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Effects of aquatic therapy in children diagnosed with cerebral palsy

Literature review

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One of the most prevalent childhood condition cerebral palsy is a result of brain injury. Movement and coordination of the individual are primarily affected in this condition. There are many types of treatment for this condition since management is the goal without a primary solution. Physical therapy aids in various ways as it helps maintain physical abilities and helps improve the condition. An intervention commonly used in physical therapy to aid the condition of cerebral palsy is aquatic therapy.

This literature review focuses on the role aquatic physical therapy plays in cerebral palsy as a form of management in children.

This thesis was subjected to the method of a literature review by following the principles of a systemic search. The databases used were PubMed, ScienceDirect, CINHAL, and manual search.

The results showed that aquatic physical therapy proved beneficial among children with cerebral palsy in many aspects like movement and coordination. It helped reduce the stiffness of muscles and the buoyancy effect of water aided in the free movement of those that suffered from spasticity due to the condition. Those who underwent aquatic physical therapy as a form of management for cerebral palsy showed greater balancing reactions and motor gains associated with truck control and head control compared to before aquatic therapy. In a few studies, children who received aquatic therapy combined with SUPAT (Stand-up paddle boarding aquatic therapy) exhibited physical, emotional, and mental benefits.

Data searches for this bachelor's thesis revealed that aquatic therapy showed gains in various features of the physical abilities of children who were subjected to cerebral palsy.

Key Words	Aquatic therapy, Cerebral palsy, Pediatrics

Contents

1 Introduction

Cerebral palsy is a brain condition that affects movement and coordination. It is feasible to be developed before, during, or after birth. (National Health Service, 2019.) An injury during the developmental stage of the brain amidst the prenatal to neonatal period is the underlying pathophysiology (Graham et al., 2016). Two main risk factors are premature birth and low birth weight (Michael-Asalu, Taylor, Campbell, Lelea & Kirby, 2019). 2–3 per 1,000 live births is the incidence rate of cerebral palsy (Patel, Neelakantan, Pandher & Merrick, 2020). In childhood, cerebral palsy is one of the most prevalent physical conditions that can affect daily activities and involvement (Rosenbaum et al., 2007).

As a consequence of cerebral palsy children diagnosed tend to develop other disorders that may affect their functional abilities, even while the underlying neuropathologic injury is non-progressive (N.G.A 2017). A prevalently used supportive treatment for children with neuromotor impairments, particularly cerebral palsy, is aquatic therapy or water intervention (Getz et al.,2006). A systematic study by Blohm concluded that aquatic interventions either as a stand-alone intervention or a major component benefit children and adolescents (Blohm, 2011). Aquatic therapy as a part of physical therapy was believed to be advantageous because it created an enjoyable and inspiring kind of physical activity that enhances the physical, social, and emotional welfare of children subjected to cerebral palsy (Gorter & Currie, 2011). A recurring conclusion was the insufficiency of evidence-based studies that document the benefits of aquatic therapy (Declerck, 2010).

This bachelor’s thesis aims to pin down the possible effects on children undergoing aquatic therapy for the management of cerebral palsy. It also elaborates on the impact aquatic therapy can have as an intervention.

2 Background

Upon being diagnosed with cerebral palsy children often project weakened endurance, balance, and strength (Walz, Doran, Potter, & Chen, 2022). It is common for cerebral palsy to be associated with secondary disorders like seizures, difficulty in

communication, disturbances of sensation, and behavioral and cognition-related disorders. (Patel, Neelakantan, Pandher, & Merrick, 2020).

The categorization of cerebral palsy is based on the type of movement disorder, topography, and scope of motor dysfunction. Movement disorders can be described as spastic, dyskinetic, ataxic, and mixed. (Sanger, Delgado, Gaebler-Spira, Hallet & Mink, 2003.)

2.1 Classification of cerebral palsy

2.1.1 Spastic cerebral palsy

An impairment in the motor cortex is the root cause of spasticity. It is the typical neurological abnormality among children recognized to have cerebral palsy. The method used widely to evaluate spasticity is the modified Ashworth Scale (MAS). (Tecklin, 2013.) Spasticity is a motor abnormality, which causes impediments to passive movements. (Rethlefsen, Ryan & Kay, 2010). Spasticity causes histological changes such as decreased muscle growth, volume, unit size, and fiber type (Miller, 2005). Secondary disorders such as hip dislocation, scoliosis, knee contracture, and torsional malalignment of the femur and tibia can be brought on by the muscular alterations associated with spasticity. These modifications may significantly impact everyday life activities and gait patterns. (Tecklin, 2013.)

2.1.2 Dyskinetic cerebral palsy

Dyskinesia is a response to an injury of the basal ganglia. Atypical posture patterns and impulsive, unrestricted, recurrent, and at times stereotypical motions of the involved body parts are examples of dyskinetic characteristics. There are two further subtypes of dyskinetic cerebral palsy: dystonic and athetotic. Dystonia or dystonic movement is often characterized by spontaneous but sustained or irregular muscle contraction with repeated movements and atypical posture. Sluggish, regular, writhing movements that suppress a stable posture are defined as athetosis. Campbell, Palisano & Orlin, 2014.)

2.1.3 Ataxic cerebral palsy

Ataxia is the failure to initiate intended or typical voluntary movements that are not due to muscular weakness or involuntary muscle activation around affected joints but rather

is the result of a cerebellar lesion (Sanger, Delgado, Gaebler-Spira, Hallet & Mink, 2003). It causes general instability, irregular postural patterns, and a lack of coordinated, rhythmic, and precise movement (Cans, 2000).

2.1.4 Mixed cerebral palsy

The symptoms of mixed cerebral palsy can include spasticity and dyskinesia (Cans, 2000).

2.2 Physical therapy and cerebral palsy

Cerebral palsy is categorized as a dynamic disability so physical activities and exercises can help children with the disease enhance their physical well-being. Children with cerebral palsy are often rehabilitated and managed through functional task-oriented training strengthening, stretching, and balance training. (Franki et al., 2012.) Despite the widespread use of these exercises, conflicts have been reported about difficulties with their implementation. According to a survey conducted in Canada among parents of children with cerebral palsy stretching was identified as the most painful form of exercise. (Hadden & von Baeyer, 2002.)

Physical therapy rehabilitation aims to enhance the standard of life for children and families going through the journey of cerebral palsy. It is common for these children to be unable to attend ordinary schools and they require schools that can aid their specific and unique needs. Physical therapists can help by advocating, educating, and supporting them. (Bourke, Cotter, Lalor & Johnson, 2018.) Therapists must address physical, and societal challenges to minimize the illness's possible adverse effect on participation levels (Mei et al., 2015).

Aquatic therapy is an intervention in physical therapy used in managing and improving the condition of cerebral palsy in children (Khalaji, Kalantari, Shafiee, & Hosseini, 2017). Children who cannot perform certain activities on land can now do them with increased comfort owing to the nature of the water which produces a buoyancy effect, as it equips an antigravity positioning, diminishes the weight, and weakens the compressive forces on joints. This may be attributed to the positive and significant improvement attained through aquatic therapy. (Kelly & Darrah, 2005.) Water's hydrostatic pressure effects reduce muscular spasticity, increase endurance to

multisensory stimuli, and increase blood circulation (Franzen & Tryniszewski, 2013). Water's thermal properties aid in the reduction of pain and spasticity while the mechanical features include weakening gravity at the joint level which in return will reduce the loading at the joint, as well as aid in muscular strength and support the posture in water (Naidoo & Ballington, 2018).

A frequent supportive therapy for children who have neuromotor impairments, particularly cerebral palsy, is aquatic intervention (Getz, Hutzler & Vermeer, 2006). Aquatic therapy caters to a secure and advantageous less impactful alternative physical therapy for children with impairments (Fragala-Pinkham, Haley & O'Neil, 2008). Studies recorded that aquatic therapy was a valuable aid for cerebral palsy among children in managing their symptoms (Chrysagis, Douka, Nikopoulos, Apostolopoulou & Koutsouki, 2009; Akinola, Gbiri & Odebiyi, 2019; Bohlm, 2011).

A study conducted to understand the result of an aquatic therapy program carried out for 10 weeks among children subjected to cerebral palsy showed a momentous enhancement in movements like lying down and rotating, sitting, crawling, and kneeling. The difference did not become apparent until the 10th week of treatment. In this study, the exercise regimen was properly assembled, and adhered to produce the desired results. (Akinola, Gbiri & Odebiyi, 2019.)

An essential part of functional activities is balance control which generally is found impaired in the condition of cerebral palsy due to a lack of stability while performing functional movements. Children having a level III on the GMFCS (Gross Motor Function Classification System) due to cerebral palsy, showed enhancement in gross motor function, gait speed, balance, and quality of life post aquatic physiotherapy. (Da Silva, De Goes, Braga, Oliveira, Magalhães & Oliveira, 2018.)

A common symptom of cerebral palsy is spasticity which is also the root cause of many issues as it impairs activity and aggravates musculoskeletal issues (Flett, 2003). Spasticity comes from a pathological deficit of inhibitory control of upper motor neurons which increases muscle tone and hyperactive reflexes (Scheker, Chesher & Ramirez, 1999). Reduced spasticity and improved motor control are required for the functional performance of children who have cerebral palsy (Dimitrijević, Aleksandrović, Madić, Okičić, Radovanović & Daly, 2012). A clinical controlled review conducted among thirty children of the age range 1-12 years in Nigeria undergoing rehabilitation for a spastic

form of cerebral palsy went through an intervention to explore the validity of aquatic exercises in inhibiting spasticity. The study showed the efficiency of aquatic exercises in diminishing spasticity and stated it to be a valuable form of treatment when the upper and lower extremities are affected. (Bolarinwa, 2021.) Posture-related deficiencies are among the typical ailment causes in children with cerebral palsy, limiting their interest and involvement (Akbarfahimi et al., 2016).

A study on aquatic therapy and its effects on motor function, pleasure, day-to-day activities, and wellness of life in a group of children diagnosed with cerebral palsy concluded that at the end of treatment, those that underwent aquatic therapy exhibited higher scores on the Physical Activity Enjoyment Scale when compared to the control group. (Lai, Liu, Yang, Chen, Wu & Chan, 2015).

3 Aim and Methods

3.1 Aim

The literature review aims to focus on identifying the effect of aquatic therapy on children with cerebral palsy. They will help further carry out aquatic therapy as a means of treatment and management for cerebral palsy.

3.2 Search Strategy

3.2.1 Data Collection

The search strategy used in this thesis was systemic search. The searches were conducted on databases; Science Direct, PubMed, CINHAL complete and manual search. This thesis was done on studies filtered between the years 2015 and 2023. This was done to ensure that the latest publications associated with the effects of aquatic therapy on children are included. Table 1 includes the exclusion and inclusion criteria. This thesis only incorporated studies published in English by origin to avoid inaccuracies in understanding the studies and to eliminate errors. The words were entered in the following format in the databases: (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric)).

The search process conducted in Science Direct showed results of fifty-eight articles using the search words (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric)) which was further filtered using article type and subject areas. The article types chosen were research articles and review articles. The subject areas chosen were Medicine and Dentistry, Neuroscience, and Nursing health professionals which resulted in twenty-one articles that then were filtered based on study headline, and irrelevant articles were excluded.

The search process in CINHAL using the search words (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric)) resulted in eleven articles.

The search process in PubMed only resulted in one article with the search words (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric)).

Manual Search had a result of nine articles with the search words (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric)).

3.2.2 Inclusion and exclusion criteria

The implementation of inclusion and exclusion criteria was done in the data collection process to sustain the quality and standard of the literature review.

Table 1. The following criteria were implemented for the data collection process

	Inclusion criteria	**Exclusion criteria**
The year of publication	Succeeding the year 2015	Prior to the year 2015
Publication language	Studies originally published in English	Translated studies or studies published in other languages
Method	All types of study methods in articles	Irrelevant articles

Contents	Children with cerebral palsy, aquatic therapy intervention.	Articles that are not related to cerebral palsy and aquatic therapy

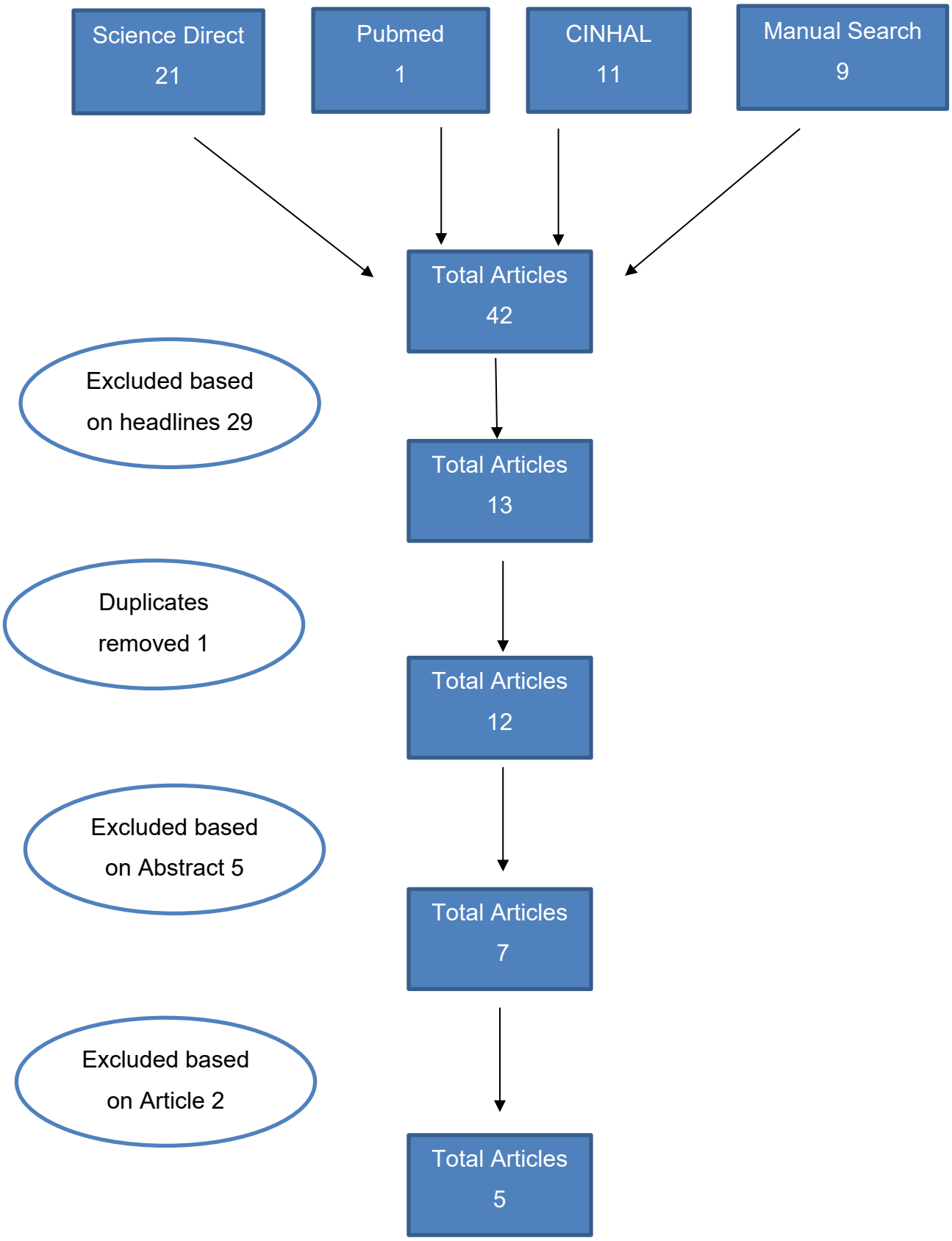

Figure 1. The flow diagram of the search process

Figure 1 The search process followed in this literature review is represented in Figure 1. This literature review was carried out utilizing the following databases: PubMed, ScienceDirect, CINHAL, and manual search. The finalized articles were refined on the basis of topic, abstract, and duplicates. Only five articles were selected to be qualified for this bachelor's thesis.

Search words - (("aquatic therapy") OR (hydrotherapy)) AND (("cerebral palsy") OR (CP)) AND ((pediatrics) OR (paediatric))

4 Results

Five articles were finalized for this literature review after a comprehensive review.

Table 2. Findings and Conclusion of finalized articles

Authors and year	Objective of research	Methods	Subjects	Procedure	Results and conclusion
Kakihata et al., 2018	Assessing the outcome of an aquatic therapy plan of action for trunk control in children subjected to cerebral palsy	Randomized clinical pilot trial	Twenty-four children aged between 4 to 10 years with a diagnosis of spastic diplegic cerebral palsy with a classification of level IV on the Gross motor function classification system	Children in the intervention group underwent treatment using an aquatic trunk regimen twice weekly (with at least one day between sessions) for eight weeks in a pool set at 33°C. Each session lasted 35 minutes.	In comparison to the control group, patients in the intervention group displayed a 30% greater balancing reaction. After receiving aquatic physiotherapy, children with level IV spastic diplegia type of cerebral palsy demonstrated motor gains associated with trunk control and functionality.
Walz, Doran, Potter & Chen, 2022	This study explored the efficacy of SUPAT (Stand up paddle	Case study	Two adolescent girls with a diagnosis of spastic cerebral	Participants went through seven 1-hour SUPAT treatments	According to this study, the SUPAT program helped

	boarding aquatic therapy) in improving gross motor skills while reducing the risk of falling in two adolescents with a diagnosis of spastic cerebral palsy.		palsy were classified as level II by the Gross Motor Function Classification System (GMFCS).	over ten weeks. The lessons covered a range of paddle-boarding techniques and a 10-minute warm-up.	pediatric cerebral palsy patients.
Ennis et al.,2018	The research's objective was to explore the influence on core strength, balance, gait speed, and standard of living in children subjected to cerebral palsy (GMFCS Levels II and III) and spina bifida (level L3 or below) after aquatic therapy.	Case study	Three children, among which two had a diagnosis of cerebral palsy and one with spina bifida participated.	Participants followed a 45 min session once a week for 7 weeks. Exercises were personalized to ensure a boost in main muscle durability, gait pace, stability, and complete function, based on initial examination findings.	All participants improved core strength and gait speed.

Roostaei, Baharlouei, Azadi & Fragala-Pinkham, 2016	Reviewing the literature on aquatic therapy intervention for children with a diagnosis of cerebral palsy and its impact on motor skills.	A Systematic study with Meta-analysis	This systematic review included 11 articles.	A comprehensive search of the English-language literature from the initiation of the review to January 2016 was done in PubMed, Web of Science, Scopus, PEDro, Google Scholar, and ProQuest.	Six out of 11 studies found progress in walking speed or distance, while two studies found significant improvements in standing, walking, sit-to-stand transfers, and running. A particular study disclosed a reduction in timed up-and-go (TUG) scores and another revealed no significant changes in PEDI (pediatric evaluation of disability inventory) scores.
Mostafa, El-Negmy, El-Maksoud, AbdAl-Rahman & Srour, 2021	The study focused on reviewing the effects on children with regards to functional movement and head control when subjected to aquatic therapy exercises as a	An experimental study	Twenty-nine children aged between 2-6 years with a cerebral palsy diagnosis	Control group (A) was assigned fifteen children on no particular basis, and they received exercises on land for head control, while another fourteen were assigned to the study	It was concluded that aquatic therapy as an intervention showed improvement in functional movement and head control.

	form of management for cerebral palsy.			group (B) and received water-based exercises. Pre-treatment and three-month evaluations were conducted, measuring functional movement and head control functional recovery utilizing GMFM (Gross Motor Function Measure) along with VEMP (Vestibular Evoked Myogenic Potential).	

All five selected studies presented in this literature review concluded that aquatic therapy does show an effective influence on cerebral palsy in children.

Kakihata et al., 2018; carried out a randomized control trial on two pediatric groups with cerebral palsy that underwent varying forms of aquatic therapy. The intervention group followed a specific protocol for exercising their trunk in the water, while the control group received general aquatic physiotherapy with exercises that did not specifically target the trunk. Both sets of participants underwent 16 private pool sessions at a temperature of 33°C, spanning 35 minutes each, spanning two sessions every week (with a minimum of one day in between), for eight uninterrupted weeks. The data for both groups were collected before and after the intervention, and standardized outcomes were used to evaluate the groups. These included the Trunk Control Measurement Scale (TCMS), Pediatric Reach Test (PRT), Surface Electromyography (EMG) readings for the rectus abdominis and latissimus dorsi muscles, seated pressure points mapping, and Wells' Flexometer. The intervention group in aquatic therapy showed a 30% improvement in balance reaction compared to the control group. Pressure mapping showed decreased lower limb pressure in the intervention group. There was an overall improvement in posterior chain flexibility and lower limb movements in both groups. The trial concluded aquatic physiotherapy for spastic diplegic cerebral palsy in children improved trunk control and enhanced performance. (Kakihata et al., 2018.)

Walz, Doran, Potter & Chen, 2022; conducted a study on stand-up paddle-boarding aquatic therapy as a form of intervention among children that were diagnosed with cerebral palsy. Over 10 weeks seven sessions were conducted, and participants attended an hour of SUPAT (Stand up Paddle-boarding aquatic therapy) sessions using a Hooch Craft SUP (Standup Paddleboarding) board under the watch of a physiotherapist and a student physiotherapist. These specific sessions consisted of a warm-up for ten minutes, a trial, and 35-40 minutes of tailored procedural interventions. Additionally, before and following therapy, the participants were surveyed to evaluate their motivation and satisfaction. The GMFM (Gross Motor Function Measure) apparatus was used to evaluate the participant's gross motor functional skills with regard to strength and stability post and pre-SUPAT (Stand up Paddle-boarding aquatic therapy) intervention. Trial runs measured time in an upright position and paddling skill, and falls were reported by parents and participants. Weekly sessions reported trial runs, amount of assistance and cueing, and skills performed in daily notes.

Participant 1 showed an improvement of 2.5% on the GMFM (Gross Motor Function Measure) scores when compared to before and after the intervention. She also exhibited an increase in the trial run period from one minute and twenty-four seconds at the beginning to six minutes and fourteen seconds towards the end of the program. Significant abilities acquired throughout the SUPAT (Stand Up Paddleboarding Aquatic Therapy) intervention includes making independent transitions on and off the surfboard, shifting from a lying face-down position to high kneeling to standing on the board unassisted, and paddling in open water against stronger winds. Observations included improved overall posture and a reduction in falls into the water, and increased confidence and motivation. The participant's mother reported a reduction in falls to just 2-3 times a week post-SUPAT (Stand Up Paddleboarding Aquatic Therapy) whereas the rate of falls before was 5-6 times a week. Participant 2 increased GMFM (Gross Motor Function Measure) scores from 96%-99%, with the trial run period increasing from one minute and twelve seconds to three minutes and seven seconds. They achieved their longest trial run (5 minutes 56 seconds) and gained various skills, such as independently transitioning from prone to standing, paddling 8 strokes, and paddling for 35 minutes without balance loss. SUPAT (Stand Up Paddleboarding Aquatic Therapy) was successful in improving gross motor function, balance, and reducing falls according to GMFM (Gross Motor Function Measure) and reports made by parents and participants. These case studies suggested SUPAT (Stand Up Paddleboarding Aquatic Therapy) is a pioneering approach to aquatic therapy for cerebral palsy that improves gross motor skills and reduces fall risk. It can be utilized as a curative tool to fill the space between conventional treatments and offer an enjoyable, distinctive method of pediatric aquatic therapy. (Walz, Doran, Potter & Chen, 2022.)

Ennis et al.,2018; conducted a 7-week aquatic therapy program held in an ultraviolet-filtered, salt-water pool, supervised by licensed physical therapists and physical therapy students. The pool was 4 feet deep with an 18-inch bench and zero-depth entry ramp. A lifeguard was always on duty and each child had a different dyad of students working with them. Aquatic interventions were tailored to the individual needs and preferences of each participant, taking into account their ages, functional limitations, likes/dislikes, and goals. They were designed specifically to address noted issues and movement limitations from the pretesting period and were carried out over the next 6 weeks. Children were supervised and supported by physiotherapy students or physiotherapists while performing seated core activities on float mats or kickboards,

challenging core muscles, and balancing issues. The intensity of activities was based on tolerance and usually lasted 45-60 min each week. Pretest data measurement was conducted in a room near the pool, including the sit-up test, Pediatric Balance Scale, and 10-meter walk test. Parents or guardians of the children filled out the PedsQL Neuro Muscular Module survey according to the age of the participant. (Ennis et al.,2018.)

All participants significantly improved core strength, and walking speed. Participant One, with a diagnosis of spastic diplegic cerebral palsy, GMFCS (Gross Motor Function Classification System) level II, showed significant improvements across physical, mental, and emotional aspects of life as a result of aquatic therapy. This participant showed improved dynamic balance and activity engagement after completing an intervention and was capable of doing 8 additional sit-ups in the time of post-testing in comparison to pretesting. Participant Two responded positively to the treatment, upon observation each week. An increase in independence was recognized, requiring less cueing during activities. Participant Three was engaged and enthusiastic during the treatment session and showed increased endurance and improved core strength. Results revealed all participants showed enhancement in core strength and walking speed, a boost in the MCID (Minimally clinically important difference) level on the Pediatric Balance Scale. This suggests aquatics can be an advantageous method for improving core strength, balance, and gait speed, though there were varying amounts of improvement for each child. Using the properties of water for activities like balance and gait could improve participation in children with neurological disorders with their neurotypical peers, according to the ICF (International Classification of Functioning). (Ennis et al.,2018.)

Roostaei, Baharlouei, Azadi & Fragala-Pinkham, 2016; through a systemic review gathered information showed the following: Three of the six studies that examined walking distance or speed in this review's 11 total studies found that walking distance or speed had significantly increased. Following the aquatic intervention, two trials found improvements in standing up, sit-to-stand transfers, gait, and running abilities, with clinically significant changes in COMPS (Canadian Occupational Performance Measure). Following the aquatic intervention, a study revealed no notable change in PEDI (Pediatric Evaluation of Disability) scores while another indicated a remarkable decline in timed up-and-go (TUG) scores. These studies suggest that aquatic therapy is a reasonable treatment with negligible adverse effects for children, yet further study

is needed to better understand dosing parameters. (Roostaei, Baharlouei, Azadi & Fragala-Pinkham, 2016.)

Mostafa, El-Negmy, El-Maksoud, AbdAl-Rahman & Srour, 2021; conducted a study on thirty-nine pediatric cerebral palsy cases and they were examined to choose the twenty-nine participants in this study, who ranged from age of 2 to 6 years and included children of both sexes. Exercise on land and in the water were both practiced at the Alnour Children's Hospital in Sohag City. Participants were grouped into two of the same size at random: 15 children in the control group (A) have been given specially tailored land-based head control exercises. Study group (B): Fourteen underwent specially crafted head control exercises in the water. Pre-treatment and three months after beginning the treatment program, the participants underwent detailed evaluations at various intervals. Using GMFM (Gross Motor Functional Measure) and VEMP (Vestibular Evoked Myogenic Potential), head control and movement functional recovery were evaluated. The Group B children of the study obtained aquatic therapy exercises for head control from prone and supine postures, such as elevating one or both upper limbs, playing with toys, and performing righting reaction exercises horizontally and sideways. Participants of control Group A received various land-based exercises including those in the prone, supine, and in-ring sitting positions. Exercises were also focused on head elevations, toy reaches with one or both hands, and righting reaction exercises. Both groups received gentle stretching for the limbs. The Research concluded that pediatric cerebral palsy cases frequently have postural control problems, movement constraints, and buoyancy of the water aids the children in performing exercise at a high intensity which helps attain their significant therapeutic goals. In this study, aquatic exercise is suggested as an alternative therapy to enhance head control and postural control, particularly in pediatric cases of cerebral palsy as they have poor functional levels. Aquatic therapy also supports movements that children were unable to do on land. This study suggests that aquatic activities may help cerebral palsy children with improved head control and functional mobility rehabilitation. There was no difference in the way land-based and water-based activities improved the children's mobility and functional recovery. (Mostafa, El-Negmy, El-Maksoud, AbdAl-Rahman & Srour, 2021.)

5 Discussion

This literature review focuses on the impact of aquatic therapy on pediatric cerebral palsy. This thesis summarizes the outcomes of aquatic therapy as a procedure that is feasible for pediatric cerebral palsy despite the limitations and requirements of further studies on specific parameters of aquatic therapy as mentioned in the presented studies of this literature review.

Significant improvement in truck control and head control was observed in pediatric cerebral palsy cases treatment using aquatic therapy in the presented studies (Mostafa, El-Negmy, El-Maksoud, AbdAl-Rahman & Srour, 2021; Kakihata et al., 2018).
Children with level IV spastic diplegia type of cerebral palsy demonstrated motor gains associated with trunk control and functionality along with a 30% greater balancing reaction. Pressure mapping also showed decreased lower limb pressure among the children who underwent aquatic therapy. (Kakihata et al., 2018.) Children also showed improvement in core strength and gait speed. (Ennis et al.,2018)

Stand-up paddle boarding aquatic therapy as a treatment for cerebral palsy showed results of improved GMFM (Gross Motor Function Measure) scores from 92.5% to 95% in one participant and increased GMFM (Gross Motor Function Measure) scores from 96%-99% in another participant. Along with improved overall posture and reduction in the number of tumbles into the water, and increased confidence and motivation. These case studies suggested SUPAT (Stand Up Paddleboarding Aquatic Therapy) is a creative approach in aquatic therapy for cerebral palsy that improves gross motor skills and reduces fall risk. (Walz, Doran, Potter & Chen, 2022.)

The systemic review conducted by Roostaei, Baharlouei, Azadi & Fragala-Pinkham, 2016 concluded that following the aquatic therapy intervention one study showed improvement in a stationary position, gait, sit-to-stand transfers, and running abilities and another study indicated a noteworthy decline in timed-up-and-go (TUG) scores though no improvement in PEDI scores was noticed in another study (Roostaei, Baharlouei, Azadi & Fragala-Pinkham, 2016).

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