

Review Paper: The Effect of Hydrotherapy on Health of Cerebral Palsy Patients: An Integrative Review



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ABSTRACT

Objectives: Hydrotherapy treatment is a type of complementary therapy which is administered in conjunction with other conventional modes of treatment for the treatment and rehabilitations of cerebral palsy patients. Though it has gained increasing popularity in many countries around the world, its application in Iran is still rare. The aim of this study was to perform an integrative review of the extant literature in the field of hydrotherapy and its applications for the improvement of ICF (International Classification of Functioning, Disability and Health) in spastic diplegia cerebral palsy patients. The review encompassed multifactorial analysis of the articles published between 2000 and 2016.

Methods: All related articles published in Iran as well as other countries from across the world (during the last sixteen years) with the keywords: hydrotherapy, cerebral palsy, participation, play, motor function, body function and body structure, were extracted from databases such as Science direct, PEDro, CINAHL, PubMed, ProQuest, magiran. The articles thus obtained were selected for evaluation and analysis.

Results: More than 33 papers were found from the literature search (as specified above). Of these, 18 articles were eliminated due to unrelated materials and addressing methods other than hydrotherapy rehabilitation. Of the remaining 15 papers that directly corresponded to the effect of hydrotherapy on improving ICF of spastic diplegia cerebral palsy patients, 11 articles were investigated in this review. The abstracts were evaluated first, followed by the full texts of the 11 articles that met the inclusion criteria.

Discussion: The results of the review showed that hydrotherapy when applied along with other conventional methods of rehabilitation, exerts positive effects on all areas of ICF. Hydrotherapy can be used in children and adolescents with spastic diplegia cerebral palsy, but the exercises chosen must be in accordance with the physical and cognitive conditions of the patients. However, studies in some areas of ICF are limited and further studies in this field are felt.

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1. Introduction

Hydrotherapy is one of the most popular forms of complementary therapies that help in the treatment of children with cerebral palsy and motor neuron disorders. It is known to provide an opportunity to the patients of cerebral palsy to do easier exercises. Hydrotherapy is also known to have useful implications in the treatment of children with neurodevelopmental disorders by improving their physiological and psychological state of being [1]. In addition, it also provides them the ability¹ to do body movements, especially among children who enjoy doing training activities with moving on the ground is difficult for them. Hence, hydrotherapy is proposed as an immune and complementary therapy in children with cerebral palsy, even those who are diagnosed with low levels of GMFCS [2].

The benefits of water based treatment methods rely on its anti-gravity position and buoyancy. It can thus help in weight loss and reduce compressive forces on joints. As a result, the therapy promotes active and easier movements for children who are not able to do certain ground activities. Finally, owing to the hydrostatic pressure effects of water, hydrotherapy can reduce muscular spasticity and improve endurance to multi-sensory stimulants, and increase blood circulation [3].

Varied applications of hydrotherapy have been displayed in the persisting literature. The most common applications of the therapy included include strength, aerobic and anaerobic training or swimming and playing in the water [4-8]. While some of these studies employed specific techniques, such as "Halliwick", "Watsu" and "Bad Ragaz". Halliwick hydrotherapy is a specially designed holistic and task-based approach which is based on the International Classification of Functioning, disability and health structure, including postural control, reducing muscle stiffness and facilitating the movement to achieve performance goals on the ground. Most Halliwick treatment methods are active and designed to facilitate the movement and sensory input. It also has a passive component, which is applied by the therapist for selective activation of muscles and stabilization of specific joints. First, the disabled person learns how to maintain their balance in a stable position and then they learn how to keep their balance on an unstable position while moving in the water [9]. Watsu is a gentle and quiet form of body therapy, which is usually performed in warm water (35°C). It is essentially a combination of massage, joint movements, shiatsu, muscle stretching and dance. The

1. Gross Motor Function Classification System

patient is continually supported while floating, swinging in the water and stretching [10]. On the other hand, Bad Ragaz is a special type of individualistic hydrotherapy which is based on the principles of PNF². In this type of therapy, the patient is supported by specific tools for floating, and the therapist applies resistance against the active movements of the patient [11].

Despite the evidences on the positive effects of hydrotherapy on children with cerebral palsy, it is still not standardized for use in Iran. It is expected that review and representation of the related resources may help in creation of a clinical guideline for its implementation in the said country. Due to the presence of a wide variety of hydrotherapy based methods and multifactorial investigation of its results on various types of cerebral palsy, it was thought that an integrative review of the varieties of hydrotherapy and their application on ICF of children with spastic diplegia cerebral palsy. The present study encompassed the analysis of the related manuscripts published between 2000 and 2016.

2. Methods

In this study, integrative review method was used. Integrative studies are the most extensive review studies that simultaneously allow empirical and non-empirical studies so as to achieve a full understanding of a phenomenon. Integrative studies can also combine data from theoretical studies as well as experimental studies with each other. In addition, integrative studies combine a wide range of purposes, including the definition of concepts, review of theories, review of the evidence and methodological analysis of a specific title [12]. For this study, Cooper's strategy in the integrated review was used. The strategy includes the following: 1. Formulation of the problem, 2. Reviewing the evidences and providing required resources, 3. Evaluating the data, 4. Data analysis and 5. Publication of results. In this regard, Hosseini and colleagues have written an article on such integrated reviews [12]. Given the type of study and pyramid of evidence, the level of evidence was determined.

Formulation of the problem

Hydrotherapy is one of the most useful therapies applicable for the rehabilitation of children with neurodevelopmental disorders and improving their physiological and psychological achievements [1]. However, previous studies based on growth levels of children with cerebral palsy showed that there exist many doubts regarding the effectiveness of hydrotherapy. Therefore, before the use

2. Proprioceptive Neuromuscular Facilitation

of hydrotherapy as a treatment measure among children with cerebral palsy is promoted, it is essential to answer the prevailing question “which hydrotherapy method, in what conditions, for which group of children and with what function level shall be used?” Therefore, the aim of this study was to investigate the effects of hydrotherapy on spastic diplegia cerebral palsy patients.

The main question of the study included the following: 1) How is the method of hydrotherapy for children with spastic diplegia cerebral palsy in the available literature?; 2) What are the specified effects of hydrotherapy on spastic diplegia cerebral palsy patients with different levels of motor development?; 3) What are the results of hydrotherapy based on the ICF?; and 4) What are the most important factors that influence the effectiveness of hydrotherapy in children with cerebral palsy?

Review of the literature and providing the required evidence

The present study encompassed a search for the information and theoretical foundations related to the application of hydrotherapy in children with cerebral palsy. It also involved the identification of effective conditions and factors that influence the outcome of the therapy and how they were dependent on the growth levels and types of hydrotherapy. This information was identified from the related sites, internet search as well as manual search in databases and reference books.

All articles related to the effects of hydrotherapy on patients with spastic diplegia cerebral palsy were investigated in following Iranian and foreign databases: OTDBASE Occupational Therapy Journal Literature Search Service³; PEDRO⁴; OT SEARCH (FORMERLY OT BIBSYS⁵; CINAHL Database; Science Direct⁶; Pub med; Elsevier; Scientific Information Database (SID); Magiran⁷; and Google scholar⁸.

Keywords used in the search process included the following: Cerebral palsy, diplegic spastic, rehabilitation, occupational therapy, hydrotherapy, aquatic therapy, water treatment and water exercises.

The obtained articles were examined on the basis of multidimensional factors, such as: purpose statements, inclusion criteria, characteristics of the research, citation of previous reviews, criticism of previous reviews,

3. <https://www.otdbase.org>

4. <https://www.pedro.org.au>

5. <https://www.lib.umn.edu>

6. www.sciencedirect.com

7. www.magiran.com

8. <http://scholar.google.com>

presentation of preliminary research findings, methods of analysis of the results, discussion of methodological problems, effective systematic searches, interpretation of results and tables. To interpret the collected data, cases based on the following specifications were used: study type, used models and tools, number of samples, date of publication and the number of papers used in this article.

Samples

A total of 33 papers based on the effects of hydrotherapy in patients with cerebral palsy were selected for this study. After careful examination of the title, abstract and full-text of articles, and the methods of study employed, 22 articles were excluded from the study due to non-relevance to the subject, being repeated in two or several databases, and poor or unrelated relevance to study aims. Finally, 11 articles were found to suffice the inclusion criteria and were hence included in the present study. Finally, the full-text of the articles were reviewed by the researchers.

Inclusion criteria were: 1) Articles based on spastic diplegia cerebral palsy in children in the age group of 4 to 21 years; 2) Summary or the full-text content of the article in Farsi and English languages; 3) Being published within the period 2000 to 2016; 4) Based on the evaluation of the effect of hydrotherapy in the domain of ICF; and 5) Investigation of hydrotherapy interventions alone or in addition to routine treatment methods.

Exclusion criteria were: 1) Articles that do not include a description of the intervention in full detail; and 2) Articles that investigated hydrotherapy with other non-occupational therapy and physiotherapy.

Data evaluation

The extracted data were prioritized according to the type and methods of study. The review section included descriptive content analysis of the collected data and was formulated based on the type and purpose of the study, the number and profile of participants, type and performing the intervention in terms of the time and number of sessions, assessment tools and the results. The findings were gathered without personal judgment and were arranged according to the order in which they were provided to the experts. Articles that met the inclusion criteria on the basis of the pyramid of evidence included systematic reviews (6 articles), randomized clinical trials (4 papers), pilot study (1 article) and case report (1 article).

Data analysis

At this point, the results of all reviewed articles were summed up and classified based on the ICF domains.

Body function and structure

In this area of the ICF, ten articles were found, and their results were related to the structure and function of the body. They investigated the effect of hydrotherapy on variables such as gross motor function, flexibility, balance, respiratory capacity, the function of heart, vessels and muscles, energy expenditure during walking and range of motion, the results of which are provided separately. The Halliwick method is an effective method for the analysis of gross motor function, balance, flexibility and respiratory capacity of children with cerebral palsy (evidence Level II) [13].

Hydrotherapy program was found to have positive effects on the body function and structure of children and teenagers with cerebral palsy. It can also strengthen the function of heart, vessels and muscles and reduce energy consumption during walking (evidence level I) [3]. Hydrotherapy program (swimming back stroke and crawl stroke) causes a reduction in spasticity of the hip adductors and knee flexors (evidence level II) [14].

Hydrotherapy program was also found to cause significant growth in GMFM, and other parameters relating to walking speed and step length. It was also found to increase strength, range of motion and cardiovascular endurance in children with cerebral palsy who can walk independently (evidence level I) [3]. It was also found that when administered in combination with occupational therapy, hydrotherapy program can help in improvement of gross motor function, particularly at GMFCS level 2 and spastic diplegia type. Hence, it can be used as a substitutional yet safe method of treatment even in children with cerebral palsy or GMFCS level 4 patients whose abilities in performing ground training are limited (evidence level II) [2].

Water aerobics program helps in improving motor skills in children with mild to moderate physical disorders, but it was not found to have any significant effects on the functional strength, balance and aerobic capacity of the patients (level III evidence) [15].

Group hydrotherapy exercises help in improving walking capabilities in cerebral palsy teenagers by establishing compatibility of functions between heart and respiratory system and reducing the rate and number of

heartbeat (level II evidence) [7]. The most significant effects of hydrotherapy on cerebral palsy patients include increased focus, muscle strength, balance, increased threshold of touch, starting and keeping eye contact (level I evidence) [16]. Furthermore, hydrotherapy also imposes positive effects on gross motor functions, such as jumping, running and walking (level I evidence) [5]. Application of hydrotherapy exercises along with resistance training was also found to be beneficial in boosting endurance and muscle strength (level I evidence) [8].

Hydrotherapy program leads to growth at all levels of ICF and increases children's motivation levels (level III evidence) [6]. It was also found to have a positive effect on physical performance and vital capacity and range of motion (level I evidence) [1].

Activity

In this area of the ICF, the results of three articles dealt with the different activities of spastic cerebral palsy children, such as ADL, work performance and consciousness. Group hydrotherapy program was found to have positive impacts on the quality of life of patients with cerebral palsy. It allows them to walk farther distances with less fatigue (level II evidence) [7].

The beneficial effects of hydrotherapy on motor functions cannot be attributed to growth in Activity Daily Living (ADL) and the quality of health of life. (Level III evidence) [6]. Hydrotherapy also impacts the work performance, but they were not found to be more effective than conventional treatments. However, children seem to really enjoy this intervention, it should not be eliminated from occupational therapy interventions. (Level A evidence) [16].

The effect of hydrotherapy on the participation of spastic cerebral palsy children was confirmed in only two papers- (Level I evidence) [3], (level III evidence) [6] and it was further remarked that there is need for further research in this area (level A evidence) [5, 8, 18] (Figure 1).

3. Discussion

This study aimed to investigate various methods of hydrotherapy in children with spastic diplegia cerebral palsy and its impact on their GMFCS performance levels. The study also aimed to implement the results of integrative review and the experts' critiques for the determination of effects of hydrotherapy on the improvement of various aspects of ICF. Interestingly no relevant evidences of the same were found in articles published

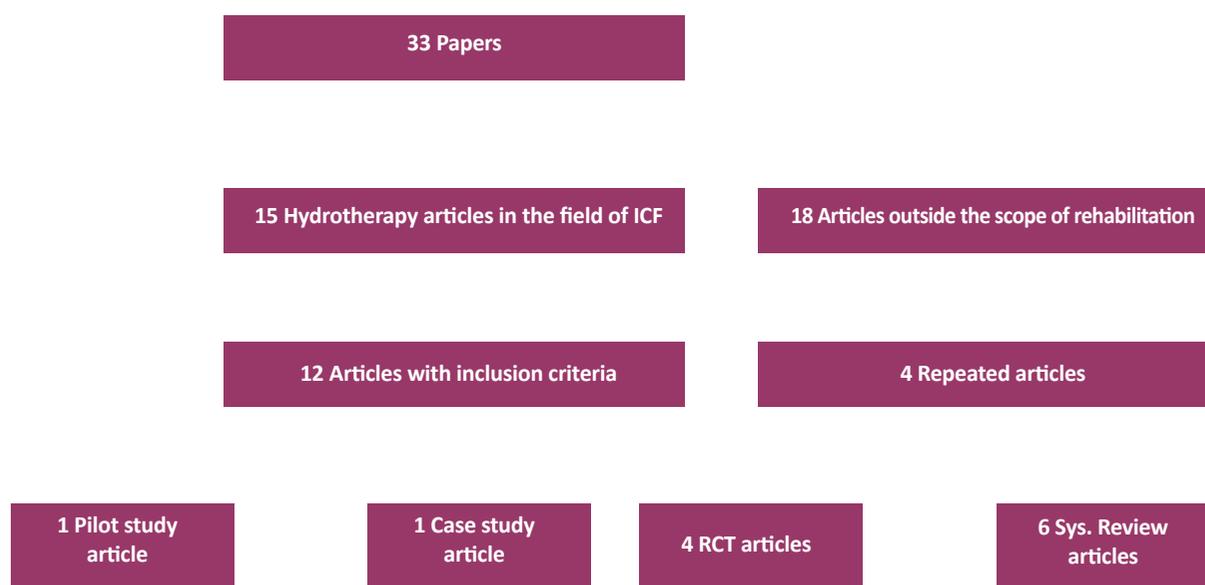


Figure 1. Number of articles

Iranian Rehabilitation Journal

by Iranian researchers. Review of the articles published by foreign researchers indicated the positive impact of water based treatment methods in improving different aspects of ICF in patients with spastic diplegia cerebral palsy. The results so obtained also indicated that the therapeutic effects of the treatment were dependent upon the types of hydrotherapeutic treatment methods. In an effort to find the answer to the question that “which treatment methods and what conditions are more effective for the treatment of various groups of children with spastic diplegia cerebral palsy, the authors integrated the evidences noted with expert opinions.

Environmental factors suitable for implementation

The environmental factors suitable for implementation are water temperature and group/individual practice. In the hydrotherapy program with Halliwick approach, it was indicated that the water temperature should be kept between 33 and 36°C [2]. It was also noted that in water aerobics exercises, water temperature should be between 31 to 32°C [7]. It was observed that group exercises increased the motivation of the children and led to their increased participation. Therefore, group practice provides an attractive environment for relaxation and entertainment during aquatic exercises such as basketball, water polo and volleyball [7].

In addition, group exercising is considered a time efficient method which reduces the duration of treatment and provides better targeted exercises to the children. While doing so, it is essential to ensure that the exercises are in compliance with the standards of the patient such

as the ability to perform exercises, level of disability, training experience in hydrotherapy as well as cognitive and social skills [18].

Though group exercising is beneficial, still individual training is recommended for participants who need more practice to perform the tasks and develop problem-solving skills. In addition, simultaneously taking care of groups of children in the water is difficult to manage, especially when there are equipment and work force constraints. Individual practice ensures that the child is properly controlled. Alternatively, the therapist may opt to use both types of the exercises by considering all the above mentioned factors so as to maximize its benefits for the participants [4, 7, 18].

Safety

Ensuring the safety of the participants while doing the hydrotherapy exercises helps in facilitating patient participation and success of training and interventions in children with varying levels of ability to move. Some of the most important safety features that may help in achieving the same include: installation of ramps, lift chairs, stairs and knobs, foam walls, suspension devices and life jackets. Considering the ability of the patient, they must be given glasses, belts and enough swimming equipment to ensure safety [4, 7, 18]. The depth of the pool should be such that the child’s feet should touch the bottom of the pool. It has been observed that large shallow pool encourages the children for running, jumping, walking and enduring other activities [4].

Severity and type of exercises

For cerebral palsy patients, a variety of techniques of hydrotherapy such as Halliwick, aerobic and non-aerobic exercises in water and water games are usually used. They were found to be effective in majority of the articles reviewed in this study and the intensity of each is explained.

The American College of Sports Medicine announced that training session, which involves 8 to 12 times repetition of the exercises that leads the children to the brink of exhaustion, is appropriate for muscle strengthening. Doing aerobic exercise for 30 to 60 minutes every day or most days of the week can help in improving the physical fitness of the children. However, it was suggested by Bar & Rowland that the intensity of exercises should be kept between 60 to 70 percent of maximum oxygen uptake, and 70 to 80 percent of heart rate [4]. Furthermore, regular administration of such hydrotherapy interventions for a period of 6-weeks can also improve the gross motor skills of the children [18].

According to the Halliwick approach, hydrotherapy programs should include 5 to 10 minutes of warm up, 40 minutes workout exercises in water and 5 to 10 minutes of cooling back down [2]. While doing so, it is recommended that the intensity of resistance training and aerobics exercises in children with GMFCS level 1 and 2 should be above 40 percent of heart rate [18]. Hydrotherapy program traditionally takes place 45 minutes every session, 2 to 3 times a week for 10 to 14 weeks. The gap between such therapy sessions helps in the recovery of the patient by strengthening and increasing the strength of cerebral palsy children (level I and II evidence) [1, 4, 6].

Application of hydrotherapy methods according to the GMFCS levels

Hydrotherapy is known to cause the growth of motor functions and delight of children with spastic cerebral palsy. It has been observed that the growth was more than GMFM-88 (level II evidence) in children with level 2 GMFCS [2]. Most studies suggest that hydrotherapy exercises are useful and effective in children with GMFCS levels 1 to 3. Only one of the studies reported the inclusion of a GMFCS level 4 (level I and II evidence) participant in hydrotherapy study [4, 7, 8, 17, 15, 18].

Results of hydrotherapy

Most reviewed papers on hydrotherapy used aerobic exercises with non-aerobic and strength activities. A program including 12 to 14 weeks of aerobic training, 2 to 3

times per week with motor functional activities such as walking, climbing stairs was found to improve the gross motor skills in children with mild to moderate mental disorders (Level II and III evidence) [2, 6, 15].

Halliwick hydrotherapy programs performed 2 to 3 times per week for an average period of 30 minutes for 12 weeks was found to have positive effects on the gross motor function and enjoyment of physical activity, especially in children with spastic diplegia cerebral palsy and GMFCS 2 levels with activity limitations on the ground. (Level II evidence) [2]. It was also found that administration of a combination of aerobic and strength exercises may increase power and endurance of such children (Level II evidence) [8].

Considering the results obtained from studies on the effect of hydrotherapy on different domains of ICF in cerebral palsy spastic diplegia patients, it was suggested that hydrotherapy based interventions should be recommended as a complementary method of treatment and rehabilitation along with other conventional rehabilitation methods. However, it must also be noted that ethical and cultural considerations of the therapy methods necessitate that the intervention protocols are performed by trained therapists only. It is also recommended to consider the conditions (cognitive and motor ability) of the patients in the domains of ICF before recommending a regimen and estimating its impacts. Doing so is extremely important as it helps maintain the patient's motivation in performing conventional rehabilitation exercises.

In this study, the researchers were faced with the limitation of lack of Persian literature in the field of effects of hydrotherapy in patients with spastic diplegia cerebral palsy. In addition, in the articles dealing with ICF, less attention was paid to the field of collaboration and evaluation tools, which are proposed to be addressed in future studies.

4. Conclusion

The results of this integrative review showed that hydrotherapy when administered with conventional methods of rehabilitation of children with spastic diplegia cerebral palsy, has positive effects on all areas of ICF. It was concluded that hydrotherapy can be used in children and adolescents. The exercises, and their duration and intensity should be decided on the basis of the physical and cognitive conditions of the patients. However, studies in some areas of ICF were found to be limited. Hence, it was proposed that further studies in this field are highly necessary.

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Conflict of Interest

All authors certify that this manuscript has neither been published in whole nor in part nor being considered for publication elsewhere. The authors have no conflicts of interest to declare.

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Appendix 1. Table of hydrotherapy evidence

Author	Summary of the Results Including Systematic Review Articles, Randomized Control Trials, Case Study and Pilot
Xiaohui et al. (2015) [13]	Halliwick is an effective method in gross motor function, balance, flexibility and respiratory capacity and can be used in combination with other methods to achieve long sports life and rehabilitation.
Usanee Sutthibuta (2014) [18]	Hydrotherapy program has a positive effect on the physical structure and function of children and teenagers. It is also effective on body functions such as heart, blood vessels and strengthening muscles and reduces energy consumption during walking in children with cerebral palsy.
Lai et al. (2014) [2]	Hydrotherapy reduces pressure on the joints and makes the participation of children easier and helps the therapists to strengthen the balance and training functional skills and reduces overuse syndrome.
Priscilla Trynieszewski & Kathleen Franzen (2013) [3]	Hydrotherapy program strengthens muscle strength, ROM, cardiovascular endurance and cooperation, especially in the population of children with cerebral palsy who can walk independently.
Fragala et al. (2013) [15]	Hydrotherapy exercises with exercises on the floor that including aerobic exercise and activity-based tasks such as walking, running, stride, jumping, boost the gross motor skills and endurance in walking and creates moderate to high changes in aerobic capacity and balance after the intervention.
Heather Wittwar (2013) [16]	Most articles statistically introduce hydrotherapy as a treatment modality to improve social skills and participation in society, fine and gross motor skills, and to increase motor control and self-esteem and supports the modality.
JW Gorter & SJ Currie (2011) [8]	Hydrotherapy with resistance training is beneficial in boosting endurance and muscle strength.
Ballaz et al. (2011) [7]	Group hydrotherapy exercise raises walking efficacy in adolescents with cerebral palsy. The efficiency is related to the cardiovascular and respiratory system compatibility and slowing breathing and heart rate.
Retarekar et al. (2009) [6]	2 to 3 times per week of hydrotherapy increases tolerance, performance, and the participation of spastic cerebral palsy in children.
Chrysagis et al. (2009) [14]	Hydrotherapy program (swimming back stroke and crawl stroke) causes reduction spasticity of the hip adductors and knee flexors.
Anna Rogers et al. (2008) [5]	Hydrotherapy can have a positive impact on children with cerebral palsy in gross motor function such as jumping, running and walking, but the impact on participation and activity is unknown.
Miriam Getz et al. (2006) [1]	The majority of articles on hydrotherapy noted its effect on physical performance, especially vital capacity and range of motion, which may be related to the quality of the aquatic environment and hydrostatic pressure.