessions would utilise a problem solving and kinaesthetic teaching approach, tailoring the sessions for different subgroups of back pain, ensuring the sessions were fun, enabling people to be more physically active and would include strategies to enable ongoing use of swimming. The findings from the feasibility study indicated that the swimming programme was a feasible and safe rehabilitation modality for people with CLBP, enabling physiotherapists and swimming professionals to collaboratively deliver rehabilitation and pain education in the community.

**CONCLUSION:** Future work will refine the swimming programme and implementation strategies incorporating feedback from service users and stakeholders. Conducting an RCT to measure outcomes, impact and cost-effectiveness compared to usual care would provide robust evidence to support the efficacy of this intervention. Furthermore, exploratory research could help identify specific subgroups of the CLBP population who could benefit from this intervention, understand the underlying mechanisms for its effectiveness and determine the most suitable context for implementation.

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