

# Systematic Review of Aquatic Exercise Programming for Children and Adolescents with Cerebral Palsy

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## Abstract

Hydrotherapy is considered as a form of treatment in children with cerebral palsy by using the buoyancy for exercise to make children have more freedom than land-based physical activities. Previous literatures still have the limitations of quality and searching techniques were not covering the entire databases. There were not clear and no reliable conclusions about hydrotherapy's effectiveness and clinical applications. Researcher aims to review the literatures according to ICF-CY for clinical applications, useful for further research and practice. Eighteen articles met the criteria for inclusion and there were 3 articles in final analysis. It was shown that the previous studies were not enough to verify the effectiveness of hydrotherapy. The further study should be design the clinically relevant program for hydrotherapy in a specific purpose for children with cerebral palsy, a low level of mobility (GMFCS IV-V) and long-term follow-up treatment considerations.

**Keywords :** Hydrotherapy, Aquatic exercise, Swimming, Cerebral palsy

## Introduction

Children with cerebral palsy (CP) generally refer to children with impairments of sensory-motor function as a result of non-progressive encephalopathy. These children are identified with various clinical symptoms, for example, a low level of mobility or disorder, a problem of the muscle

tone, and other complications of respiration, swallowing activity, and speech (Gregory, 2005). Modern treatments are dependent on applications of conventional medicine, alternative medicine, and complementary medicine to promote the children's ability for their self-management in daily life, social participation, and better quality of life. The recent surveys reveal that Complementary and Alternative Medicine (CAM) has been widely applied, in particular, in children with chronic diseases such as CP, inflammatory bowel disease (IBD), and cancer. Moreover, CAM is mainly administered to most children with cerebral palsy (McCann & Newell, 2006).

Hydrotherapy is considered a form of CAM's treatments typically applied in children with cerebral palsy (Edward, Christina, Rita & Virginia, 2003). In fact, it is an exercise adopting the buoyancy of water to lessen the gravity to facilitate the mobility of these children apart from having a good posture control. Water properties help these children to do workouts in water more freely than on the land base (Michelle & Johanna, 2005). Aquatic exercise programming is also capable of reducing the weight and lifting against the children's joints with instability and deformities (Curtis & Gailey, 1996). Previous studies cited several advantages of the aquatic exercise such as an increase of the body flexibility, lung capacity, cardiorespiratory endurance, and muscle strength for a walk and mobility control (Hutzler, Chacham, & Bergman, 1998; Peganoff, 1984; Thorpe & Reilly,

2000). Hydrotherapy is therefore deemed as the teaching-learning process since the proper manual ability is to promote the learning process influencing more social participations in children with cerebral palsy (Aidar FJ et. al., 2007). Even though hydrotherapy increases the fitness levels in these children, aquatic exercise programming still requires the knowledge-based decision, analysis, and selection of interventions particularly suited to a single patient. Despite advantages of hydrotherapy previously mentioned, the reviews conducted by Kelley and Darrah in 2005 described three selected articles differently. One of them showed a weak metrological rigor whereas the other two articles were considered the single case report (Michelle & Johanna, 2005). Another review on the same study by Gorter and Currie in 2011 pointed out that hydrotherapy application in children with cerebral palsy in six articles selected in the study showed limitations of both child patient numbers and research quality apart from a lack of systematic review and failure to cover other relevant databases. Moreover, a few studies on hydrotherapy in children with cerebral palsy made it unable to select only the randomized-control trials along with no reliability assessment of the studies before the literature reviews were performed (Gorter & Currie, 2011).

According to the World Health Organization (WHO), health classification is based on International Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2012). Its focus turns from the medical model to social one through the integrated life quality which includes well-being of the body, mind, and capability of living in society and environment enabling the treatment to cover factors in other dimensions for better life quality (Tongsiri, 2013). Aimed to obtain reliable information used as a guideline for the therapist adopting hydrotherapy in these patients, the researcher reviewed the literature by searching relevant studies through the

quality assessment, and conducting a systematic data analysis to ensure the most reliable study results and practical applications (Kritsanaprakorn, 2008). The hydrotherapy treatment was then subject to this study and review, particularly in children and adolescents with cerebral palsy along with some considerations on the treatment results among the participants in terms of body structure and functions, activities, and participation. Relevant factors both personal and environmental in accordance with ICF (World Health Organization, 2012) would be also considered for the clinical application and feasibility study beneficial for the further studies.

## Methods

### *Scope of Research*

This research was considered a systematic review on the effectiveness of hydrotherapy in children and adolescents with cerebral palsy to comply with WHO's ICF from 2007 to September of 2012.

### *Research Instruments*

1. Computer and printer
2. Preliminary Data Recording Form for the relevant studies collected
3. Detailed Data Recording Form for the selected studies with full text
4. Programs implemented for the research e.g.
  - EndnoteX3 for the bibliography management

### *Research Procedures*

In this study, the researcher surveyed the literature reviews by searching the relevant studies, setting the selection criteria, assessing the quality, analyzing the data, synthesizing the collected data, and writing a summary as well as a study report.

#### **1. Finding the relevant studies**

This process was conducted through the

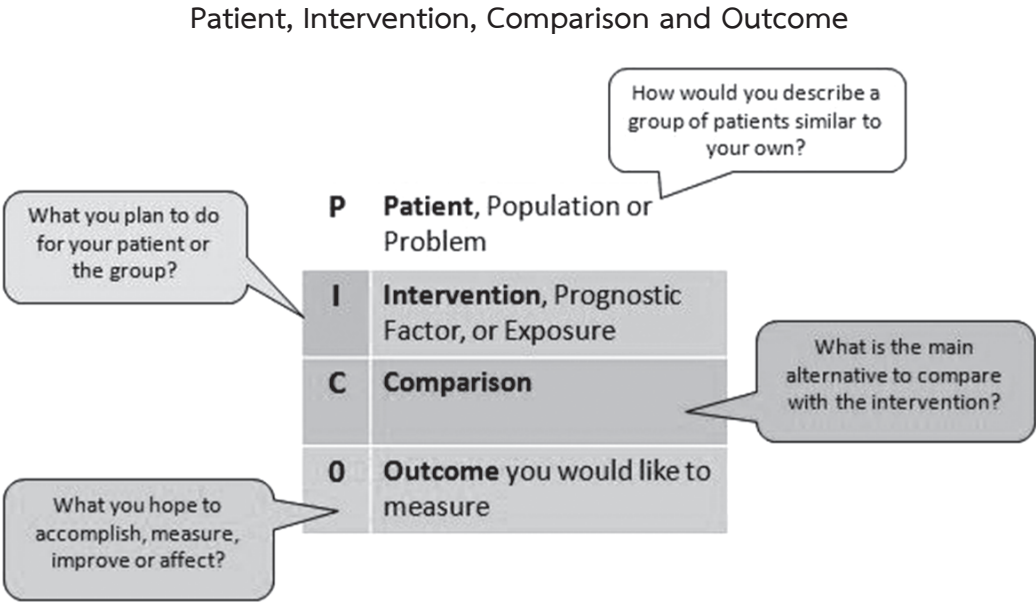
validity of medical resources to obtain the studies in relation with the research questions as follows.

**1.1 Electronic databases** e.g. EBSCO (<https://search.ebscohost.com/>), Chiang Mai University Online Databases including CINAHL with Full text via EBSCO, CENTRAL (The Cochrane Central Register of Controlled Clinical Trials) at <http://www.thecochranelibrary.com>, MEDLINE (Pubmed) at <http://www.pubmed.gov>, EMBASE at [www.info.embase.com](http://www.info.embase.com), Regional databases e.g.

Science-direct via Chiang Mai University's Online Database and PEDro Physical therapy database at <http://www.pedro.org.au/>.

*Example of Search Strategy*

Use the search strategy under the PICO Model (Figure 1) and develop the searching method by breaking down the question into smaller parts as shown in Figure 1.



**Figure 1:** Factors to be considered in developing the search strategy in accordance with PICO Model (The Cochrane Handbook, 2011)

Table 1: Developing the search strategy

<b>How to develop search strategy</b>	
<b>The question</b>	
What are the effectiveness for aquatic exercise programming for children and adolescents with cerebral palsy?	
Break down of the question into “facets” (not all may be need to searching)	
<ul style="list-style-type: none"><li>• Population: Patients undergoing children and adolescents with cerebral palsy</li><li>• Interventions: Aquatic exercise</li><li>• Outcome: Body structure and functions, Activity, Participation</li></ul>	
Identify synonyms, spelling variants and subject headings associated with each “facet”	
Aquatic exercise	for Cerebral palsy
Aqua therapy, hydrotherapy, swimming, water therapy/ training, pool activities, exercise (aerobic, anaerobic, strength, and other)	Children and adolescents with cerebral palsy, athetoid, ataxia, spastic diplegia, hemiplegia, quadriplegia

**Examples of searching the data in the database of Medline (PUBMED): since 2008**

Searching by the text word  
((hydrotherapy\*) AND (cerebral palsy))  
Limit clinical trials, humans  
Searching by MeSH  
((hydrotherapy [MeSH Terms]) AND cerebral palsy)  
Limit clinical trials, humans

**1.2 References and Bibliography**

Consider the relevant topics of research listed as references and then search the original documents from valid databases based on the available references.

**1.3 Manual search**

Search the journals, reports, books or relevant documents in the libraries of educational institutes and other agencies.

**1.4 Grey literature**

Search the electronic databases of grey literature e.g. SIGLE (international.inist.fr/article55.html), BC Environmental and Occupational

Health Research Network (<http://www.bceohm.ca/search/greylit/org>), System for Information on Grey Literature in Europe (<http://www.opengrey.eu>), ADS archaeology (<http://archaeologydataservice.ac.uk/archives/view/greylit>).

**1.5 Abstracts from conferences and seminars**

Search the conference-related documents conferences e.g. meetings and association’s journals while many of them might be obtained through the meeting attendance.

**1.6 Research data during the study**

This includes the studies which are not published such as independent study, thesis, research papers of the medical schools or medical centers. Another way is to search via the electronic databases e.g. [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov) or [www.nottingham.ac.uk/ongoingskintrials](http://www.nottingham.ac.uk/ongoingskintrials).

**2. Study Inclusion**

The collected studies would be evaluated through the following procedures.

2.1 Screened a single study by taking

out the brief data from the EndnoteX3 program such as titles, author’s names, year of publication, and abstracts for selection of the relevant primary studies contained in each database. If the abstract failed to help the researcher to decide whether it was useful or not, the studies with full text were subject to further searches.

2.2 The researcher screened the studies in the step one, specifically those associated with the research topic. If identified as unclear studies, suggestions from the second researcher were then requested. After reaching the conclusion, recorded

the number of studies which met the criteria.

2.3 Searched the selected studies with full text and verified duplications by employing the Endnote X3 program.

2.4 The researcher read the studies with full text, recorded the necessary data in the form, and selected the studies according to Inclusion and Exclusion Criteria as shown in Table 2.

2.5 Recorded the selection results e.g. a number of studies matching the criteria and reasons to exclude some studies from this research.

**Table 2 :** Inclusion criteria and Exclusion criteria

<b>Study selection criteria</b>		
<b>The question</b>		
What is the effectiveness for aquatic exercise programming for children and adolescents with cerebral palsy?		
<b>Selection criteria</b>	<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
Population	Participants had to be children and adolescents with diagnose CP aged three months to 21 years at the start of the program.	Other conditions or exceeded the age limits and the data could not be separated, the study was exclude
Interventions	Aqua therapy, hydrotherapy, swimming, water therapy/ training, pool activities, exercise (aerobic, anaerobic, strength, and other) in the pool were included as a main therapy	Lack of aquatic exercise intervention and other treatments combination
Outcome	The international classification of functioning, disability, and Health for Children and Youth (ICF-CY) effect on body structure and functions, Activity, Participation	
No limitations of Language		
Study reports from January 2008 – September 2012		

### 3. Quality Assessment

The researcher would assess each full-text study following the set criteria for each topic by blinding the names of journals and authors to alleviate any biases and categorize the quality by adopting the Modified Jadad Scale (Jadad & Enkin, 2007) consisting of 8 aspects below.

1. Randomization
2. Randomization procedure
3. Blinding
4. Blinding procedure
5. Withdrawal/dropout
6. Inclusion/exclusion criteria
7. Adverse event
8. Statistical analysis

The score for each topic was equal to 1. The lowest score for poor quality was 0 whereas the highest score was 8. The score ranging from 0-3 referred to poor to low quality and the score ranging from 4-8 referred to good to excellent quality.

### 4. Data Extraction

In this step, the data extraction forms would be created as follows.

1. General information: name of the authors, year of publication or study

#### 2. Research information

- Inclusion and exclusion criteria  
- Population and location for the research

- Research methodology

- Treatment

- Results for assessment and assessment methods

- Result analysis

- Study results

### 5. Statistical Synthesis and Analysis: Non-quantitative

#### 6. Summary and Study Report

Report of the systematic review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher D, Liberati A, Tetzlaff J, & Altman DG, 2009).

### Result

1. Search results; the researcher obtained data from valid sources as shown below.

**Table 4:** Search results from relevant sources

Valid Sources	Number of Studies Found
Electronic Databases	114
Searchable References of Studies	2
Domestic Research or Studies	0
Grey Literature	4
Abstracts from Seminars	0
On-progress Research	0
Other Sources	25
<b>Total</b>	<b>145</b>

### **1.1 Search results from the electronic databases**

In this study, there were totally 112 studies found according to the searches from electronic databases as shown in Figure 2. The screening process of title and abstract employing the Endnote X3 pointed out that 14 studies were duplicated in the database and 80 studies failed to fulfill the inclusion criteria.

The database anticipated for searches was inaccessible due to no service in the domestic country and incurring expenses for access to such a database e.g. EMBASE ([www.info.embase.com](http://www.info.embase.com)).

### **1.2 References and Bibliography**

Only two studies were obtained from the list of references regarding the studies which met the criteria or failed to satisfy the criteria. However, they were not included in this study as they did not match the inclusion criteria.

### **1.3 Manual search**

There was no study which met the

criteria through searches in the journals, reports, and relevant books at Chiang Mai University's Library.

### **1.4 Grey literature**

Only four studies were obtained via the electronic database but they failed to satisfy the inclusion criteria.

### **1.5 Abstracts from seminars**

Only general information was presented in these abstracts. Therefore, they were not included in this study due to insufficient information.

### **1.6 On-progress research**

No studies such as independent study, thesis, or relevant research were found in the electronic database.

**1.7 Trying to search other sources** via [www.google.com](http://www.google.com), the researcher found 7 books, 2 seminar documents, 3 theses, 13 studies. However, only 5 studies were included in this research.

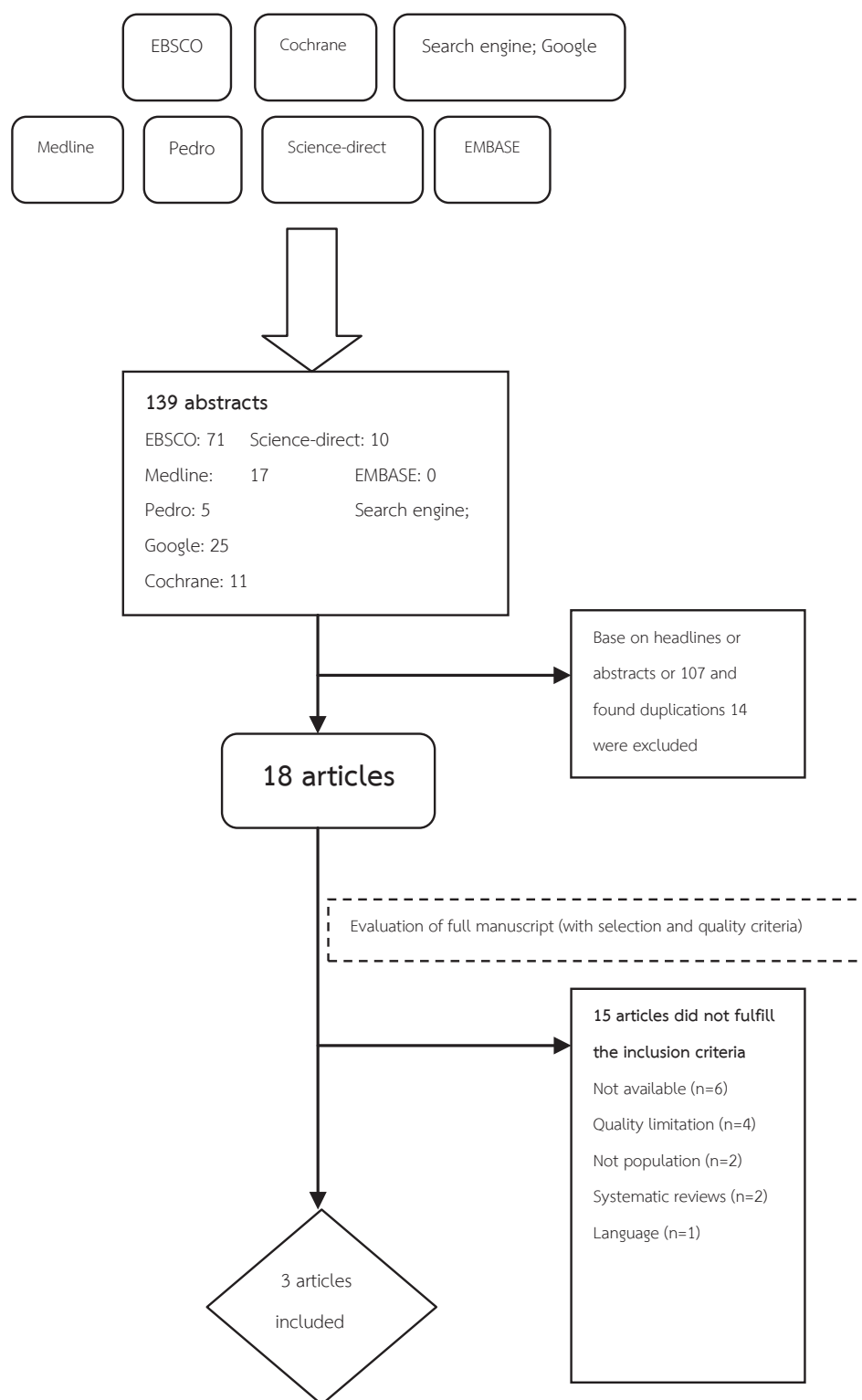


Figure 1: Diagram summarizing the systematic search procedures for documents and search engine



Totally 145 studies were collected from the relevant sources and 4 of them were grey literature which did not fulfill the inclusion criteria. After that, the researcher selected the duplicated studies obtained through different databases by employing the Endnote X3 Program, especially the accessible databases, for example, Pubmed, Science-direct, and EBSCO. For other electronic databases which were not compatible with the Endnote X3 Program, the researcher manually screened and excluded all the overlapped studies. Meanwhile, topics were considered according to the set selection criteria and only 18 studies were finally selected for further searches of the full-text article. As a result, totally 12 articles were collected. In this process, studies excluded from this study were the two articles with only the literature reviews, two articles with the participant selection failing to meet the inclusion criteria, one article with the language barrier, and 4 articles with no matches for the inclusion criteria and quality assessment. Therefore, only 3 articles were used in

this final analysis.

## 2. Results of quality assessment

The three articles selected for this research were based on the Modified Jadad Scale (Jadad & Enkin, 2007) consisting of eight assessments as demonstrated in Table 5 regarding the results of quality assessment.

The study was regarded as the clinical trial according to the table of quality assessment. Two studies which met the inclusion criteria were those done by Fragala-Pinkham et al. (Fragala-Pinkham, Haley, & O'Neil, 2008) and Ballaz (Ballaz, Plamondon, & Lemay, 2011). Both of them featured the quality assessment level of 4-4.5, meaning the good level of study (4-8 meaning good to excellence) (Jadad & Enkin, 2007). These two studies were also considered as a single group pre-post design of aquatic intervention. Another study was the randomized control trial showing the eligible group before randomization for the aquatic intervention group and control group.

**Table 5 :** The quality assessment of each selected study

First author, published year	Randomization*	Randomization procedure*	Blinding†	Blinding procedure*	Withdrawals/ dropouts*	Inclusion/ exclusion criteria*	Adverse events*	Statistical analysis*	Total	Quality
1. Fragala-Pinkham (2008)	0	0	0.5	0	1	1	1	1	4.5	Good
3.Ballaz (2010)	0	0	0	0	1	1	1	1	4	Good
2.Dimitrijević (2012)	1	0	0.5	0	1	1	0	1	4.5	Good

\*Studies that provide sufficient information for the question obtain a score of 1

†Double-blinded studies obtain a score of 1 whereas single-blinded studies obtain a score of 0.5

### 3. Selection results of the studies following the criteria and data extraction

Based on the search for the studies which fulfilled the criteria, there were 18 studies in total, published during 2008 – September 2012 as shown in Figure 2. Only 3 studies were included in this research as details of each study listed in Table 6.

The participant selection of these studies was found with no gender limitation. All of them were children and adolescents with cerebral palsy aged between 6-21 years. The number of participants through Intervention was N=12, 14, and 16 whereas GMFCS (Gross Motor Function Classification System) (Palisano, Rosenbaum, Bartlett, & Livingston, 2008) (Table 7) of the participants was diversified with different mobility levels below.

1. 13 participants of GMFM Level I
2. 11 participants of GMFM Level II
3. 8 participants of GMFM Level III
4. 4 participants of GMFM Level IV
5. 13 participants of GMFM Level V

The participants classified with Level I-III capable of good ambulation accounted for 78.04% of the total participants. The hydrotherapy duration lasted from 6-14 weeks and around 45-60 minutes of each treatment per time. Treatments for children with cerebral palsy used in three studies included an aerobic exercise using the half mile walk/run scale, and a strengthening exercise using the lower extremity isometric muscle strength test. The mobility in daily life such as gait analysis, mobility level based on GMFM, and swimming ability using WOTA 2 (Water Orientation Test Alyn2) was also evaluated.

**Table 6 :** Summary of findings of the selected intervention studies (population, intervention, and outcome)

Study Author Year	Fragala-Pinkham (2008)	Ballaz (2010)	Dimitrijević (2012)
Group size and age	N=16 (2 CP) ,6-11 ปี	N=12, 14-21 ปี	N=29 EG*= 14,CG*=13, 5-14 ปี
GMFCS level	I=1, II=1	I=2,II=4,III=4,IV=2	I=10,II=6,III=4,IV=2,V=5
Study design	A single group pre-post design	A single group pre-post design	randomized control trial
Exercise parameters	14wk,twice a week 45 minutes/session	12 wk,3 times/wk 60 minutes/session	6 wk, twice a week 55 minutes/session
Exercise description	5-10 minutes of warm up,20-30 minutes of aerobic exercise 5-10 cool-down	15 minutes of warm up 30 minutes of group Aquatic training program 5 minutes of cool down	10 minutes of warm up 40 minutes of swimming 5 minutes of play
Outcome Body function	- Cardiorespiratory endurance (Half mile walk/run) - Muscle strength (Lower extremity isometric muscle strength)	EEI* Muscle strength (isomet- ric strength test) Gait analysis	
Activities	- Motor skills (Functional Skills Mobility Scale (M-PEDI), Floor to Stand (FTS) Modified curl-ups 3-meter test	GMFM (sections D and E)	GMFM* WOTAS*
Participation	-	-	-

EG= intervention group, CG=control group, GMFM= Gross Motor Function Measure, WOTAS= Water Orientation Test Alyn2, EEI= energy expenditure index

**Table 7 :** Gross Motor Function Classification System (GMFCS) (Palisano, et al., 2008)

Level	Description
I	Walks without limitations
II	Walks with limitations
III	Walks using a hand-held mobility device
IV	Self-mobility with limitations; may use powered mobility
V	Transported in a manual wheelchair

**4. Adverse events**

Two studies out of three systematically recorded adverse events through hydrotherapy with no report of injuries, fatigue, muscle soreness, and discomfort in daily activities.

**Discussion**

**1. Search, selection, and quality assessment**

The preliminary search revealed that nearly all studies (114 out of 145 articles) were done on the electronic database regarded as the main and important database which allowed searches for full-text studies, references, grey literature, and theses with no language barrier. The database which contained a great number of research studies with most accessibility was EBSCO covering multidisciplinary studies and varied databases such as CINHALL with full text, and Scopus (Nonthiwatwanich, 2555). Additional searches were performed through Chiang Mai University’s database and Pubmed (Medline) whereas other databases provided a few number of studies.

The Cochrane Library’s database served as the main source of evaluation and synthesis for the study results of clinical trials or randomized controlled trials in terms of patient care, treatment, and disease prevention whereas information was regularly updated (Phothisat, 2003). It was therefore the reliable database for systematic reviews. The search results and selection for this research found

only 10 relevant studies. However, they failed to fulfill the set inclusion criteria as applications of hydrotherapy or aquatic exercise programming mostly showed the reviews in other groups of patients or different adoptions. Studies associated with hydrotherapy for children with cerebral palsy were fairly limited in terms of study entries and quality.

The scope of this research was set for the duration between 2007-October 2012 as the studies of the past five years were updated. It was stated that the studies with full text were not accessible, accounted for 33.33% (6 out of 18 articles) whereas the studies with limitation of the quality was accounted for 22.22% (4 out of 18 articles). With respect to the step of data collection, the researcher found that one article listed as a reference was unsearchable, showing that searches for data in books, theses, journals, or grey literature were not fully covered as a different database might require a different searching method. The further study should include a searching method targeted at a specific source of information such as search engine and grey literature which demonstrated different searches in the journals. Also, cooperation from a librarian for effective data searches was another requirement.

Even though the quality assessment was based on the Modified Jadad Scale (Jadad & Enkin, 2007), the topic assessment was rather difficult because some articles were not clearly reported

or failed to include the reports, resulting in no record of quality assessment as required by the set criteria. All these reasons limited accessibility of searches and selection of the studies with the same quality as part of this research. Furthermore, quality assessment conducted by only one researcher might not be accurate. Therefore, coordination with an individual researcher for the accurate quality assessment should be established in the further study.

The studies included in this research showed different treatments. For instance, the study conducted by Fragala-Pinkham et al. (Fragala-Pinkham, et al, 2008) put more focuses on an aerobic exercise in the water than other studies which set an aquatic exercise accompanied by strengthening exercises. Subject to differences of participants in the study, the study conducted by Fragala-Pinkham et al. featured a more diversity of children selected in this study than other studies. Only one study was based on the participant randomization and control group. As a result, these differences caused some difficulties in reaching a summary of study results. Moreover, only a few applications of aerobic exercise in children with cerebral palsy were reported along with a lack of quality research used as the intervention model. The researcher also had some limitations associated with the time duration since this research consumed approximately 8 months, starting from the topic selection. Thus, a period of five months for searches might be insufficient for some studies, particularly those written in foreign languages excluding English. Direct correspondence regarding the search questions between each researcher was not yet established. Finally, the researcher did not completely review the literature.

## **2. Effectiveness of aerobic exercise for cerebral palsy**

### **2.1 Exercise type and effectiveness**

The selected studies demonstrated the effectiveness of hydrotherapy for body

functions such as cardiopulmonary/cardiovascular endurance and muscle strengthening. The assessment regarding activities such as changes of GMFM and WOTAS (Water Orientation Test Alyn2) was also performed. However, the assessment on participation of the participants in the intervention program was not conducted.

Most aquatic exercise types used in the research were based on an aerobic exercise which was useful for body functions of the participants such as cardiovascular capacity and endurance, weight management and lower blood lipid levels, and preservation of bone mass maintenance of function (Anna Rogers, Barbara-lynn Furler, Stephen Brinks, & Johanna Darrah, 2008). An evaluation on cardiovascular endurance after hydrotherapy made by Fragala-Pinkham et al. (Fragala-Pinkham et al., 2008) revealed that the participants exhibited the half mile walk/run and ability of exercising in the target HR zone for a longer duration. This significantly disclosed that the participants of this program had cardiovascular endurance after the treatment. However, this research, during the exercise, mentioned about importance of controlling the intention of participants throughout the training whereby the trainer was not capable of controlling the participants to do workouts to increase the heart rate as much as children with skills of swimming. This research based on the literature reviews associated with outcome of aerobic exercise in children with cerebral palsy discovered that it enabled cardiopulmonary endurance in these children (Anna Rogers, et al., 2008). The study conducted by Dimitrijevic et al. using the swimming exercise similar to the aerobic exercise pointed out its ability to help children with cerebral palsy to have more mobility and swimming skill after receiving hydrotherapy. Likewise, the study by Ballaz et al. using the aquatic exercises such as exercise for hands and legs, water polo, or volleyball indicated that physical exercise reduced the EEI (gait

energy expenditure index). Three studies mentioned above all adopted the aquatic aerobic exercise to enable children with cerebral palsy to have better changes for body functions, respiration system, and blood circulation. However, suggestions made on the aerobic exercise in these children stated about a lack of information with respect to the proper variables concerning this type of exercise in these children, for example, intensity, duration, and frequency so as to be used in the clinic for the greatest effectiveness and safety to these children (Anna Rogers, et al., 2008). In fact, the study done by Laurent Ballaze et al. (Ballaz, et al., 2011) was the first study which evaluated the intensity of exercising in water by the subgroup analysis in children with cerebral palsy. Meanwhile, the participants were grouped according to the GMFCS while Group 1 referred to the group with high mobility (GMFCS I-II), moderate mobility (GMFCS III-IV), and low mobility (GMFCS I-IV) respectively. The study also discovered that application of hydrotherapy for every group showed the intensity of exercise higher than 40% of the heart rate reserve (HRR). In GMFCS I-II, the intensity of children's exercise (higher than 40% HRR) exhibited more frequency than the rest two groups. After the treatment, children with low mobility showed a more statistically significant reduction of EEI (gait energy expenditure index) than that of GMFCS I-II although the frequency of training to reach 40% HRR was found lower.

A strengthening exercise is deemed as another aquatic exercise. Based on the study by Fragala-Pinkham et al. and Laurent Ballaze et al. combining this type of exercise for hydrotherapy with an aerobic exercise, there were no statistically significant changes in muscle strengthening. In this manner, it might result from hydrotherapy which mainly focused on an aerobic exercise and swimming without a specific exercise for muscle strengthening by using the water resistance. Moreover, the strengthening program conducted

in a short duration with low intensity did not demonstrate any changes after the treatment with no effect on the musculoskeletal system and gait kinematics (Ballaz, et al., 2011). Therefore, the clinical or further study ought to set the treatment program with the clear target specifically at an individual. This might be achieved through the hydrotherapy planning for an increase of strengthening based on an increase of speed in doing an activity by using the water resistance together with exercise tools such as paddle, ankle and wrist weight. Cooperation of the participants in controlling their attention and during the training is also required. An assessment on participation in activities such as GMFM, WOTAS (Water Orientation Test Alyn2), and walk shows better mobility of these children.

The studies of hydrotherapy's effectiveness throughout the past ten years mainly focused on children with cerebral palsy who exhibited high mobility (GMFCS I-II-III). Accordingly, it is hard to reach a conclusion or use it for designing the exercise suited to children with cerebral palsy with the severity and more limitations (GMFCS I-IV) (Gorter & Currie, 2011). On the other hand, the study conducted by Laurent Ballaze et al. revealed that hydrotherapy also provided advantages in patients with low mobility. Hence, hydrotherapy application is capable of treating the existing symptoms or body structures and functions such as muscle strengthening, muscle tension, and range of motion. Hydrotherapy additionally promotes the activity to comply with the ICF guidelines. To put it more simply, viewpoints on evaluation after the treatment are based on an ability that children are able to apply for their daily life such as some evaluations regarding half-mile walk/run, 3-minuted test, Motor skills, Floor to stand GMFM, and WOTAS. These are related to the viewpoint on the integrated life quality of the participants

## 2.2 Comparison of individual and group exercise

Under the ICF guidelines, impairment is not only from the physical structure but also from other environmental and individual factors. If the environment is adjustable to suit children with cerebral palsy along with a proper integration of daily life to recover the mental ability and promote the disabled to get social involvements, this may develop an ability and better life quality of the disabled. A group exercise is therefore to improve the social and environmental dimension as well as more participation apart from raising the motivation of these children for practice. Furthermore, it is to create an interesting environment and more social involvement together with the rule recognition while promoting relaxation and entertainment during the practice through the aquatic activities such as basketball, polo, volleyball, and competition. The study by Laurent Ballaze et al pointed out that a group exercise enhanced the walking ability in children with cerebral palsy (Ballaz, et al., 2012). In addition, it is practical in clinical applications for providing the treatment targeted at each group and decreasing the time duration of treatment for a single patient. The group exercise should accord with some criteria, for example, a capability of doing aquatic exercises of an individual, level of disability, hydrotherapy training experience, cognitive skill, and sociability (Phothongsunan, 1990).

However, an individual exercise is beneficial when a participant requires more practices and problem-solving skills. This type of exercise facilitates the control of children's attention while using the equipment appropriately and safely which reduces the risk when there is a limitation of staffs to take care of children. The trainer may combine these two types of exercises based on relevant factors to maximize the benefits and values to the participant. Meanwhile, parents or guardians are encouraged to take part in this treatment by joining the exercise or assessment and sharing the problems during the practice.

## 2.3 Treatment duration and follow-up period

The treatment duration of hydrotherapy has an effect on the treatment assessment of all studies including its existence after the treatment with a lack of follow-up periods in several studies. Most of the studies showed the response of hydrotherapy ranging from 6-14 weeks (at least 2 times per week/ 45-60 minutes per time). In this regard, Dimitrijevic et al. conducted the study of aquatic intervention's impacts after a six-week hydrotherapy program and found out that the gross motor function (GMFM) and aquatic skills demonstrated some statistically significant changes. Regarding the follow-up period of three weeks, there was a decrease of GMFM, serving as a clinical indicator that should be considered especially with respect to the outcome of hydrotherapy and treatment duration which prolonged the treatment effects in children with cerebral palsy. Existence of treatment effects in the same level would enable these children to sustain the mobility, self-management in daily life, and better life quality while suppressing the complications (Dimitrijevic et al., 2012). The further study ought to focus on the treatment duration to prolong the treatment effects in these children.

## 2.4 Barriers and adverts events

The barriers and adverts events of hydrotherapy application in the selected studies were not systematically recorded (Gorter & Currie, 2011). Nonetheless, some studies valued the follow-up concerning the adverts events during the treatment or barriers for the participants who did not receive hydrotherapy throughout the study as summarized below.

2.4.1 Lack of motivation for practice

2.4.2 Problems of too many appointments such as doctor or multi-disciplinary appointments

2.4.3 Problems of transportation during the treatment

2.4.4 Problems of the heart rate



measurement during the practice which affects the data recording process with a limitation of device placements on the body due to trunk deformity of some participants, belt displacements, and floatation belt interference

2.4.5 Sickness problem during the practice such as hospital admission and infection

The safety measures to prevent the risk factors during the treatment include an assessment of prohibitions or cautions before the treatment, assessment of children's ability, adequate care givers, heart rate measurement, and inquiry for the follow-up from parents or guardians such as muscle inflammation and fatigue (Ballaz, et al., 2011; Dimitrijevic, et al., 2012; Fragala-Pinkham, et al., 2008). A consideration on the environment and safety of the pool for children with cerebral palsy is another requirement as these children have different levels of mobility. Hence, proper equipment such as chair lifts, ladder, handrail at the swimming pool, and spacious shallow pool for children to do a group exercise enabling them to jump, run, walk, and do workouts safely. More importantly, it requires an expert instructor of hydrotherapy whereas parents or guardians ought to take care of children in water (Michelle & Johanna, 2005). The above study results are beneficial for clinical planning associated with continuous treatments, facilitating the location, making a doctor appointment and multidisciplinary team, and designing the program contributed to a motivation

for the participants to attend the treatment program continuously, properly, and safely.

## Conclusion

There are a few numbers of studies on impacts of hydrotherapy in children and adolescents with cerebral palsy with the quality limitation. The further study ought to include a more number of participants by considering children with cerebral palsy diagnosed with low mobility (GMFCS IV-V). Moreover, exercise parameters in water such as intensity of exercise, duration, and frequency ought to be more considered so as to enhance the effectiveness and serve as the model for practical applications in children and in children with cerebral palsy in a different level of ability. The viewpoint on treatment in children with cerebral palsy is limited only to the body structure and promotion of mobility activity with a lack of an assessment on participation of the participants under the ICF guideline. The integration of treatment in children with cerebral palsy with aspects of the body, mind, society, and environment will promote a better life quality. Apart from that, a systematic record of safety regarding hydrotherapy applications in clinics is necessary to prevent the adverts events and risks. The follow-up of treatment compared with the long-term treatment effects should be conducted to transfer this activity for the land-based exercise or mobility in daily life.



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