The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka

By

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Abstract

Problem: Poor balance is considered a major issue that children with Cerebral Palsy (CP) encounter. Since balance skills constitute a crucial part of gross motor ability, compromised balance control in these children with CP have a varied impact on their everyday life. Hydrotherapy has been used in the rehabilitation of children with CP, but little is known about the effects of this rehabilitative modality on both static and dynamic balance of children with CP especially in Sri Lanka where no hydrotherapy study has been conducted. Therefore, the purpose of this present study is to examine the feasibility of a 6-week aerobic exercise-based hydrotherapy program and its effects on static and dynamic balance in children with CP in the Sri Lankan context.

Methods: A quasi-experimental pretest-post-test design without a control group was used. Five children with mild to moderate CP between the ages 7 and 11 years participated in 45-minute hydrotherapy sessions twice per week for 6 weeks. Training intensity was monitored and expressed as a percentage of Heart Rate Reserve (HRR). The primary outcome measures were static and dynamic balance as measured by the Pediatric Reach Test (PRT) and modified Timed-Up and Go (mTUG) test, respectively. As the secondary outcome measure, Health-Related Quality of Life (HRQOL) of children was assessed by the primary caregiver using 5-item Visual Analogue Scale (VAS).

Results: All participants were able to achieve and maintain an intensity level of 30% to 60% of HRR with an average intensity level of 43% during the intervention period. Except forward reach distance when sitting, all other components of the PRT showed improvement with statistical significance at p < 0.004 with Bonferroni correction. The mTUG test did not show statistically significant improvement even though there was a positive trend towards
improvement. All the participants showed improvement in HRQOL, but the findings were not statistically significant.

Conclusion: This 6-week aerobic exercise-based hydrotherapy program was feasible and demonstrated potential for improving static and dynamic balance abilities in children with CP.
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Dedication

This thesis is dedicated to:

My beloved parents: Mr. Ariyadasa Wadu Mesthri and Mrs. Nanda Jayawardena,

and

My sister: Mrs. Erandi Wadu Mesthri

and

My brothers: Mr. Channa and Prasanna Wadu Mesthri

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List of Abbreviations

ACSM: American College of Sports Medicine
BMI: Body Mass Index
CHQ: Child Health Questionnaire
CHIP: Child Health and Illness Profile
CP: Cerebral Palsy
CPQOL: Cerebral Palsy Quality of Life
CPQOL-Child: Cerebral Palsy Quality of Life Cerebral Palsy Questionnaire for Children
ERC: Ethics Review Committee
FR: Forward Reach
FRT: Functional Reach Test
GMFCS: Gross Motor Function Classification System
GMFCS - E & R: Gross Motor Function Classification System - Expanded and Revised
GMFM: Gross Motor Function Measure
HR: Heart Rate
HR_{rest}: Resting Heart Rate
HR_{max}: Maximum Heart Rate
HREB: Health Research Ethics Board
HRR: Heart Rate Reserve
HRQOL: Health-Related Quality of Life
ICF: International Classification of Functionning Disability and Health
ICC: Intraclass Correlation Coefficient
LLR: Left Lateral Reach
MCID: Minimal Clinically Important Difference
MDC: Minimal Detectable Change
MET: Metabolic Equivalent
mTUG: modified Timed-Up and Go
NCCCPDD: National Center for Children with Cerebral Palsy and other Developmental Disorders

PBS: Pediatric Balance Scale

PedsQL: Pediatric Quality of Life

PEDI: Pediatric Evaluation of Disability Inventory

PFRT: Pediatric Functional Reach Test

PRT: Pediatric Reach Test

QOL: Quality of Life

RCT: Randomised Control Trial

RLR: Right Lateral reach

ROM: Range of Motion

SPSS: Statistical Package of Social Sciences

THR: Target Heart Rate

TUDS: Timed-Up and Down Stairs

TUG: Timed-Up and Go

TUG-IC: Timed-Up and Go-In Children

VAS: Visual Analogue Scale

VO_2R: Oxygen Uptake Reserve

VO_2: Oxygen Uptake
Chapter 1 Background

Cerebral Palsy (CP) is the most common form of physical disability during childhood (Lai et al., 2014; Reddihough & Collins, 2003; Rosenbaum, 2003). It is “an umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of development” (Mutch, Alberman, Hagberg, Kodama, & Perat, 1992, p. 549). Motor impairments affecting the body’s movement, posture and balance are main characteristics of CP, because the brain injuries affect single or multiple locations of the brain such as the motor cortex, basal ganglia and cerebellum that control muscle tone and motor coordination (Graham et al., 2016). Also, most children with CP have many associated neurodevelopmental defects such as cognitive, visual, hearing and speech impairments affecting their functioning and health in addition to locomotor disabilities (Gowda, Kumar, Shivappa, & Srikanteswara, 2015; Kliegman, Stanton, St. Geme, Schor, & Behrman, 2011; Vargus-Adams, 2005). As such, CP is a broad term used to cover a spectrum of conditions with varying severity.

Body balance, both static and dynamic, is a basic requirement for motor development in children (Khasawneh, 2015; Westcott & Burtner, 2004; Yi, Hwang, Kim, & Kwon, 2012). “The ability to provide body balance in a specific place or position is called static balance and the ability to provide body balance while moving is called dynamic balance” (Bozkurt, Erkut, & Akkoç, 2017, p 927). According to Khasawneh (2015), “Static balance is the one in which the individual retains poise in one single situation, whereas the dynamic balance is the body's ability to retain poise or steadiness when moving or shifting from one balanced situation to another” (p. 87). Body balance is crucial in functional independence (Fournier
et al., 2010). When viewed from a developmental aspect, postural control and balance are hurdles on the developmental pathway of certain gross motor milestones such as locomotion (Geuze, 2005). While static balance is necessary to maintain body equilibrium during stationary posture, dynamic balance is essential to execute all body movements and most functional activities (Westcott & Burtner, 2004; Woollacott & Shumway-Cook, 2005). Static balance is needed to manage the internally induced perturbation such as task of keeping one’s trunk over the seated surface while sitting on a stationary surface like a chair. The other type, dynamic balance, adjusts the body for both internally and externally induced perturbation such as walking and maintaining balance in a moving vehicle, respectively (Santos, Kanekar, & Aruin, 2010).

Poor balance is considered a major problem that children with CP encounter (AlSaif & Alsenany, 2015; Tarakci, Ozdincler, Tarakci, Tutuncuoglu, & Ozmen, 2013). Deficiency in balance control is frequently experienced by children with CP compared to children with normal development (Gan, Tung, Tang, & Wang, 2008; Rose et al., 2002). Since balance skills constitute a crucial part of gross motor ability, deficient or compromised balance control has a varied impact on physical tasks involved in daily living activities (AlSaif & Alsenany, 2015; Kembhavi, Darrah, Magill-Evans, & Loomis, 2002; Liao & Hwang, 2003). For children with CP of various functional severity, this phenomenon is evidenced by limited physical involvement in daily life activities, at home and in the community (Gorter & Currie, 2011).

CP is incurable (Rosenbaum, 2003). For this reason, children with CP will have to live with limited activities (Benda, McGibbon, & Grant, 2003). Physical inactivity in this population causes increased risk of developing secondary physical complications such as
pain, fatigue, pressure sores and mobility limitations as well as psychological complications such as depression and social isolation (AlSaif & Alsenany, 2015). Additionally, they are at increased risk of developing metabolic and cardiovascular complications such as hypertension, hypercholesterolemia, and obesity with aging (Verschuren, Peterson, Balemans, & Hurvitz, 2016). Muscle imbalances bring many subsequent problems such as unequal bone growth, spinal deformities (scoliosis), contractures, hip dislocation, and weight bearing difficulties. Furthermore, people with lack of muscle balance suffer from chronic pain which challenges their fundamental motor skills e.g., sitting, standing and walking (as stated in Benda et al., 2003).

Numerous therapeutic interventions targeting children with CP, are being practiced worldwide. Graham et al. (2016) and Rosenbaum (2003) described 2 goals of therapy: to promote functional abilities and avert development of secondary conditions. As already noted, CP is not curable. Therefore, children with CP commonly undergo different types of supplementary rehabilitation programs such as hippotherapy, electrical stimulation and acupuncture (Liptak, 2005). Another common form of supplemental treatment that children with CP undergo is hydrotherapy or aquatic therapy (Getz, 2006; Gorter & Currie, 2011; Hurvitz, Leonard, Ayyangar, & Nelson, 2003).

Hydrotherapy is an appealing mode of rehabilitation for children with CP (Badawy & Ibrahim, 2016; Kelly & Darrah, 2005), and it has become popular over the last couple of years (Fragala-Pinkham, Dumas, Barlow, & Pasternak, 2009; Fragala-Pinkham, Smith, Lombard, Barlow, & O’Neil, 2014). There are several reasons why hydrotherapy is very attractive. One reason is that children with CP find it easy and enjoyable to exercise in water compared to exercising on land (Fragala-Pinkham et al., 2014; Kelly & Darrah, 2005; Lai et
In contrast to practising on the land setting, hydrotherapy allows children with CP to exercise in the water for long periods of time before becoming fatigued. Children with CP find it easy to engage in more strenuous rehabilitation program in the water compared to the land (Badawy & Ibrahem, 2016). Also, a growing body of research involving children with CP shows significant beneficial effects of pediatric hydrotherapy programs, reporting improvements in gross motor function (Fragala-Pinkham et al., 2014; Lai et al., 2014), gait efficiency (Ballaz, Plamondon, & Lemay, 2011), functional mobility (Thorpe, Reilly, & Case, 2005) and physical activity enjoyment (Lai et al., 2014). Retarekar, Fragala-Pinkham, and Townsend (2009) reported improved body function, activity and participation, i.e., 3 major components of the International Classification of Functioning, Disability and Health (ICF) of a child affected with CP (moderate severity) after participating in a 12-weeks hydrotherapy program.

Multiple studies have reported the effects of varied interventions on balance enhancement in children with CP including hippotherapy (Zadnikar & Kastrin, 2011), neuromuscular block and neuromuscular electrical stimulation (Kazon et al., 2012), swiss ball exercises (Kim, Lee, Kim, Chang, & Lim, 2017), and Wii-based balance therapy (Tarakci et al., 2013). However, studies assessing the effects of hydrotherapy on balance of children with CP are limited in the existing literature.

Children with CP face many challenges when performing physical tasks and therefore, both static and dynamic body balance are important parts of their lives as for any other human being. To date, only 6 studies reported balance in children with CP following participation in hydrotherapy intervention programs. These include a Randomised Control Trial (RCT) utilizing Biodex balance system to assess dynamic balance (Badawy & Ibrahem,
2016), a study with a group aquatic intervention program evaluating balance of children and adolescents with CP using Pediatric Balance Scale (PBS), Timed Up and Go (TUG) test, and Timed Up and Down Stairs (TUDS) test (Zverev & Kurnikova, 2016), and 4 studies with aquatic intervention program utilizing outcome measures such as Functional Reach Test (FRT) (Fragala-Pinkham et al., 2009; Thorpe et al., 2005), TUG test (Adar et al., 2017; Thorpe et al., 2005), timed single limb stance test (Fragala-Pinkham et al., 2009), and Pediatric Berg Balance scale (Fragala-Pinkham et al., 2014). However, even though almost all these study outcome measures have reported positive trends towards improvement in balance, not all concluded that hydrotherapy is effective in improving the balance in children with CP.

In Sri Lanka, epidemiological evidence and research on CP are lacking; however, anecdotal evidence suggests that CP is a serious problem that affects many children and majority of them do not receive any type of treatment. Although there is no national survey conducted to assess the epidemiology of CP in Sri Lanka, it is estimated that nearly 40,000 children out of the total population of 22 million in the country live with CP (Aloysius, 2016). While hydrotherapy is a popular treatment in most western countries, in other developing countries like Sri Lanka this treatment modality has not been explored well. A significant number of children have no access to hydrotherapy treatment in Sri Lanka. Even the awareness about hydrotherapy as a treatment modality for children with CP is lacking among Sri Lankan health care providers. Also, there has not been any study on hydrotherapy conducted so far in Sri Lanka. Thus, the purpose of this study was to examine the feasibility of an individual hydrotherapy program and its effects on static and dynamic balance in children with CP in the Sri Lankan context.
Chapter 2 Literature Review

2.1. Cerebral Palsy

In 1862, an orthopedic surgeon, William James Little first described CP (as cited in Pervin et al., 2015). Since then, the definition of CP was revised by various paediatricians and neurologists (Graham & Selber, 2003). Currently the most widely used definition was proposed by the International Executive Committee for the Definition of CP in 2006 and according to that CP is defined as follows:

Cerebral Palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain.

The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication and behaviour, by epilepsy, and by secondary musculoskeletal problems (Rosenbaum et al., 2007, p 11).

2.2. Etiology and Risk Factors of Cerebral Palsy

Cerebral palsy etiology can be separated into 2 categories: antenatal and perinatal (Graham et al., 2016). Some well-known antenatal causes include congenital malformations of brain development, vascular events such as middle cerebral artery occlusion, and maternal infections during first and second trimester, while important perinatal causes include intrapartum hypoxia (secondary to prolapsed cord, prolonged or traumatic delivery, etc.), infections and injuries (Reddihough & Collins, 2003). In general, among identified risk factors of CP, low birth weight, intrauterine infections and multiple gestation are most important (Odding, Roebroeck, & Stam, 2006). However, the causes of CP are not the same in both developed and developing countries. In developed countries, prematurity is the most common reason for CP (Gladstone, 2010). In contrast, prevalent risk factors in developing
countries are infections such as meningitis, septicaemia and malaria (Reddihough & Collins, 2003). Further, compared to developed countries, in developing countries higher proportion of children with CP are due to a third category, called post-neonatal pathologies such as infections which can be prevented and treated (Colver, Fairhurst, & Pharoah, 2014).

2.3. The Epidemiology of Cerebral Palsy

The global prevalence of CP has been estimated at 15 – 17 million people or 2/1000 neonates (Graham et al., 2016; Oskoui, Coutinho, Dykeman, Jette, & Prinsheim, 2013; Veličković & Perat, 2005). In Sri Lanka, it is estimated that approximately 40,000 children out of the total population of 22 million in the country live with CP (equivalent to 1.8 per 1000 live births) (Aloysius, 2016). Even with improvements in antenatal and perinatal care settings, the prevalence of CP in both developed and developing countries has plateaued around 2.0 – 3.5 per 1000 live births over the last 4 decades (Colver et al., 2014).

2.4. Classification of Cerebral Palsy

CP can be classified in many ways according to: (a) type of movement disorder, (b) anatomical region of the body with impaired motor activity and (c) extent or the severity of motor dysfunction (Graham et al., 2016; Graham & Selber, 2003; Tecklin, 2015). According to the movement disorder type, three main subtypes of CP, spastic (90%), dyskinetic (6%) and ataxic or hypotonic (4%) have been reported (Lissauer & Clayden, 2012). Depending on the topographical distribution of the impaired motor function, CP is further classified as hemiplegia, diplegia and quadriplegia (Tecklin, 2015), but sometimes it is noted that only the spastic subtype has been further divided into these 3 categories (Gladstone, 2010;
Lastly, further classification of CP is done with the Gross Motor Function Classification System-Expanded and Revised (GMFCS - E & R) gradings that has been developed to classify children and youth with CP based on the severity level of their affected age-specific gross motor function (Palisano, Rosenbaum, Bartlett, & Livingston, 2007). Essentially, voluntary movements with a focus on sitting, transfers, and mobility are assessed by this scale (Palisano et al., 2007). GMFCS - E & R gradings are used by clinicians and researchers to identify and record the functional ability of individuals with CP. Considering the changes that may occur during each developmental phase of childhood, it has incorporated 5 age ranges from early childhood to the early adulthood; before 2y, 2 to 4 y, 4 to 6y, 6 to 12y, and 12 to 18y, and each range has further divided in to 5 levels (from I to V). Functional severity of CP increases with increasing the level number denoting level I as the mildest form and level V as the most severe form for all age ranges (Palisano et al., 2007).

2.5. Balance and Cerebral Palsy

Balance is an integral component of movements due to its foundational nature for the performance of motor skills such as sitting, standing, walking, running and other complex movements (Franjoine, Gunther, & Taylor, 2003; Gan et al., 2008; Jiang et al., 2018; Vasile & Stănescu, 2013).

The balance system has 3 basic elements: (a) coordinating inputs received from multiple sensory systems: visual, vestibular, and somatosensory system, (b) central nervous system processing of information and (c) movement coordination using musculoskeletal system to maintain balance (Błażkiewicz, 2013; Gribble & Hertel, 2004; Yim-Chiplis &
Maturation of the 3 basic elements occurs non-linearly at different rates and at various stages of the development (Westcott & Burtner, 2004). By the age of 15, balance skills have developed to those seen in adults (Jiang et al., 2018).

In CP, impaired interactions between the 3 basic elements of balance results in failure to maintain balance (Woollacott & Shumway-Cook, 2005). For example, Cherng, Su, Chen, and Kuan (1999) showed children with CP experience problems with intersensory conflicts and therefore, are subjected to difficulties in maintaining static balance compared to children without disabilities. Also, motor impairments of CP frequently coexist with deficiency in balance control (Katz-Leurer, Rotem, Keren, & Meyer, 2009; Woollacott & Shumway-Cook, 2005). Children with CP suffer from problems of sensation, perception and secondary musculoskeletal problems such as muscle contractures and bony deformities in addition to impaired motor system (Rosenbaum et al., 2007). Consequently, as stated earlier, compared to children developing normally, children with CP present with a compromised ability to maintain balance. Therefore, depending on the severity of the disease, static and dynamic balance may vary among children with CP.

2.6. Health-Related Quality of Life (HRQOL) in Children with CP

Quality of Life (QOL) has been defined by World Health Organization as “individual’s perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards and concerns” (The WHOQOL Group, 1995, p 1405). The subcategory of QOL that specifically related to health status of an individual has been described as HRQOL (Bjornson & McLaughlin, 2001; Office of Disease Prevention and Health Promotion, 2010).
An increasing number of children with CP are living longer due to medical and technological advances. As such, measuring and improving the HRQOL in children with CP has become progressively important. Literature on HRQOL in children with CP has gradually increased in the recent years (Bjornson & McLaughlin, 2001). Basically, two types of measures; generic measures and condition-specific measures have been used to assess the HRQOL of children with CP. Examples for the former include Child Health Questionnaire (CHQ), Child Health and Illness Profile (CHIP), Pediatric Quality of Life (PedsQL) Questionnaire and those for the latter include Cerebral Palsy Quality of Life Questionnaire for Children (CPQOL-Child) and PedsQOL Cerebral Palsy Module (Ozdemir & Tezcan, 2017). In comparison, the sensitivity of condition-specific measures is much higher than generic measures in evaluating HRQOL of Children with CP (Ozdemir & Tezcan, 2017) especially in studies focused to investigate the effectiveness of an intervention program (Davis & Waters, 2010).

For the assessment of HRQOL researchers have used either parent/proxy version or children self-reported versions or both. However, due to children’s immature cognitive level, lack of social experience and dependent nature, it is observed that parent-reported versions are capable of rating certain aspects of QOL of their children more than the child-reported version (Davis & Waters, 2010). However, parent’s expectations and past experiences with the child could influence their rating. Therefore, parent-reported versions tend to either underestimate or overestimate some aspects of HRQOL, and this might affect the true representation of the real scenario (Davis & Waters, 2010).

The HRQOL of children with CP has been measured and found to be poor due to various factors (Dobhal, Juneja, Jain, Sairam, & Thiagarajan, 2014; Power et al., 2018;
Vargus-Adams, 2005). Motor disability with multiple associated comorbidities of the disease such as behavioral issues, impairment of cognition, sensory perception and epilepsy coupled with overall functional limitations adversely affect the HRQOL in children with CP (Ozdemir & Tezcan, 2017; Power et al., 2018). Vargus-Adams (2005) reported that poor HRQOL in these children is mostly due to issues that they face with physical functioning and impact of the disease on parents and caregivers such as parental worries and concerns regarding their children with disabilities plus additional time and efforts needed for caring. Another study, a systematic review that included 16 studies which investigated the HRQOL of children with CP (n = 1579) across 5 instruments revealed poor HRQOL especially in terms of physical well-being among children with CP from low and middle income countries compared to their peers without CP from similar countries (p < 0.003) and peers with CP from high income countries (p < 0.001).

2.7. Hydrotherapy

2.7.1. Physical properties

The history of therapeutic usage of water dates to the time of ancient Greece, and the 2 Greek words ‘hydro’ referring to water and ‘therapeia’ referring to healing made its derivative, hydrotherapy (Duffield, 1976). Due to the physical properties of water, it is an appropriate medium for implementing a number of rehabilitation approaches (Cameron, 2003). Some of these properties that may contribute to the effectiveness of a hydrotherapy treatment program are describe below.
**Buoyancy.** Buoyancy, the experience of upward thrust force exerted by a fluid on the body, acts against the gravitational force, or in the opposite direction to the weight of the body (Cameron, 2003; Campion, 1997; Schrepfer, 2002; Torres-Ronda & Alcázar, 2014). Therefore, two types of forces: gravity acting on the center of gravity and the buoyancy acting on the center of buoyancy act on the body when the body is immersed in a fluid medium (Campion, 1997; Schrepfer, 2002). Rotational force occurs when these two centers are mal-aligned, and it aids the floatation of the body (Campion, 1997; Schrepfer, 2002).

Buoyancy is a very important physical property of water that brings many advantages for rehabilitation programs mainly by reducing the effects of gravity on the body depending on the water level that an individual is immersed (Cameron, 2003). Accordingly, waist deep, chest deep and shoulder deep water reduce 50%, 70% – 75% and 90% of the individual’s body weight, respectively (Bates & Hanson, 1996). Therefore, water provides feeling of lightness and facilitates easy moving of the body by reducing the impact on joints and muscles (Cameron, 2003; Norton & Jamison, 2000). As a result, individuals with CP including those with severe function limitations find it easier to do water-based exercises compared to land-based exercises (Dimitrijević et al., 2012; Getz, Hutzler, & Vermeer, 2007; Kelly & Darrah, 2005).

**Viscosity and resistance.** Viscosity, simply called the thickness of a liquid, results from intermolecular frictional forces and brings resistance to movement (Bates & Hanson, 1996; Norton & Jamison, 2000). When the medium of exercise is air, these resistive effects are minimal and usually disregarded, however; when the water acts as the medium, resistance plays a substantial role (Bates & Hanson, 1996; Norton & Jamison, 2000). Also, the resistance is easily modified by changing movement speed and allows the individual to
perform exercises within his or her comfort zone (Norton & Jamison, 2000) and is considered an important hydrodynamic principle for aquatic exercises.

**Hydrostatic pressure.** The moment an individual enters a liquid medium, fluid exerts pressure on the immersed body part, and this is called hydrostatic pressure (Torres-Ronda & Alcázar, 2014). As described in Pascal’s law, when the body is submerged and at rest at a given depth, this pressure is directly proportional to the depth of immersion (Cameron, 2003; Wilcock, Cronin, & Hing, 2006a). Therefore, hydrostatic pressure on the body increases with the increasing depth of immersion. This multidimensional external pressure has numerous beneficial effects on most of the major body systems. By improving the venous return and, in turn, the efficiency of the cardiac muscle, hydrostatic pressure promotes the functioning of the cardiovascular system. On the musculoskeletal system, this exterior pressure acquires the function of external devices such as compression bandages and stabilizes the weak joints and muscles by its compressive effects (Cameron, 2003; Norton & Jamison, 2000).

### 2.7.2. Effects of hydrotherapy on cerebral palsy

Effects of hydrotherapy on various physiological and physical performance, and psychological aspects and QOL of children with CP have been reported. However, number of studies evaluating the psychological background and QOL of children following participating hydrotherapy programs are minimal in the current literature. In contrast, studies investigating the physiological and physical (mainly mobility related) performance are quite substantial.

Getz, Hutzler, and Vermeer (2007) conducted a study for 22 children where 12 participants underwent an aquatic intervention program, and another 10 participants
participated in a land-based exercise program (control group). The study concluded that when the 2 groups were compared, improvement gained in perceived social acceptance was more in the aquatic intervention group than the control group, however; a significant difference was not found in social function measured by social function domain of the Pediatric Evaluation of Disability Inventory (PEDI). In 2014, Lai et al. conducted an aquatic therapy study that included a land-based rehabilitation program as the control group and reported that enjoyment of the children measured by physical activity enjoyment scale was higher in the aquatic intervention group compared to the conventional group (p = 0.015), but there was no significant difference found in the HRQOL evaluated by the Cerebral Palsy Quality of Life (CPQOL) questionnaire-parent version. Another study (Thorpe et al., 2005), a case series with 7 participants, assessed the self-perception of children with CP using 5 components of self-perception profiles for adolescents and children and commented that except 1 component; global self-worth, all the other 4 components showed improved scores. In a more recent study by Adar et al. (2017) the QOL of children with CP (n=32) was evaluated using both the child self-reported and parent proxy-reported versions of Pediatric Quality of Life Inventory (PedsQL)-CP. Results of that study reported that compared to the control group (land-based exercise group), children who were in the aquatic exercise group demonstrated higher improvement in most of the subdomains of the PedsQL-CP in both versions.

Moreover, regarding the physiological effects of hydrotherapy intervention program, Fragala-Pinkham, Haley, and O’Neil (2008) reported improved cardiovascular endurance of a group of children with disabilities including 2 children with CP following an aquatic aerobic exercise program. Hutzler, Chacham, Bergman, and Szeinberg (1998) stated that
compared to normally developing children, children with CP had reduced lung function but, at the end of a 6-month aquatic therapy program their vital capacity improved markedly.

Throughout the literature many hydrotherapy studies have concentrated on assessing motor skills of children with CP, and this may be because it is a disorder of motor activity. Gross Motor Function Measure (GMFM) has been the most commonly used assessment tool for this purpose. Most of the studies that used this outcome measure reported significant improvement in either some Dimensions (D and/or E) or in all Dimensions of the GMFM-66 or GMFM-88 versions (Adar et al., 2017; Ballaz et al., 2011; Dimitrijevic et al., 2012; Fragala-Pinkham et al., 2014; Fragala-Pinkham, O'Neil, & Haley, 2008; Lai et al., 2014; Retarekar, Fragala-Pinkham, & Townsend, 2009, Thorpe et al., 2005). Additionally, improved Range of Motion (ROM) (Chrysagis, Douka, Nikopoulos, Apostolopoulou, &Koutsouki, 2009; Fragala-Pinkham et al., 2009), gait efficiency (Ballaz et al., 2011), gait velocity (Thorpe et al., 2005), and walking endurance (Fragala-Pinkham et al., 2014; Retarekar et al., 2009) have been reported. Even though these hydrotherapy studies reported various balance related effects, by reviewing the history of using hydrotherapy for the children with CP, it is evident that there are limited experimental studies that were designed to measure the effects of these exercises on balance.

### 2.7.3. Studies on hydrotherapy, cerebral palsy and balance

In reviewing literature, only 6 studies have been conducted to assess the balance parameters of children with CP following hydrotherapy programs (Adar et al., 2017; Badawy & Ibrahem, 2016; Fragala-Pinkham et al., 2009; Fragala-Pinkham et al., 2014; Thorpe et al., 2005; Zverev & Kurnikova, 2016). One of those; a 14-week aquatic exercise-based study (n
used the Pediatric Berg Balance Scale as a secondary outcome measure to evaluate the balance of participants. The findings of that pilot study in which most participants performed exercises with moderate to vigorous intensity reported that balance improvement gained by aquatic exercises was not considerable, though all 8 participants demonstrated a positive trend toward improvement (Fragala-Pinkham et al., 2014). Thorpe, Reilly, and Case (2005) conducted another hydrotherapy study; a 10-week aquatic exercise program for 7 children with CP (6 with spastic diplegia and 1 with spastic hemiplegia belonging to GMFCS I – III levels and aged 7 – 13 years) and focused on assessing balance using 2 balance assessment tests; FRT and TUG test. Results of that study reported significant improvement in TUG test in all 7 participants, but only 4 children showed improved FRT score while the other 2 tested demonstrated deterioration from the pre-intervention score. However, as in the previous study, this study did not measure the exercise intensity.

In the case series study (n = 4) of Fragala-Pinkham, Dumas, Barlow, and Pasternak (2009) which includes 2 children with CP (GMFCS level I), one child with Juvenile idiopathic arthritis and one child with Prader-Willi Syndrome, an improvement in balance measured by Timed Single Limb Stance and FRT has been reported in all 4 of them. Again, this study did not concentrate on measuring the exercise intensity levels. Zverev and Kurnikova (2016) conducted a study for a period of 24 weeks and this is a reasonable period to assess a difference in the balance function of children with CP. This study used balance training exercise and swimming as the intervention and evaluated the balance of participants (n = 13) using 3 measures; PBS, TUG test and Timed Up and Down Stairs test and reported statistically significant improvement (p < 0.000) in all 3 of them. However, the training
intensity, which is an important component of any exercise program was not measured in this study.

The other study that mainly focused on accessing dynamic balance (Badawy & Ibrahim, 2016) is a RCT, which included aquatic therapy group as the experimental group (15 participants) and land-based exercise group as the control group (15 participants). This study was conducted for 12 weeks and used Biodex balance system to evaluate dynamic balance of children with spastic diplegic CP and reported that stability indices (overall, mediolateral and anteroposterior stability indices) significantly improved in both groups; however, more improvement was seen in the aquatic therapy group. As in the Zverev and Kurnikova (2016) study, this study also did not measure the training intensity of the program. Also, only the dynamic balance was measured but not the static balance. Another study, again a RCT that had 32 children with CP (17 in the aquatic exercise group and 15 in the land-based exercise group as the control), carried out an aquatic exercise program for a period of 6 weeks. In addition to the various outcome measures, that study also used TUG test and reported that both the experimental group and the control group showed improved TUG score, but there was no statistically significant difference between these two groups (Adar et al., 2017).

2.8. Limitations of Studies on Hydrotherapy, Cerebral Palsy and Balance

In the available literature, evidence for the effects of hydrotherapy on balance in children with CP is limited mainly due to study designs, sample size and functional level
(GMFCS levels) of children with CP, and optimal conditions of a hydrotherapy program, i.e. frequency and duration of sessions and the exercise intensity.

Even though RCT is the ideal study design for this type of experimental studies, only 2 studies have been published on RCTs (Adar et al., 2017, Badawy & Ibrahem, 2016). Whereas 3 studies used quasi-experimental pretest-post test designs (Fragala-Pinkham et al., 2014; Thorpe et al., 2005; Zverev & Kurnikova, 2016), and one study used single case series design (Fragala-Pinkham et al., 2009).

Regarding the sample size, the highest number of participants involved in a study is 32 (17 in the aquatic exercise group and 15 in the land-based exercise group) (Adar et al., 2017) followed by 30 (15 in the aquatic exercise group and 15 in the land-based exercise group) (Badawy & Ibrahem, 2016). All other 4 studies included 13, 8, 7 and 2 children with CP.

In addition to that, as explained earlier, children with CP are divided in to 5 levels as GMFCS I – V according to functional severity. Among available studies, only one included children with GMFCS level IV (Adar et al., 2017), while other studies confined to the children from GMFCS level I – III. However, none of those studies covered most severely affected children, i.e., V groups. Therefore, generalization of the current evidence on the effects of hydrotherapy to all children with CP is not reasonable.

Furthermore, there is no apparent consensus on optimal frequency and duration of hydrotherapy programs for children with CP (Dimitrijević et al., 2012). In the reported research studies that were aimed to assess the balance of children with CP, duration of the programs was ranged from 6 weeks to 6 months with one session duration of 45 to 60 minutes and a session frequency of 2 to 5 sessions per week (Adar et al., 2017; Badawy & Ibrahem,
Nevertheless, the systematic review by Jorgić et al. (2012) that analyzed 13 studies (from 1990 to 2011) which investigated the effects of hydrotherapy program on children and adolescents with CP reported optimal conditions for a hydrotherapy program as entire program duration of 10 weeks, single session duration of 45 minutes and frequency of 3 times per week.

The intensity of exercise is also as important as the frequency and duration of exercise. However, except the study by Fragala-Pinkham, Smith, Lombard, Barlow, and O’Neil (2014) none of the above studies that focused on assessing balance of children with CP following an aquatic exercise program assessed the exercise intensity levels.
Chapter 3 Study Purpose, Objectives and Hypotheses

3.1. Study Purpose

Based on the evidence from the review of literature and due to the limited information available on the effects of hydrotherapy programs on static and dynamic balance in children with CP, this study intends to fill the knowledge gaps in rehabilitating children with CP, particularly in the context of a developing society such as Sri Lanka, where access to such therapy is limited. Thus, the purpose of this study is to examine the feasibility of a 6-week individual hydrotherapy program and its effects on static and dynamic balance in children with CP in the Sri Lankan context.

3.2. Objectives

The first step of this study was to investigate the feasibility of a 6-week hydrotherapy program in children with CP in the Sri Lankan context.

The second step involves investigating 4 objectives:
1. To investigate the effects of a 6-week hydrotherapy program on static balance, as assessed by PRT, in children with CP.
2. To investigate the effects of a 6-week hydrotherapy program on dynamic balance, as assessed by mTUG test, in children with CP.
3. To determine whether the effects of a 6-week hydrotherapy program on static and dynamic balance differ among children with CP of various functional levels (GMFCS I – III).
4. To investigate the effects of a 6-week hydrotherapy program on HRQOL, as assessed by 5-item VAS, in children with CP.
3.3. Hypotheses

Four objectives of this study will be addressed with following testable hypotheses.

1. Hydrotherapy will improve static balance in children with CP.
2. Hydrotherapy will improve dynamic balance in children with CP.
3. There will be a difference in the static and dynamic balance for children with CP depending on their functional severity level (GMFCS I, II, and III) following a 6-week hydrotherapy program.
4. Hydrotherapy exercise will improve HRQOL in children with CP.
Chapter 4 Methods

4.1. Ethics Approval

The protocol of this study was approved by Health Research Ethics Board (HREB), Research Ethics-Bannatyne, University of Manitoba (H2018:332) and Ethics Review Committee (ERC), University of Kelaniya, Sri Lanka (P/134/07/2018).

4.2. Study Design

This is a quasi-experimental pretest-posttest design without a control group. Assessment of outcome measures was at 2 time points; once before the hydrotherapy intervention program was commenced (pre-test assessment) and once at the end of the 6-weeks intervention period but within one week of completion of the program (post-test assessment). At the end, pre-test values were compared with post-test values to evaluate the effects of hydrotherapy program.

4.3. Sample Size Calculation

Participants for this study were children with CP and their primary caregivers (all primary caregivers were parents of children) registered at the National Center for Children with Cerebral Palsy and other Developmental Disorders (NCCCPDD) in Colombo, Sri Lanka.

Although the total number of children with CP registered at NCCCPDD was roughly 50 during the time of recruitment for this study, based on the facility records, most of them were severely impaired (with GMFCS IV and V) in terms of functional abilities. Out of these
50 children, only 15 children belonged to GMFCS levels I, II, and III (mild to moderate impairment) while the rest were categorised as having GMFCS IV and V (severe impairment). The planned hydrotherapy program for this study contained tasks that were not practically possible for a child with GMFCS IV or V. For this reason, a formal sample size calculation was not used for this study with the intent of recruiting all those with GMFCS levels below IV.

4.4. Study Participants

4.4.1. Inclusion criteria
1. Diagnosis of CP
2. Age of 6 – 12 years
3. Gross Motor Functional Classification System (GMFCS) levels of I, II and III
4. Ability to follow simple instructions
5. Having no medical contraindication for exercising in water

4.4.2. Exclusion criteria
1. Having a fear of being in a pool
2. Having undergone an orthopedic surgery in the preceding 6-months
3. Having active infection, or open wounds, or risk of aspiration or swallowing difficulties

4.5. Study Setting

The hydrotherapy intervention program was carried out at an institution called NCCCPDD in Colombo, Sri Lanka. This facility has an outdoor shallow therapeutic pool:
rectangular 12 × 22.5 feet with the depth ranging from 1 foot to 4 feet maximum (Appendix K) where this hydrotherapy program was implemented. For water entry and exit, this pool has a ramp and stairs. However, this pool does not have a temperature regulation system. Therefore, pool water temperature varied with the air temperature and usually this ranged from 27°C to 30°C during the 6-week period that this hydrotherapy program was implemented.

4.6. Recruitment and Obtaining Consent and Assent

Initially, 13 Children with CP who matched the inclusion criteria were identified through the facility via existing client records maintained by the facility. Then, depending on their primary language (Sinhala, Tamil or English), a package which contained a letter of invitation to participate (Appendix C), participant information sheet (Appendix D) and consent form (Appendix E) was given in a sealed envelop to take home to the primary caregiver/parent of each potential participant through the facility. Primary caregivers who were willing to participate were asked to contact the principal investigator within the next two weeks via the contact details provided. However, within the next day, 11 primary caregivers expressed willingness to involve their children in this study while 2 primary caregivers informed their inability to participate since their children were sick for some time.

Next day, a meeting was conducted for the 11 interested parents by the primary investigator with the support from the chief physiotherapist to explain the details of the study. At the end of the meeting, one parent did not want to involve her child in this study since she was concerned that this hydrotherapy program would cause exercise-induced seizures which could be potentially harmful to her child’s epilepsy status. Except one parent,
all other parents gave their informed written consent on the same day. On the following day, informed consent was obtained from the remaining parent by the principal investigator. On the same day, 10 children were screened and noted that 4 of them had communication impairment. Therefore, at the end of the screening process, only 6 children met all inclusion criteria. Subsequently, all 6 of them were enrolled after obtaining the assent (Appendix F) by the principal investigator using the developmentally appropriate terms with the support from the parents and the chief physiotherapist.

4.7. Hydrotherapy Intervention Program

This hydrotherapy program was designed with pre-determined intensity ranges which were calculated using the HRR method. The intensity range of entire program was targeted to maintain within 40%–80% of HRR with varying intensity ranges for each phase of the program. To obtain the intended intensity level, Target Heart Rate (THR) Zone; upper and lower limit of the THR range was calculated. A water-resistant Polar H10 heart rate sensor attached to a chest strap and a Polar A300 heart rate monitor wristwatch receiver were used for heart rate monitoring and recording (Polar Electro, 2018). Additionally, Polar Beat application installed in a mobile phone was also used for heart rate recordings.

Before entering the pool, chest strap was fastened around child’s chest followed by attaching the heart rate sensor to the strap and wearing the wristwatch. Just before entering the water, wristwatch was switched on. Therefore, heart rate monitoring was started while the child is still on the land. Throughout the training session, after every 5 minutes, the assistant checked the heart rate monitor to make sure that the child was exercising within the predetermined THR Zone. To maintain heart rate within the predetermined heart rate limits,
the physiotherapist and the training assistant encouraged the child to engage in pool sessions by making the event more enjoyable.

The initial plan of the study was to conduct hydrotherapy intervention sessions twice per week for 6 continuous weeks with at least 2 – 3 days maximum gap between sessions. However, to fit in with the school’s schedule and to avoid children suffering from common cold entering the pool, occasionally, maximum gap between sessions varied from 1 – 7 days for some participants. During the 6 weeks period each child underwent 12 hydrotherapy sessions. Three certified physiotherapists with experience in pediatric rehabilitation conducted the hydrotherapy program. For assistance and to ensure optimal participation and safety always there was a physiotherapist in the pool with the child; 1:1 child: physiotherapist ratio.

Additionally, the principal investigator or a volunteer participated as training assistants. While waiting at the pool boundary, parents also participated in the pool activity to help children when needed. Throughout the intervention program, children wore standard life jackets and used aquatic devices such as aquatic noodle, swim ring and kickboard accordingly to facilitate aquatic exercises. During the program, whenever the participant was tired and could not continue exercising, he/she was allowed to rest for 1 – 2 minutes.

Each single session of this intervention program comprised of 3 basic components: Warm-up, aerobic exercise activities, and cool-down and stretching exercises, which were developed based on previous studies (Badawy & Ibrahem, 2016; Fragala-Pinkham et al., 2008; Fragala-Pinkham, O'Neil, & Haley, 2010; Fragala-Pinkham et al., 2014; Retareka et al., 2009). The 3 exercise components were performed in the order mentioned below.
**Warm-up exercise (in waist deep water for 5 minutes at 40% – 60% intensity):**
This includes walking slowly on the pool floor (pool walking) in all directions, i.e., forwards, backwards and sideways while holding onto underwater parallel bars and stepping up and down on a pool step in waist deep water.

**Aerobic exercises (in ankle deep to shoulder deep water for 30 minutes at 60% – 80% intensity):** These exercises were performed in ankle deep to shoulder deep water and include kicking, jumping, shuttle running, running, and swimming. The participant did flutter kicks while holding the kickboard at the sides near the top in prone position or participant sat on a pool stair and splashed out water as much as possible by kicking with both legs. Jumping activities were performed by jumping forward and backward and sideways in ankle deep to waist deep water. Shuttle running involved transferring pool toys such as water ducks and water balls from one side of the pool to the opposite side either by walking as fast as possible or running in waist-shoulder deep water. Running activities were performed both in waist deep water and shoulder deep water. Waist deep water running mimicked a play activity like racing a family member or an assistant who was at the pool boundary outside. For running in shoulder deep water, physiotherapist supported the participant to move forward by maintaining her/his body in the upright posture. Swimming activity was performed in waist deep to shoulder deep water and included swimming in competition with the assistant while maintaining a horizontal position with the aid of aquatic equipment and the physiotherapist.

**Cool down and stretching exercises (in waist deep water for 10 minutes at 40% – 60% intensity):** Same exercises performed for warm-up were repeated to cool-down.
Additionally, activities such as marching in water, arm and leg circles were performed at slow pace. Muscles or muscle groups and tendons targeted for stretching exercises varied with the individual participant’s affected body structures and included internal rotators of shoulder, triceps, flexors of elbow and wrist and upper limb pronators, hamstring, quadriceps, lower limb adductors and flexors, and Achilles tendon. All stretches were performed bilaterally by the physiotherapist. Each stretch was held for 20 – 30 seconds and repeated twice. The training assistant stabilized the subject as required by the physiotherapist.

And at the end of the 45 minutes intervention program, the child left the pool and took a shower and rested in the changing room roughly for 15 minutes. During this period, each child received some candy and fruit juice.

At the end of each single-day session, saved training data in the Polar A300 heart rate monitor (wristwatch) was synced with Polar Flow web service using a password-protected personal computer of the principal investigator. Subsequently, data from Polar Flow web service was downloaded, exported and saved in a specific folder of the same computer as Microsoft Excel files.

During the study period, children were asked to undergo this new hydrotherapy program instead of the bi-weekly hydrotherapy treatment that they were receiving at the NCCCPDD. Basically, the therapy that children received at the facility was individualized according to their level of impairment and based on various hydrotherapy concepts such as
13 children with CP were identified through the existing client records maintained by the NCCPDD and recruitment forms forwarded.

11 parents expressed their willingness to participate.

A parents meeting was held by the principal investigator to explain the details of the study.

Informed written consent obtained from 10 parents.

10 children underwent initial screening.

6 children met inclusion criteria were enrolled after obtaining the assent.

5 children completed the study.

2 parents informed their inability to involve children in the study due to illness related issues.

One parent declined to participate due to the health status of the child.

4 children had communication impairment and they were excluded from the study.

1 child withdrawn from the study due a medical reason.

Figure 4.1 Flow chart of participants throughout the study
Halliwick method, Bad Ragaz ring method and Ai Chi. Because of this bi-weekly program at the facility, all children were used to being in pool environment. However, the regular program offered by the facility was not framed on the intensity level of aerobic exercise.

Also, participants did not receive any other land-based therapy during the study period.

4.8. Exercise Intensity of Hydrotherapy Program

According to the American College of Sports Medicine (ACSM) (2014) there are 5 ways to monitor the intensity of an exercise program: 1. Heart Rate Reserve (HRR) method 2. Heat Rate (HR) method, 3. Oxygen Uptake Reserve (VO$_2$R) method, 4. Oxygen Uptake (VO$_2$) method, and 5. Metabolic Equivalent (MET) method. In the published literature HRR method (Ballaz et al., 2011; Fragala-Pinkham et al., 2008; Retareka et al., 2009) and HR method (Fragala-Pinkham et al., 2014) have been used to assess the exercise intensity levels of children with CP during hydrotherapy programs.

HRR is obtained by deducting resting heart rate (HR$_{rest}$) from the maximum heart rate (HR$_{max}$) (HRR = HR$_{max}$ – HR$_{rest}$) (ACSM, 2014). The best time to measure the HR$_{rest}$ is when the subject wakes up in the morning and before leaving the bed (American Heart Association, 2019). The HR$_{max}$ is age dependent and can be obtained by deducting the age of the subject from 220 (HR$_{max}$ = 220 – Age). Therefore, HRR equation comes as; HRR = (220 – Age) – HR$_{rest}$ (ACSM, 2014).

To obtain the Target Heart Rate (THR) range for a desired intensity level of an exercise program, this HRR equation needs to be modified as below.

HRR method: THR = [(220 – Age – HR$_{rest}$) × % intensity desired] + HR$_{rest}$
Therefore, depending on the expected range of intensity level THR will have an upper limit and a lower limit; THR zone.

As defined by the ACSM, HRR between 30% – <40%, 40% – <60% and 60% –<90% are light, moderate and high intensity exercises, respectively. The centers for disease control and prevention (2019) and American Heart Association (2018) explained that children should engage in physical activity within the range of moderate to vigorous intensity for more than 60 minutes per day. According to the ACSM (2014), individuals with CP of mild to moderate functional impairment should engage in aerobic exercise programs with moderate to high intensity.

Figure 4.2 Components of a single hydrotherapy session
Therefore, considering all those factors, this hydrotherapy program was developed to achieve intensity level of 40% – 80% of HRR with different intensity ranges for the 3 phases of the intervention: warm-up (40% – 60%), aerobic exercise (60% – 80%) and cool down and stretching (40% – 60%). Hence, to obtain the intended range of intensity levels, THR Zone; upper and lower limit of the THR range was calculated (Table 5.2).

4.9. Instrumentation

4.9.1. Primary outcome measures

4.9.1.1. Pediatric Reach Test (PRT)

In 1990, Functional Reach Test (FRT), the foundation of the PRT was developed to examine the standing balance in adults (Duncan, Weiner, Chandler, & Studenski, 1990). Later, FRT was used for the pediatric population of normal development (Donahoe, Turner, & Worrell, 1994) and neurological diseases (Niznik, Turner, & Worrell, 1996) and reported as a reliable tool that can be used to evaluate balance function of children with or without neural disabilities.

FRT measures the maximum distance (starting from the level of the acromion) that an individual can reach in the forward direction (forward reaching) while maintaining the balance in standing position and keeping the base of support structure fixed (Duncan et al., 1990). In 2003, Bartlett and Birmingham expanded original FRT by incorporating another dimension that assesses subject’s ability to reach maximally in lateral directions, i.e. right and left (lateral / side reaching) in both standing and sitting postures and named it as PRT, also called Pediatric Functional Reach Test (PFRT) (Kaya, Alemdaroğlu, Yılmaz, Karaduman, & Topaloğlu, 2015). The average distance that the child can reach in forward,
right lateral and left lateral directions is considered as PRT scores for each direction. Therefore, for both sitting and standing positions, PRT has 6 reaching activities, giving 6 PRT scores (Bartlett & Birmingham, 2003).

According to Bartlett and Birmingham (2003), PRT has moderate to excellent test-retest and interrater reliability for children with CP (ICC values ranged from 0.54 – 0.88 and 0.50 – 0.93 respectively). However, this study was conducted only for 10 children with CP belonging to GMFCS I, III and IV. Another study conducted for 28 children with CP from all 5 GMFCS categories (I – V) aged 2 – 7 years reported excellent test-retest reliability (ICC = 0.94) and interrater reliability (ICC = 0.84) of PRT (Randall, Bartlett, & McCoy, 2014). In 2009, Katz-Leurer, Rotem, Keren, and Meyer investigated the reliability of 3 standing subcomponents of PRT: forward, left and right reach, and reported excellent intrarater reliability both in children with traumatic brain injury (ICC = 0.92 – 0.98) and normal development (ICC = 0.94 – 0.95). Later, in 2012, Rajendran, Roy, and Jeevanantham investigated reliability of standing forward reach and lateral reach (only in one direction) components of the PRT among 65 children with hearing impairment and reported excellent intrarater reliability; ICC = 0.94 – 0.98 for forward reach and ICC = 0.95 – 0.96 for lateral reach, and interrater reliability: ICC = 0.9 for forward reach and ICC = 0.97 for lateral reach.

In terms of concurrent validity of PRT, moderate to high positive correlation (r = 0.42 – 0.77) between standing component of the PRT and standing balance tests (performed on a force platform) was found. In addition, the evidence for the construct validity was demonstrated by the high correlation noted between: (a) standing component of PRT and steadiness element of force platform test (r = – 0.79) and age (r = 0.83), and (b) total score of PRT and GMFCS levels (r = – 0.88) (Bartlett & Birmingham, 2003).
In the existing literature, Minimal Detectable Change (MDC) and Minimal Clinically Important Difference (MCID) values and responsiveness of each PRT scores have not been established.

In this study, the protocol prescribed by Bartlett and Birmingham (2003) was followed to perform the PRT. Permission for using this tool was obtained from the correspondence author.

To administer the PRT, the child sat down on a wooden bench (without armrest or back rest) keeping his feet flat on the floor, with hips and knees at 90° and handssitting on the lap. Only if the child was able to maintain this seated position independently for 15 seconds, were the sitting components of the PRT administered. To begin the test, tip of the measuring tape was secured to the tip of the middle finger of the child’s dominant hand with a piece of adhesive tape. The therapist kneeled stably behind the child facing his back. Next, child sat up straight and lifted his/her hand to 90° shoulder flexion and held this position for 3 seconds. After the child held this position for 3 seconds, the therapist took the first measurement; the distance between the tip of the middle finger and the acromion process. Next, child reached forward direction as far as possible aiming to touch a motivating object such as a toy held by the assistant and held the maximum distance reached for 3 seconds. Again, after child held this position for 3 seconds, the therapist took the second measurement. To obtain measurements, the therapist supported his forearm with the opposite hand. Subsequently, the difference between first and the second measurements was taken as the PRT score for the sitting-forward direction. These same steps were repeated to obtain the PRT scores for the sitting-left lateral direction and right lateral directions.
This was followed by administering the standing subsections of the PRT. For this, child stood on a sheet of paper taped to the floor, and child’s footprint (in this case the footwear print) +/- contact position of the mobility aids was traced on the paper sheet taped to the floor. As for the sitting components, the next step was to check whether the child could stand independently for 15 seconds. If the child was able to stand for 15 seconds, standing components of PRT were administered as for the sitting components. This time, the therapist positioned steadily behind the child and followed the same steps mentioned above to obtain the PRT scores for the standing Forward Reach (FR), Left Lateral Reach (LLR) and Right Lateral Reach (RLR). All the participants in this study took one practice trial, followed by 3 test trials on the same day with 5 minutes break between trials.

4.9.1.2. modified Timed Up and Go (mTUG) Test

The Get-up and Go test, designed to clinically access elderly people’s dynamic balance while performing tasks associated with risk of falling (Mathias et al., 1986), was the foundation for the TUG test which was developed in 1991 by Podsiadlo and Richardson. This standard TUG test was modified for children with disabilities and named as modified TUG test (also called TUG-In Children / TUG - IC) (Dhote, Khatri, &Ganvir, 2012; Williams, Carroll, Reddihough, Phillips, & Galea, 2005; Zverev & Kurnikova, 2016).

Due to the simplicity and ease of application, TUG test is being widely used in pediatrics (Nicolini-Panisson & Donadio, 2013). Moreover, the validity and the reliability of this test have been reported by many studies on children with cerebral palsy. TUG has excellent test-retest reliability (ICC = 0.99) between 5 to 12 years old children with CP (Gan et al., 2008). Similarly, mTUG test shows excellent test-retest reliability (ICC = 0.99) and
intra-class reliability (ICC = 0.99) for children with CP between 2 to 12 years old (Dhote et al., 2012). In supplement to that, in the Williams, Carroll, Reddiough, Phillips, and Galea (2005) study conducted for children with CP (n = 33) and spina bifida (n = 8), it was reported that test-retest reliability and intra-class reliability of mTUG test as ICC = 0.99 and 0.98, respectively.

In 2016, Carey, Martin, Combs-Miller, and Heathcock reported that MDC and MCID value ranges of the mTUG test for the children with CP of GMFCS I – III vary between 1.40 – 8.74 s and 0.22 – 5.31s, respectively and concluded that this test can be used as a reliable and responsive measure to evaluate the balance function of children with CP aged 3–10 years in GMFCS I – III levels. Further, some studies have reported the significant variability in the TUG scores among children with CP of GMFCS I, II and III, and that TUG score is directly proportional to the GMFCS level (Carey, Martin, Combs-Miller, & Heathcock, 2016; Dhote & Ganvir, 2013; Dhote et al., 2012). However, according to Hassani et al. (2013), TUG cannot differentiate children with CP of GMFCS I and II who are independent ambulators.

For the present study, the protocol of the mTUG test described by Williams et al. (2005) was performed to assess the dynamic balance of children with CP. Permission to use this tool was obtained from the corresponding author.

To begin the test, child sat on a seat without armrests but with a backrest. The height of the seat was considered appropriate when the child’s feet were level on the ground with 90° knee joint flexion. Next, child was asked to stand and walk along the 3m distance marked on the floor and touch a star on the wall. Immediately after, child returned along the same path and sat down on the same seat. Time taken for this entire process was counted in seconds
and considered as mTUG test scores. One practice trial and 3 test trials were conducted on the same day with a resting period of 5 minutes between trials. Including resting periods, total time that took for these 4 test trials was approximately 30 minutes. One physiotherapist who also involved in the hydrotherapy intervention program applied the test to all children pre and post-intervention.

4.9.2. Secondary outcome measure

4.9.2.1. Visual Analogue Scale (VAS)

In children, VAS has been used to measure perceived enjoyment of physical activity (Winkels, Kottink, Temmink, Nijlant, & Buurke, 2013), emotionally distressing symptoms such as anxiety, anger, sadness, worry, fatigue and pain intensity (Sherman, Eisen, Burwinkle, & Varni, 2006) and HRQOL of children (Wehby, Naderi, Robbins, Ansley, & Damiano, 2014). Upon examining the literature, VAS is considered as a reliable and valid measure (Klimek et al., 2017). Both children self-reported version and parent-proxy reported version of VAS showed preliminary test-retest reliability, internal consistency reliability and construct validity (Sherman et al., 2006). Wehby, Naderi, Robbins, Ansley, and Damiano (2014) reported the correlation ($r = 0.67$) between VAS and Pediatric Quality of Life Inventory 4.0 (PedsQL TM) in assessing overall HRQOL in children with oral clefts. VAS has been used widely in various settings due to its simplistic nature and easy-to-use feature (Wehby, Ohsfeldt, & Murray, 2006).

The VAS is a 10cm long straight horizontal line with word anchor point of worst imaginable health (Score 0) and perfect health (Score 100) on the left and right ends, respectively. Except 0 and 100 marked either side, the line is not gauged in between. When
using VAS as a measure of HRQOL, evaluator is instructed to mark a vertical line at the point that is most representative of HRQOL of the respective subject. To measure the HRQOL as a score, the distance between the 0 and the marked vertical line on the scale is measured and divided by the full length of the scale that corresponds to 10 cm (Wehby et al., 2014; Wehby et al., 2006).

In the current study, HRQOL of children was assessed under 5 items: 1. Pain or discomfort during physical activity 2. Enjoyment of physical activity 3. Self-confidence in participating in physical activity 4. Comfort level at social settings and 5. Overall HRQOL. For each item, one VAS was used. Therefore, it was a 5-item VAS with separate scales for each item. Instead of using 10 cm long VAS described before, for this study 20 cm long VAS was used (score 0 at 0 cm and score 1 at 20 cm). Therefore, to get the final score of each item, the distance between the 0 cm and the marked vertical line on the scale was divided by 20 cm. The word anchor points of each VAS were varied depending on the item (Appendix J). For all items, a higher score indicated improvement, e.g. higher score in the VAS item 01 means reduced pain and discomfort during physical activity. Depending on the primary language, each primary caregiver was given 5-item VAS before and after the hydrotherapy program to assess their children’s HRQOL. Permission for using this description of VAS was obtained from the correspondence author.

4.10. Study Procedure

At the end of the recruitment process, each child was given an identification number. Next, child’s basic demographic data: age (in years), sex, height and weight and some clinical data (type of CP; whether spastic, dyskinetic or ataxic and hemiplegic, diplegic or quadriplegic and functional level according to the GMFCS classification) were recorded
from the charts available in the facility. At the same time, type and frequency of current rehabilitation treatments that children were receiving was obtained from the facility records. During the same time period, the 5-item VAS of HRQOL of the participating children, was distributed and completed forms collected from parents.

Subsequently, child’s $HR_{\text{rest}}$ was recorded after subject had been quietly and comfortably seated for 4.5 minutes. After 4.5 minutes of resting, for the next 30 seconds 3 heart rate recordings were obtained (one recording for each 10 seconds) and then, the average of these 3 values was taken as the $HR_{\text{rest}}$ (Ballaz et al., 2011). Next, depending on the predetermined range of intensity levels for each phase of the hydrotherapy intervention program, THR zones were calculated using the HRR method.

Next step was balance assessment. Balance was examined by a physiotherapist involved with the hydrotherapy program using two clinical tests: mTUG test and PRT test. All the children performed mTUG test first, followed by the PRT on two different days with 4 day’s maximum gap between two tests. For the first test, the child was asked to stand from a sitting position and then walk for a total of 6 meter and then sit down on the same chair. The second test was conducted on a different day. During this test, the maximum distance that the child could reach in various directions in both sitting and standing positions was assessed. Each test was repeated 4 times with 5 minutes break between trials.

Thereupon, 1 – 2 days after completion of the pre-intervention balance assessment, the hydrotherapy intervention program was started and continued twice per week for 6 consecutive weeks; during the day time, with 1 – 7 day’s maximum gap between each 2 sessions. Each session lasted 45 minutes. However, including the 15 minutes of resting period, single pool session took an hour to complete.
Within 5 days following completion of the program, balance was reassessed by the same physiotherapist using the same two clinical tests in the same order described above. During this period, the 5-item VAS was provided to each primary caregiver for post-intervention assessment of HRQOL of their children.

4.11. Data Analysis

Descriptive statistics (mean and standard deviation (SD)) were calculated and reported for the age, height and weight of participants and for both pre and post test scores of each primary and secondary measures. Participant-specific data were plotted on bar graphs.

For the inferential statistical analysis, 2 approaches were chosen: binomial probability distribution and paired t-test. Binomial probabilities were calculated to determine the likelihood of number of children showing improvement by chance. This method was chosen as an initial step due to the inability of the study data to meet the assumptions for parametric testing. As a second step, paired t-tests were performed to assess the magnitude of differences between pretest and posttest outcome scores.

The success or failure of the hydrotherapy program for each child was considered to follow a binomial distribution, with probability of success equal to 50%. This assumption is reasonable if one speculates an equal chance of improvement (success) or non-improvement (failure) for each child, and outcomes for each child are independent from another child.

To compare mean pre-post scores and to determine the significance of mean differences in all 3 outcome measures a paired t test was used. A Bonferroni correction was used to minimize the risk of type I error which could result from multiple paired
comparisons. This resulted in significance level (alpha) of \( p < 0.05 \) to reduce to \( p < 0.004 \) (0.05/12).

Also, effect size for each of the outcome variable was calculated to identify the magnitude of group differences and interpreted according to the Cohen’s \( d \) guidelines: 0.2, 0.5, and 0.8 as small, medium, and large effects, respectively (Ferguson, 2009).

All statistical analyses were carried out with the aid of the Statistical Package for Social Sciences (SPSS), version 17.0 (SPSS Inc., Chicago, IL, USA).

However, due to the inadequacy of the sample size leading to very limited number of children participated from each 3 categories of GMFCS levels (two participants from GMFCS level I and II, and 3 participants from GMFCS level III), a comparison of pre- post test score differences of static and dynamic balance measures by GMFCS levels of participants were not carried out.
Chapter 5 Results

5.1. Demographic and Clinical Data Description

Basic demographic and clinical information of individual participants are shown in Table 5.1. Though 6 children with CP were recruited initially (as represented in the flow chart of the participants (Figure 4.1), only 5 children (age: 9.6 ± 1.3 years (mean ± SD), height: 122 ± 6.3 cm, weight: 24 ± 8.1 kg), with male to female ratio of 4:1, completed the hydrotherapy program.

Table 5.1

Demographic and Clinical Information of the Participants

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age (years and months)</th>
<th>Gender</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>GMFCS Level</th>
<th>BMI (kg/m²)</th>
<th>Types of CP</th>
<th>Ambulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9y 4m</td>
<td>Male</td>
<td>132</td>
<td>20</td>
<td>I</td>
<td>11.5</td>
<td>Dyskinetic</td>
<td>Independent</td>
</tr>
<tr>
<td>2</td>
<td>9y 5m</td>
<td>Male</td>
<td>116</td>
<td>17.5</td>
<td>II</td>
<td>13</td>
<td>Dyskinetic</td>
<td>Independent</td>
</tr>
<tr>
<td>3</td>
<td>7y 8m</td>
<td>Male</td>
<td>119</td>
<td>38</td>
<td>III</td>
<td>27</td>
<td>Spastic Diplegic</td>
<td>Walker</td>
</tr>
<tr>
<td>4</td>
<td>11y 2m</td>
<td>Male</td>
<td>124</td>
<td>22</td>
<td>III</td>
<td>14.3</td>
<td>Spastic Diplegic</td>
<td>Walker</td>
</tr>
<tr>
<td>5</td>
<td>10y 4m</td>
<td>Female</td>
<td>119</td>
<td>22</td>
<td>III</td>
<td>15.5</td>
<td>Spastic Diplegic</td>
<td>Walker</td>
</tr>
</tbody>
</table>
5.2. Training Intensity of the Hydrotherapy Program

Heart rate was used to define the exercise intensity of this program. Although it was planned to collect 12 heart rate recordings per participant during the period of 6-weeks, which comes as 60 recordings per all 5 participants, only 45 recordings were able to be collected despite 100% attendance. While the minimum number of successful recordings obtained from a single participant were 8, the maximum number of successful recordings were 11 (Table 5.2). Some heart rate data was incomplete due to some technical and feasibility issues. Even though the smallest chest strap available was used, it fitted properly only to a single child. Therefore, for each session, the length of the chest strap was adjusted using some cloth bands to suit them individually. Since none of these children had chest wall deformities, shortening the strap resolved this problem. However, since children were wearing life jackets on top of the chest strap and using flotation devices, in certain times, these caused displacement of the chest strap or interfered with heart rate recordings. Occasionally, children pressed the wristwatch recording buttons which resulted in losing some heart rate data.

Average exercising heart rate and intensity level achieved during the 6-week hydrotherapy program are plotted in Figure 5.1 and 5.2, respectively.

Generally, throughout all sessions, all 5 children exercised within light intensity (>30% – <40% of HRR) to moderate intensity (>40% – <60% of HRR) range with an average intensity level of 43% of HRR for a period of 50 minutes (Figure 5.2). For the warm-up, aerobic exercise and cool down and stretching phases, the performing average intensity levels were 40%, 47% and 41% of HRR, respectively.
Table 5.2

*Heart Rate Data of Individual Participant*

<table>
<thead>
<tr>
<th>Case No</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of heart rate recodings per participant (out of 12 total recordings)</td>
<td>10</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Average HR_{rest} (bpm)</td>
<td>80</td>
<td>81</td>
<td>83</td>
<td>86</td>
<td>81</td>
</tr>
<tr>
<td>THR Zone (bpm) for each phase of the program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm-up (40% – 60% intensity)</td>
<td>133-159</td>
<td>135-157</td>
<td>135-161</td>
<td>135-160</td>
<td>133-158</td>
</tr>
<tr>
<td>Aerobic exercise (60% – 80% intensity)</td>
<td>159-186</td>
<td>157-186</td>
<td>161-187</td>
<td>160-184</td>
<td>158-184</td>
</tr>
<tr>
<td>Cool-down and stretching (40% – 60% intensity)</td>
<td>133-159</td>
<td>135-157</td>
<td>135-161</td>
<td>135-160</td>
<td>133-158</td>
</tr>
<tr>
<td>Average HR (bpm) achieved during each phase of the program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm-up</td>
<td>134</td>
<td>151</td>
<td>122</td>
<td>121</td>
<td>137</td>
</tr>
<tr>
<td>Aerobic exercise</td>
<td>142</td>
<td>153</td>
<td>133</td>
<td>133</td>
<td>152</td>
</tr>
<tr>
<td>Cool-down and stretching</td>
<td>136</td>
<td>144</td>
<td>127</td>
<td>123</td>
<td>143</td>
</tr>
<tr>
<td>Average HR intensity achieved across all 3 phases of the program</td>
<td>137</td>
<td>149</td>
<td>127</td>
<td>126</td>
<td>144</td>
</tr>
<tr>
<td>Average exercise intensity (as a % of HRR) achieved during each phase of the program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm-up</td>
<td>42%</td>
<td>54%</td>
<td>30%</td>
<td>29%</td>
<td>44%</td>
</tr>
<tr>
<td>Aerobic exercise</td>
<td>48%</td>
<td>56%</td>
<td>39%</td>
<td>39%</td>
<td>55%</td>
</tr>
<tr>
<td>Cool-down and stretching</td>
<td>38%</td>
<td>44%</td>
<td>31%</td>
<td>28%</td>
<td>44%</td>
</tr>
<tr>
<td>Average exercise intensity (as a % of HRR) achieved across all 3 phases of the program</td>
<td>44%</td>
<td>52%</td>
<td>36%</td>
<td>34%</td>
<td>50%</td>
</tr>
<tr>
<td>Time spent (minutes) at different intensity levels across all 3 phases of the Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>10</td>
<td>5</td>
<td>35</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Moderate</td>
<td>40</td>
<td>45</td>
<td>15</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>High</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note.* HR_{rest}: Resting Heart Rate, THR: Target Heart Rate
5.3. **Outcome Measures**

Following completion of a 6-week hydrotherapy program, regardless of the outcome measure used, all 5 children showed some improvement (success) (Figure 5.3 – 5.14). The probability of achieving 5 successes among the 5 children is \((0.5)^5 = 0.031\). Thus, the 5 successes of the hydrotherapy program are quite unlikely \((p < 0.05)\) to occur by chance.

5.3.1. **Primary outcome measures**

5.3.1.1. **PRT**

Post intervention distance reached in all directions: Forward Reach (FR), Left Lateral Reach (LLR), and Right Lateral Reach (RLR) in both the sitting and standing position showed an improvement. And, for all paired comparisons, except forward reach distance when sitting \((p=0.015)\), all other components of the PRT showed statistical significance.

*Figure 5.1 Exercising heart rate during the hydrotherapy program*
where p value is < 0.004. Table 5.3 represents mean difference, mean standard deviation, 95% CI, p value and effect size for each section of the PRT. Table 5.4 shows the percentage of relative change, i.e., pre and post score difference divided by pre-score for PRT.

Figure 5.2 Exercise intensity during the hydrotherapy program

Figure 5.3 Pretest and post-test comparison of sitting -FR component of PRT
**Figure 5.4** Pretest and post-test comparison of sitting - LLR component of PRT

**Figure 5.5** Pretest and post-test comparison of sitting - RLR component of PRT
Figure 5.6 Pretest and post-test comparison of standing -FR component of PRT

Figure 5.7 Pretest and post-test comparison of standing -LLR component of PRT
5.3.1.2. mTUG

With reference to mTUG test, results showed time to complete this test before the intervention (39.5 ±28.88; mean ± SD) was reduced (i.e., improved) after the intervention (30.91 ±23.05) (Figure 5.9). However, a paired t-test revealed (Table 5.3) that mean pre-post difference of mTUG test was not statistically different from zero (p = 0.07, effect size = 0.81, 95% CI = −4.57 to 21.92). Table 5.4 shows the percentage of relative change, i.e., pre and post score difference divided by pre-score for mTUG test.
Table 5.3

*Paired Sample t-test Results for mTUG test and PRT*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Paired Differences</th>
<th>95% CI of the Difference</th>
<th>t value</th>
<th>df</th>
<th>Significance(1-tailed)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
<td>Lower</td>
<td>Upper</td>
<td></td>
</tr>
<tr>
<td>mTUG Pre and Post</td>
<td>8.68</td>
<td>10.67</td>
<td>4.77</td>
<td>-4.57</td>
<td>21.92</td>
<td>1.819</td>
</tr>
<tr>
<td>PRT-Sitting FR Pre and Post</td>
<td>-1.66</td>
<td>1.12</td>
<td>0.50</td>
<td>-3.05</td>
<td>-0.27</td>
<td>-3.304</td>
</tr>
<tr>
<td>PRT-Sitting LLR Pre and Post</td>
<td>-0.89</td>
<td>0.29</td>
<td>0.13</td>
<td>-1.26</td>
<td>-0.53</td>
<td>-6.809</td>
</tr>
<tr>
<td>PRT-Sitting RLR Pre and Post</td>
<td>-0.94</td>
<td>0.31</td>
<td>0.14</td>
<td>-1.33</td>
<td>-0.55</td>
<td>-6.687</td>
</tr>
<tr>
<td>PRT-Standing FR Pre and Post</td>
<td>-1.03</td>
<td>0.33</td>
<td>0.15</td>
<td>-1.44</td>
<td>-0.62</td>
<td>-6.986</td>
</tr>
<tr>
<td>PRT-Standing LLR Pre and Post</td>
<td>-0.95</td>
<td>0.41</td>
<td>0.18</td>
<td>-1.47</td>
<td>-0.44</td>
<td>-5.182</td>
</tr>
<tr>
<td>PRT-Standing RLR Pre and Post</td>
<td>-0.76</td>
<td>0.15</td>
<td>0.07</td>
<td>-0.95</td>
<td>-0.57</td>
<td>-11.087</td>
</tr>
</tbody>
</table>

Note. *Statistically significant (Bonferroni corrected α level is p < 0.004). Units for the mTUG test is in seconds and for the PRT is in centimeters (cm).*
In terms of GMFCS level, both before and after the intervention, 2 children with GMFCS I and II (independent ambulation) spent the least time to complete the mTUG test than the other 3 children with GMFCS III (walker-dependent ambulation) who showed substantial variability in their timing.

Table 5.4

<table>
<thead>
<tr>
<th>Variable</th>
<th>% of Relative Change</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>mTUG</td>
<td>20.8</td>
<td>12.72</td>
</tr>
<tr>
<td>PRT - Sitting – FR</td>
<td>6.0</td>
<td>5.48</td>
</tr>
<tr>
<td>PRT - Sitting – LLR</td>
<td>7.2</td>
<td>2.59</td>
</tr>
<tr>
<td>PRT - Sitting – RLR</td>
<td>8.0</td>
<td>3.61</td>
</tr>
<tr>
<td>PRT - Standing – FR</td>
<td>9.2</td>
<td>3.7</td>
</tr>
<tr>
<td>PRT - Standing – LLR</td>
<td>11.8</td>
<td>4.66</td>
</tr>
<tr>
<td>PRT - Standing – RLR</td>
<td>9.8</td>
<td>3.42</td>
</tr>
</tbody>
</table>

Overall, during both pre and post intervention, 2 children with GMFCS I and II showed lower mTUG test scores than those 3 children with GMFCS III.

4.3.2. Secondary outcome measure

4.3.2.1. VAS

For all the participants across all 5 items (pain and discomfort during physical activity, enjoyment of physical activity, self-confidence in participating in physical activity, comfort level at social setting and overall HRQOL), pre-post comparison of mean VAS scores showed improvement following the 6-week hydrotherapy program (Figure 5.10 – 5.14).
However, paired t test results demonstrate that mean pre-post differences of 5-item VAS has no statistical significance (p > 0.004). Table 5.5 represents mean difference, mean standard deviation, 95% CI, p value and effect size for each item of the VAS.

![Pain and discomfort during physical activity](image1)

*Figure 5.10 Pretest and post-test comparison of pain and discomfort during physical activity (High score indicates less pain and discomfort)*

![Enjoyment of physical activity](image2)

*Figure 5.11 Pretest and post-test comparison of enjoyment of physical activity (High score indicates increased enjoyment)*
Figure 5.12 Pretest and post-test comparison of self-confidence in participating in physical activity (High score indicates improved self-confidence)

Figure 5.13 Pretest and post-test comparison of comfort level at social setting (High score indicates improved comfort level)
**Figure 5.14** Pretest and post-test comparison of overall HRQOL (High score indicates improved overall health)

**Table 5.5**

*Paired sample t-test Results for 5-item VAS*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Paired Differences</th>
<th>95% CI of the Difference</th>
<th>t value</th>
<th>df</th>
<th>Significance (1-tailed)</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paired Differences</td>
<td>Lower</td>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain and discomfort Pre – Post</td>
<td>-18%</td>
<td>0.13</td>
<td>0.06</td>
<td>-0.34</td>
<td>-0.02</td>
<td>-3.097</td>
</tr>
<tr>
<td>Enjoyment Pre – Post</td>
<td>-19%</td>
<td>0.12</td>
<td>0.06</td>
<td>-0.35</td>
<td>-0.04</td>
<td>-3.429</td>
</tr>
<tr>
<td>Self-confidence Pre – Post</td>
<td>-14%</td>
<td>0.17</td>
<td>0.08</td>
<td>-0.36</td>
<td>0.07</td>
<td>-1.849</td>
</tr>
<tr>
<td>Comfort level Pre – Post</td>
<td>-04%</td>
<td>0.04</td>
<td>0.02</td>
<td>-0.09</td>
<td>0.01</td>
<td>-1.994</td>
</tr>
<tr>
<td>Overall HRQOL Pre – Post</td>
<td>-17%</td>
<td>0.11</td>
<td>0.05</td>
<td>-0.31</td>
<td>-0.03</td>
<td>-3.456</td>
</tr>
</tbody>
</table>

*Note: Mean are in percentage.*
5.4. Safety/ Adverse effects

None of the children or parents complained of any physical pain, discomfort or injuries during the study period. Three participants started drinking pool water from the first session and for them, throughout all sessions, repeated reminders were needed to prevent this happening. Two children developed common cold during the intervention period and refrained from entering the pool for 1 week.
Chapter 6 Discussion

The goal of this study was to investigate the feasibility of a 6-week aerobic exercise-based hydrotherapy program and its effects on static and dynamic balance in children with CP in Sri Lanka. Good feasibility was demonstrated through consistent achievement of target exercise intensities throughout this program. Specifically, all 5 participants were able to achieve and maintain a meaningful heart rate (30% – 60% of HRR with an average intensity level of 43%) during the intervention period of 45 minutes for 6 weeks. Following completion of the program, all 5 children showed improvement in all 3 outcome measures used irrespective of their statistical significance. Regarding the PRT, except forward reach distance when sitting, all other 5 components showed improvement with statistical significance denoting improved static balance. However, the mTUG test used to assess the dynamic balance did not show statistically significant improvement even though there was a positive trend towards improvement. Moreover, all the participants showed improvement in the 5-item VAS used to evaluate the HRQOL, but the findings were not statistically significant.

This study gives evidence for the feasibility of a 6-week hydrotherapy program in children with CP of mild to moderate functional impairment in Sri Lankan context. Primary support for feasibility is taken from the HR data collected during the exercise. The observation that participants maintained an exercise intensity of 30% – 60% of HRR throughout the 6-week program indicated that the children could be suitably engaged in the exercises. Excluding the warm-up and cool-down phases, children achieved 47% intensity level during the aerobic phase of the intervention. Also, no consistent drop-off in HR was
seen from first to last session indicating exercises were suitably progressed and the children’s interest was maintained.

The training intensity plays a critical role in any aerobic exercise program whether it is land-based or water-based. American College of Sports Medicine (2014) recommends moderate to high intensity aerobic exercise for individuals with mild to moderate physical impairments. In the present study, to achieve and maintain moderate to high training intensity levels, children performed aerobic exercises (walking, running, jumping, and swimming) at a relatively fast speed with the supports received from the physiotherapists, assistant and parents. This increased speed exaggerated the already existing natural resistance to move in the water (Retarekar et al., 2009) making aquatic performance more challengeable. However, children of the current study couldn’t achieve the high intensity levels but maintained their average training intensity at moderate levels. This suggests that these children received a good dose of aerobic exercises during this 6-week period. As noted previously in the literature section, among 6 available studies that assessed balance in children with CP following a hydrotherapy program, only one study (Fragala-Pinkham et al., 2014), focused on evaluating the exercise intensity level, and it used the HR method instead of HRR method as in the present study. In that study, which included 8 children with CP (GMFCS I and III), reliable heart rate data was available only for 5 children, and according to those available data, 4 out of 5 participants of the study performed at or above the THR, (i. e., 70% to 80% of HRmax determined using the Shuttle Run Test) for more than 20 minutes during the total session duration of 60 minutes. This, and the current study support the use of hydrotherapy in terms of achieving a good exercise intensity level especially for children with disabilities, like CP.
Additional support for the feasibility of the intervention can be discussed from several observations. The intervention program was considered desirable based on the strong interest in the program given the high response rate to initial delivery of the information package to parents. Also, the 100% attendance and good compliance evidenced by the achieved exercise intensity levels denote that the intervention was engaging for participants. Lastly, the hydrotherapy program was perceived as beneficial based on both children’s and parents’ interest in continuing therapy. Parents anecdotally reported that their children vastly preferred exercising in the pool compared to exercising on land. Even at the end of the 6-week program, none of the parents or children wanted to discontinue it, and even 3 parents started to find alternatives to continue hydrotherapy for their children.

Aside from feasibility, this study also sought to collect preliminary data regarding the effectiveness of the hydrotherapy program to improve balance outcomes. Static balance was assessed using the PRT, and all children showed some improvement for all 6 components of the test with varying degrees of relative change (Table 5.4). Further, all the components of the test except sitting forward component demonstrated statistical significance (p < 0.004). In the available literature, there were no published studies reported to have used the PRT for assessing the balance of children following hydrotherapy programs except a PhD dissertation carried out in Seoul, South Korea (Jeon, 2013). It was based on the Halliwick concept of hydrotherapy and included 10 children with CP (GMFCS II – IV) aged 4 to 10 years and was conducted for 6 weeks. However, instead of 6 components of the PRT, that study used only the 3 sitting components of the test (forward, left and right reach when sitting) and reported improvement (p < 0.05) following the intervention which is consistent with the current study.
Due to the scarcity of using PRT in hydrotherapy studies, comparison of findings of the current study with other studies is limited. In the available literature, 2 hydrotherapy studies have used FRT which was carried out while the subject is standing and is similar to the forward reach components of the PRT when standing. The first study by Thorpe et al. (2005) conducted a 10-week aquatic exercise program for 7 children with CP (6 with spastic diplegia and 1 with spastic hemiplegia belonging to GMFCS I to III levels and aged 7 to 13 years) and reported improvement in FRT in 4 out of 6 children evaluated. The second study, a case series by Fragala-Pinkham et al. (2009) applied FRT to a single child with CP (GMFCS I) and reported clinically significant improvement after a 6-week hydrotherapy program.

Non-hydrotherapy studies have also use the PRT to assess balance. One such study is a RCT (n = 60 with each group having 30 children aged 3 to 8 years) that has used PRT to assess sitting balance following a 9 months of postural training compared to conventional therapy in children with spastic diplegic CP (Dixit, Senapati, & Kumar, 2018). Since this study focused on sitting balance, only the 3 sitting subcomponents of the PRT were used. A total score for sitting balance was also obtained by adding PRT scores of each sitting subcomponent. The results of that study revealed statistically significant improvement in PRT scores in both experimental and conventional therapy groups (p < 0.004 and p < 0.014, respectively). Another non-hydrotherapy study, an 8-week virtual reality-based video-game system conducted to examine the psychomotor status of children with CP, reported using PRT as a balance assessment tool. PRT results of that study showed a statistically significant increase in forward movements of the center of gravity (p = 0.003) (Luna-Oliva et al., 2013). Another study, a RCT that was carried out by Pin and Butler (2019) to investigate the sitting
balance of children with CP of moderate to severe functional impairment (GMFCS III and IV) used the PRT following a 6-week interactive computer-based training. According to that study, sitting balance of both the experimental and control group was improved as indicated by increased PRT scores that were assessed by a single blinded accessor. Therefore, it is seen that some studies have used only the sitting component of the PRT (as mentioned above) while some other studies used only the standing components. For example, Rajendran, Roy, and Jeevanantham (2012) used forward and lateral standing components of PRT for children with hearing impairment to investigate the effectiveness of a 6-week vestibular specific neuromuscular training and reported statistically significant improvement (p = 0.001) in the experimental group. Collectively, these studies provide evidence that the PRT can be used to assess balance function in response to various interventions.

Dynamic balance was assessed using the mTUG test. All 5 participants showed an improvement with a mean reduction of 8.7 seconds to complete the test. Although absolute times varied widely across GMFCS levels, the mean relative reduction in time was 21% ± 13% (mean ± SD). Moreover, even though TUG test and mTUG test are slightly different, the mTUG test results of this study are in accordance with the 10-week hydrotherapy study (n = 7) conducted by Thorpe et al. (2005). In that study Thorpe et al. (2005) found improvement in TUG test of all the participants (P < 0.02). Another study demonstrated improved TUG test (p < 0.000) following completion of a 24-week hydrotherapy program which included mainly swimming and some balance-based aquatic exercises (Zverev & Kurnikova, 2016). However, according to the 6-week RCT that had 32 children with CP from GMFCS I to IV levels, both the experimental group and the control group showed significant improvement in TUG scores (13% ± 14% Vs 16% ± 13%, respectively), but no
statistically significant difference between the groups (Adar et al., 2017). Therefore, although the mean difference of pre-post mTUG test scores is not statistically significant in the current study, the large effect size and the percentage of relative change (21% ± 13%) may suggest that the present hydrotherapy intervention program was able to improve the dynamic balance of children with CP.

The improvement gained by all the participants in all 5-item VAS measures suggested that this hydrotherapy exercise program also improved the HRQOL of the children. Water provides a desirable environment to perform motor activities (Adar et al., 2017) due to its physical properties, and therefore what a child feels physically as well as mentally while in the water is quite different from what he or she feels on the land. For example, engaging in physical activities in water increases the level of confidence an individual has in performing more physically challenging tasks (Fragala-Pinkham et al., 2009). Additionally, performing exercises aerobically and at higher intensity levels is easier in the water than on the land, and this is a result of the desirable environment that water creates for patients by reducing the loads on joints. Further, the fun environment that water activities can create enhances the motivation as well as interest (Retarekar et al., 2009) which play a crucial role for children with CP. (32). Ultimately, all these factors might have contributed to the improved HRQOL in children with CP.

An important consideration of this study is the use of water-based aerobic exercise to improve balance in children with CP. Specifically, aerobic exercises that did not incorporate components intended to develop balance skills directly.

Although limited, the current literature reports two hydrotherapy studies that used water-based balance training activities to improve balance in children with CP. One of those
showed significant improvement in dynamic balance, as measured by Biodex balance system, following the balance specific hydrotherapy program (Badawy & Ibrahem, 2016). Similarly, the second study that implemented balance training-based water activities reported improved balance as assessed by 3 tests namely PBS, TUG test, and TUDS test (Zverev & Kurnikova, 2016). However, it should be noted that those studies included some aerobic exercise components such as water walking, running, and swimming. Thus, separating effects due to balance verses aerobic components can be challenging. The question of whether water-based aerobic exercise without specific balance components improve balance in this population of children has been addressed in 3 prior hydrotherapy studies, all of which reported positive effects. Fragala-Pinkham et al. (2014) reported improved PBS outcome (p < 0.005), and Thorpe et al. (2005) and Adar et al. (2017) reported improved TUG test scores (p < 0.02 and p < 0.001, respectively). The aerobic exercise component of those studies consisted of water activities such as pool walking, running, kicking, jumping and swimming. Thus, to the extent that balance is required to perform any given aerobic activity, the aerobic activity can serve to challenge and improve balance.

Further, evidence that concurrent balance improvement can be seen with aerobic water exercise is available in the adult population. To evaluate balance in the elderly, Kaneda, Sato, Wakabayashi, Hanai, and Nomura (2008) implemented a 12-week aquatic program which included different water exercises: water-walking (forward, backward and sideways), kicking and deep water running which were similar to those of current study. They reported improvement in both static and dynamic balance as measured by postural-sway test (postural-sway distance and postural sway area were measured) and Tandem-walking time, respectively. Bigongiari et al. (2018) also investigated aerobic gait training by comparing
walking in deep water verses walking on a treadmill in 2 groups of patients with stroke and reported that gait training in water improved knee joint position sense and suggested it as an important rehabilitation mode for developing postural stability. In Australia, Merom et al. (2014) studied the association between common sports activities and rate of falls in older men. Their results revealed improved static and dynamic balance as indicated by reduced postural sway and improved timing in narrow walk test (walking a 6-meter distance), respectively, among the group of swimmers compared to the group who underwent just lifestyle physical activities and concluded that falls may be prevented by swimming. Further, they reported that swimming strengthens the core muscles of the body and this may result in lowering postural sway and subsequent improved balance. Therefore, results of these studies support the fact that aquatic aerobic exercise can improve the balance in humans.

6.1. Study Limitations

The findings of this study are limited by several potential factors that can be categorized as primary and secondary limitations. While major primary limitations include lack of a control group, lack of random assignment, small sample size and lack of blinding leading different types of possible bias, secondary limitations are due to participant attributes, time constraints leading to low frequency (twice per week) and short duration of the study (6 weeks), absence of gold standard laboratory measures for accurate balance evaluation, using VAS that was newly developed and not validated, and lack of a follow-up assessment.

As mentioned under the sample size calculation of the methodology section, most children with CP at the NCCCPDD had severe impairments. Among those children with
mild to moderate impairment, most of them did not match with the inclusion criteria. This created a situation where a limited population was available for sampling and having a control group or random sampling was not practical. In the literature, this common limitation is evident in many other hydrotherapy studies conducted for children with CP (Ballaz et al., 2011; Fragala-Pinkham et al., 2014; Thorpe et al., 2005; Zverev & Kurnikova, 2016). Further, the small sample size and that the sample was not population-based, i.e., convenience sample (children who had enrolled in the NCCCPDD), means that the results of this study cannot be generalized to the universal population of children with CP. Lastly, children with CP are not alike and represent a group of children with marked heterogeneity though they are categorised into similar groups by GMFCS classification. i.e., every single child with CP is unique and making it difficult to compare to another child with CP who even has approximately similar characteristics. Therefore, due to this reason and sample size being very small (n = 5) which resulted in having markedly limited number of children for each GMFCS group, the results of this study may not be representative of a given GMFCS level.

Three physiotherapists conducted the hydrotherapy intervention sessions and one of them assessed all the children for pre and post-intervention balance measures. There was no blinding in this study and both participants (children and parents of those children) and therapists knew to which category they belonged. Therefore, results of two balance measures and VAS are at risk of detection bias. Additionally, these positive results of VAS may have been influenced by knowledge and expectation bias (Renjith, 2017), and acquiescence bias, a type of response bias that occurs due to respondents (in this case parents) trying to please
the researcher by providing positive answers to the all the survey questions (Knowles & Nathan, 1997).

As mentioned previously in the literature section of this study, the systematic review by Jorgić et al. (2012) reported optimal conditions for a hydrotherapy program as entire intervention duration of 10 weeks, single session duration of 45 minutes and frequency of 3 times per week. However, the current program was conducted for a total duration of 6 weeks with a frequency of 2 sessions per week and each session lasted for 45 minutes. These time limits were based on several feasibility issues. As implied by the name, the NCCCPDD where this study was conducted is a school for more than 100 children with various forms of disabilities including CP, Down syndrome and autism spectrum disorders. According to the school schedule, each child undergoes hydrotherapy once in two weeks for 20 minutes. This regular time duration limits are a result of having had to give equal opportunities for all the children studying at the institution. Therefore, conducting this current study for more than 6-weeks was practically not possible due to time constraints. Additionally, the total number of physiotherapists available at the time of the study duration was three which also limited the study-time. Further, very occasionally, the gap between pool sessions was 1 – 7 days, and one reason for this was that the facility had a fixed school schedule due to which incorporating sessions in between or increasing the gap between sessions were not practically possible due to limited physiotherapy time and the inability to have the program going on after school (after 1 pm) since all children left the institution at 1 pm during weekdays. Therefore, sometimes, some participants underwent a single session per week, but they managed to complete all 12 sessions within the 6 weeks. However, due to theses multiple reasons, it was not practically possible to achieve the optimal standards of a
hydrotherapy program reported by Jorgić et al. (2012) further limiting the quality of this current study.

The other limitation of this study is the absence of gold standard laboratory measures such as Biodex stability system for accurate evaluation of results in terms of static and dynamic balance, and this is due to the unavailability of such measures in this clinical setting.

Moreover, even though VAS had been used in the literature to assess the HRQOL of children, the 5-item VAS used to assess the HRQOL in this study was a new measure developed specifically for this study, and it has not been validated for children with CP. Also, it is questionable whether the proxy-administered VAS truly represent the HRQOL of children if they were to be self-administered it.

Additionally, since there was no follow-up assessment, in contrast to many other hydrotherapy studies, the present study did not evaluate the long-term effects of this hydrotherapy program; sustainability of the improvement gained after the intervention was not assessed for any outcome measures. Therefore, it is unknown whether the improvement gained is transient or permanent, and if transient, what is the maintenance duration of the improvement. Therefore, in future studies, it is important to periodically assess the improvement gained to understand the sustainability of the results.

6.2. Conclusion and Recommendations

In conclusion, regardless of some limitations, this 6-week aerobic exercise-based hydrotherapy program demonstrated feasibility in the Sri Lankan context and showed positive effects on static and dynamic balance and HRQOL of children with CP. Even though this study does not give confirmatory evidence due to numerous study limitations, it provides
preliminary evidence that hydrotherapy is beneficial for the children with CP irrespective of their age and functional limitations. However, this needs to be further studied in the future addressing these limitations, ideally with a RCT, a bigger sample size, standard laboratory balance measures, and periodic follow-up. Additionally, since the current study was beneficial for all the children who participated, this program could be expanded islandwide in Sri Lanka benefiting many affected children with CP.
References


Accessed on August 13, 2109.


A: Ethical Clearance Letter-University of Manitoba
In respect to clinical trials, the HREB complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations of Canada and carries out its functions in a manner consistent with Good Clinical Practices.

QUALITY ASSURANCE
The University of Manitoba Research Quality Management Office may request to review research documentation from this research study/project to demonstrate compliance with this approved protocol and the University of Manitoba Policy on the Ethics of Research Involving Humans.

CONDITIONS OF APPROVAL:
1. The study is acceptable on scientific and ethical grounds for the ethics of human use only. For logistics of performing the study, approval must be sought from the relevant institution(s).
2. This research study/project is to be conducted by the local principal investigator listed on this certificate of approval.
3. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to the research study/project, and for ensuring that the authorized research is carried out according to governing law.
4. This approval is valid until the expiry date noted on this certificate of approval. A Bannatyne Campus Annual Study Status Report must be submitted to the REB within 15-30 days of this expiry date.
5. Any changes of the protocol (including recruitment procedures, etc.), informed consent form(s) or documents must be reported to the HREB for consideration in advance of implementation of such changes on the Bannatyne Campus Research Amendment Form.
6. Adverse events and unanticipated problems must be reported to the REB as per Bannatyne Campus Research Boards Standard Operating procedures.
7. The UM HREB must be notified regarding discontinuation or study/project closure on the Bannatyne Campus Final Study Status Report.

Sincerely,

[Redacted]
Chair, Health Research Ethics Board
Bannatyne Campus

Please quote the above Human Ethics Number on all correspondence.
Inquiries should be directed to the REB Secretary Telephone: (204) 789-3255/ Fax: (204) 789-3414
Appendix B: Ethical Clearance Letter-University of Kelaniya

Table: English, Sinhala, Tamil

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Please note that the ERC approval period and condition of approval remains as stated in the previous approval letter.

Thank you,
Yours sincerely,
Appendix C: Letter of Invitation to Participate-English, Sinhala and Tamil

Letter of Invitation to Participate in a Study on Hydrotherapy and Cerebral Palsy

Study Title: The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka

My name is Surandi Krishna Kumari Wadu Mesthri. I am a graduate student in the College of Rehabilitation Sciences at the University of Manitoba, Canada.

I am conducting a research study on hydrotherapy and cerebral palsy. This study will look at the effects of hydrotherapy on balance in children with cerebral palsy in Sri Lanka. You and your child have been identified as suitable to take part in this study because your child enrolled in the National Center for Children with Cerebral Palsy and other Developmental Disorder (NCCCPDD) where this study will be conducted, and your child meets the inclusion criteria of this study.

This study involves your child’s participation in a 6-weeks hydrotherapy program. During this 6-weeks, your child will be asked to participate in 2 hydrotherapy pool sessions per week during his/her regular attendance at the NCCCPDD. Before and after the hydrotherapy program, your child’s balance will be assessed using 2 clinical tests. The total time commitment for the study would be 26 hours (2 hours per day for 4 days of balance assessments, and 1.5 hours per day for 12 days for the 6-weeks of hydrotherapy program). All the study participation time will occur during the regularly allotted physiotherapy time when the child is at the NCCCPDD.

This will also involve your rating of your child’s health related quality of life.

Participation in this research is completely voluntary and you may choose to withdraw your child from the study at any time.

If you would like your child to participate in this study, please contact me via email at …………………… or on my mobile ……………………

For more details, please refer to the attached Participant Information Sheet and Consent Form.

Thank you.

………………………………(Signature of the Principal Investigator)
Surandi Krishna Kumari Wadu Mesthri
Principal Investigator
College of Rehabilitation Sciences,
University of Manitoba, Canada.
Email: ..........................
Cell Phone: ....................
යන යනන්තිඳ ේැති වේගිීම්ට, සුතිේකිරීනිවෙරී, ම්භ්ඥ්ජකචිකිත්තිවශ්ැඩතිට පවෙෝවනාත්රියේදක් ආඝාතය පිළිබඳ කකකෙනා ලිපියක් අධ්‍යයනයි.

බැලීවෙස්වක් වටුතතුවේකයන්ේ යන ප්‍රවාදය, සහාාිවීමම ආඝාතය පිළිබඳ කකකෙනා ලිපියක් අධ්‍යයනයි.
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முறையே குறிப்பிட்டுள்ளார்கள் பல்லிகள் குறுக்கு வகுப்புகளின் பணியிலிருந்து அனைத்து வகுப்புகள்

அப்புரோ லிங்கம் மற்றும் செயற்குறிகள் குறிப்பிட்டுள்ளது அல்லது விளக்கம் செய்யப்பட்டுள்ளது. முறையே குறிப்பிட்டுள்ளார்கள் பல்லிகள் குறுக்கு வகுப்புகளின் பணியிலிருந்து அனைத்து வகுப்புகள்

ஜூன் 6 - நவம்பர் 1

1. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

2. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

3. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

4. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

5. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

6. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

7. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

8. ஆய்வு முறையிலிருந்து அனைத்து வகுப்புகளின் பணியிலிருந்து வேறுபட்டது என்றால் செயலில் உள்ளது. 

9. ஆய்வு முறை�ாக பல்லிகளின் வேறுப்புக்ககைகளைக் குறிப்பிட்டுள்ளார்கள் பல்லிகளின் வேறுப்புக்ககைகளை குறிப்பிட்டுள்ளார்கள்.
நேர்மாற்றுகள் தெளிவாகவும் தளபதியும் இல்லாதக்குடி விளைகுண்டும் வீரன புனிதக்குநர் தனது அறிகுறிபெறுவாகவும் வெளிப்படுத்தி பார்க்க வேண்டும் பார்க்கும்.


c

......................................................... (இல்லாமல் ஆய்வுக்குறிக்கு தக்குப்பணம்)

காரணி இறக்கு குரர் என்ன விளக்கம்

(இல்லாமல் ஆய்வுக்குறிக்கு)

புனிதக்குநர் மீத்தான் குரர்

புனிதக்குநர் பங்கைக்கொள்ளவும், காலம்

புனிதக்குநர்: ........................................

சீனவியூர் தேவாரம்: ........................................
Appendix D: Participants Information Sheets-English, Sinhala and Tamil

The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka

I am Surandi Krishna Kumari Wadumesthri, a graduate student of the College of Rehabilitation Sciences, University of Manitoba, Canada. I would like to invite you to take part in the research project titled “The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka” conducted by me with the assistance of the staff at National Center for Children with Cerebral Palsy and other Developmental Disorders (NCCCPDD), Rajagiriya, Colombo, Sri Lanka.

1. Purpose of the Study
The purpose of this research project is to examine the effects of an individual hydrotherapy program on static and dynamic balance in children with cerebral palsy in the Sri Lankan context.

2. Voluntary Participation
You and your child’s participation in this study is voluntary. You and your child are free to not participate at all or to withdraw from the study at any time despite consenting to take part earlier. If you chose not to participate, there will be no loss of medical care or any other available treatment for your child’s illness or condition to which your child is otherwise entitled.

3. Participant Selection
You and your child have been identified as suitable to take part in this study because your child enrolled in the NCCCPDD where this study will be conducted, and your child meets the inclusion criteria of this study.

4. Duration, Procedures of the Study and Participant’s Responsibilities
Once your child has been identified as a suitable participant through the existing records at NCCCPDD, you will be given a package in a sealed envelop that contains a letter of invitation to participate, a participant information sheet and a consent form to take home. If you are willing to participate you will be asked to contact the principal investigator within next 2 weeks by phone or email. Subsequently, consent from you and the assent from your child will be obtained by the principal investigator. At the end of this process, your child will be given an identification number.

You will rate your child’s health-related quality of life using a 5 scales tool called Visual Analogue Scale (VAS). This will take 5 to 10 minutes.
Your child’s resting heart rate will be recorded. Your child’s balance will then be examined by a physiotherapist using 2 clinical tests. The total time to complete each test, including resting periods, would be approximately 2 hours.

As the next step, hydrotherapy program will be started and conducted in 3 phases; warm-up exercises, aerobic exercises, and cool-down and stretching exercises. During the hydrotherapy program, your child will be asked to exercise with moderate to high intensity. The exercise intensity levels will be monitored using a heart rate sensor with chest strap and a wristwatch. Three certified physiotherapists with experience in pediatric hydrotherapy will conduct the hydrotherapy program. Parents/guardians and volunteers will also be invited to participate in the pool activities to help children when needed.

During the program, whenever the child is tired and cannot continue exercising, your child will be allowed to rest for 2 minutes. And at the end of the program, your child will leave the pool and take a shower and rest in the changing room for roughly 20 minutes.

This program will take place twice per week for 6 continuous weeks during your child’s regular attendance at the NCCCPDD with at least 2-3 day’s gaps between each two sessions. Your child will be asked to undergo 12 hydrotherapy sessions during these 6 weeks. Each session will last an hour. However, including the 20 minutes of resting period, single pool session will take an hour and a half to complete. Within 5 days following completion of the program, your child’s balance will be reassessed by the same physiotherapist using the same 2 tests describe above. During this period, you will be asked to re-evaluate your child’s health-related quality of life using same 5 scales tool.

The total time commitment for the study would be 26 hours; 2 hours per day for 4 days of balance assessments, and 1.5 hours per day for 12 days for the 6-weeks of hydrotherapy program. During the study period, your child will be asked to undergo this new hydrotherapy program instead of regular hydrotherapy treatment that your child receives at the facility. Since all the study participation time will occur during the regularly allotted physiotherapy time when the child is at the NCCCPDD, participating in the hydrotherapy program will not affect your child’s academic activities.

You can stop the testing at any time you would like. If you or child decide to stop participating in the study, we encourage you to talk to the study staff first.

5. Potential Benefits
By participating in this study, you will learn your child’s ability to control the balance. Exercising in the pool will be a fun activity for your child. However, there may or may not be direct benefits to you or your child from participating in this study, and your child’s balance may or may not improve. We hope the information learned from this study would
help other children with cerebral palsy and hydrotherapy rehabilitation programs in the future.

6. Risks, Hazards and Discomforts
Training sessions and balance assessment may be tiring to your child. Child may feel some pain or discomfort or dizzy during or after doing exercises in the pool, or during or after the assessment of balance. Child may feel cold and chilly when he/she is in the pool for an hour. Wearing the chest strap, the wristwatch and the life jacket continuously for an hour may be uncomfortable to the child. Some children may feel some frustration if they are unable to perform all the tests and the training sessions well. Your child may experience loss of balance during the assessment but, in addition to the accessor, a vigilant assistant will always be there to hold the child to prevent injury.

This study will be conducted in a shallow therapeutic pool with the depth ranges from 1 to 4 feet maximum. Throughout the pool sessions children will be wearing standard life jackets, and the therapist will always be present working one-on-one with the child with at least one other adult present. Therefore, children’s safety in the pool will be assured, and there will not be a risk of drowning. You must tell study staff or principal investigator if your child feels pain or discomfort or unwell while participating in the study. For any injury related to the study, we will refer your child to the proper medical care through the facility. You are not waiving any of your legal rights by signing the consent form or releasing the investigators from their legal and professional responsibilities for any injury related to the study.

7. Reimbursements
You or your child will receive no payment to take part in this study.

8. Confidentiality
Confidentiality of all records is guaranteed and no information by which you and your child can be identified will be released and only anonymous data will be published. These data will never be used in such a way that you and your child could be identified in any way in any public presentation or publication without your express permission. Data without identification information may be shared with other researchers as many journals expect the authors to make their data available to other researchers.

9. Sharing the Results
The results will be available with the principal investigator and can be reviewed by the participants at the end of the study.

10. Termination of Study Participation
You may withdraw your consent to participate in this study at any time, with no penalty or effect on medical care or loss of benefits. Please notify the investigator as soon as you decide to withdraw your consent.

11. Clarification
You may take your time to make your decision about participating in this study and you may discuss it with your friends, family or your doctor before you make your decision. If you have questions about any of the tests / procedures or information, or if any questions come up during or after the study please feel free to ask any of the persons listed below.

Principal investigator: Surandi Krishna Kumari Wadu Mesthri at ………………..
Study staff: Rajkaran Mahendran (physiotherapist) at ……………………..

12. If you have any complaints about unethical conduct related to this research, you may make a complaint to Ethics review committee, Faculty of Medicine, University of Kelaniya using information given below.

ERC Office Address: Ethics review committee, Faculty of Medicine, University of Kelaniya, Sri Lanka.

Telephone No: 0112-961267 (please contact during working hours 8 am – 4 pm)
Email: ercmed@kln.ac.lk

Signed
Surandi Krishna Kumari Wadu Mesthri, Graduate student, College of Rehabilitation Sciences,
University of Manitoba

Principal Investigator

………………………………………………………… (Signature of the Principal Investigator)

Overseas Office Address: ………………………

Local Address: ……………………………

Phone: …………………

Email: …………………
නවිනතිවරයන්ගේ අදහස් ගැනීමයි

නවිනතිවරයන්ගේ අදහස් කොළඹ පිළිති පැවතියන්නන් සම්බන්ධ කැපක්ෂණයක් නැවතියේ තවානුරිට ටායවන්වත්වය විශේෂයක් අදහස් විශේෂයක් අදහස් විශේෂයක් අදහස්

1. ප්‍රධානංගකරිය

දෙවීමේ අදහස් කොළඹ පිළිති පැවතියන්නන් සම්බන්ධ කැපක්ෂණයක් නැවතියේ තවානුරිට ටායවන්වත්වය විශේෂයක් අදහස් විශේෂයක් අදහස් විශේෂයක් අදහස්

2. මවසියා කොළඹකරිය

දෙවීමේ අදහස් කොළඹ පිළිති පැවතියන්නන් සම්බන්ධ කැපක්ෂණයක් නැවතියේ තවානුරිට ටායවන්වත්වය විශේෂයක් අදහස් විශේෂයක් අදහස් විශේෂයක් අදහස්

3. දැනියමුණින්නන්කොළඹකරිය

දෙවීමේ අදහස් කොළඹ පිළිති පැවතියන්නන් සම්බන්ධ කැපක්ෂණයක් නැවතියේ තවානුරිට ටායවන්වත්වය විශේෂයක් අදහස් විශේෂයක් අදහස් විශේෂයක් අදහස්

4. ප්‍රධානංගකරියයින්න් අදහස් කොළඹ, තැළිපුරාම අතර දැනියමුණින්නන් විධානය.

NCCCPDD කොළඹකරියයින්න් මෙම ප්‍රධානංගකරියයින්න් විධානය යන ප්‍රධානංගකරියයින්න් විධානය යන ප්‍රධානංගකරියයින්න් විධානය යන ප්‍රධානංගකරියයින්න් විධානය

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5. ප්‍රේමා පිලිබඳ

6. විද්‍යී, බිංජ සහ ප්‍රශුමට

7. විද්‍යීය

8. අධ්‍යාපනය
9. නාමය ප්‍රශ්නය
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10. ආරක්ෂානය විද්‍යාභාලවයිම මහාණිය
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11. මාලිගය කෘෂීන්
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12. මාලිගය කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන් කෘෂීන්

ERC මාලිගය කෘෂීන්: නියැලහි ප්‍රශ්නය ප්‍රශ්නය, ප්‍රශ්නය ප්‍රශ්නය, ප්‍රශ්නය ප්‍රශ්නය, ප්‍රශ්නය

E-කාර්ය: ercmed@kln.ac.lk

0112-961267 (පොදුමන් වසර් 8වි. 9වි. 10වි.)

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විශේෂව දෙළදොමුට ආරම්භ කිරීම.
ක්‍රියාත්මක පිළිතුව මිදින්දායක් මෙන්ම යුතු යුතුම් පිළිතුරු පරිදි මදන් කිරීම.

ප්‍රධාන සිදුවන

......................................................... (ප්‍රධාන සිදුවනය දෙරෙහෙත)

ළදින පිළිතුරු උපකාරී: ............................

පිළිතුරු උපකාරී: .........................................

ස්වේච්ඡා උපකාරී: .................................

E- උපකාරී: .................................
பாராமைசான் தகவல் அறிக்கை

1. அமைதியின் தீர்மானம்

2. களங்கரைகள்-அமைதியின் பொருட்பாட்டுகள்

3. பாராமைசான் உள்ளிட்டுப் பொருட்பாட்டுகள்

4. அமைதியின் தனியா, தனியாகும் என்று பாராமைசான் உள்ளிட்டுப் பொருட்பாட்டுகள்

பாராமைசான் தகவல் அறிக்கை

1. அமைதியின் தீர்மானம்

2. களங்கரைகள்-அமைதியின் பொருட்பாட்டுகள்

3. பாராமைசான் உள்ளிட்டுப் பொருட்பாட்டுகள்

4. அமைதியின் தனியா, தனியாகும் என்று பாராமைசான் உள்ளிட்டுப் பொருட்பாட்டுகள்

பாராமைசான் தகவல் அறிக்கை

1. அமைதியின் தீர்மானம்
நரம்பா 2 கண்டாடி பிளானேல் பிரிவுக் குறிப்பிட்டு விளக்கம் அப்பாரேனியர் குண்டுகளுக்கான
நாட்டுமுக்கியமானவை. இது சமயநிலையில் திறனை 2 கண்டாடி அறிக்கைகள்
அமைந்து நிறையும் முறையாகும்.
5. சுத்தியல் புனைப்படுத்தல்
சிற்றிதமான பாதுகாப்புச் செயல்கள் என்று சுத்தியல் புனைப்படுத்தல் என்றும் குறிப்பிடுகிறார். சுத்தியல் பிள்ளைகள் எனும் பண்புகளை ஆண்டு சுத்தியல் புனைப்படுத்தல் என்றும் சொல்லும் படிகங்களின் மூலமாக சுத்தியல் புனைப்படுத்தல் என குறிப்பிடுவது காரணமாகும். முதலில், இவை உயர்ந்த நிலையில் இருந்து வரும் சுத்தியல் புனைப்படுத்தல் என்றும் கூறுமல்லினால் சுத்தியல் புனைப்படுத்தல் என்றும் குறிப்பிடுமல்லினால் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தலும் ஒவ்வொரு சுத்தியல் புனைப்படுத்தallahum
7. எந்தேற்றங்கள்
இன்றைய பதவியை கவர்க்கத் தவறாய் வருமாறு குறைவாகவே ஒட்டப்பட்டுவேண்டும்.

8. வித்யாப்புரிந்து
அவர்கள் பரிபாலப்பு விழாக்கங்களின் சமையல் நடவடிக்கைகளின் தோற்றங்களும் பெருமாறு அமைந்துள்ளன. சாத்தியம் புகழ்பெற்று காலக்கட்டம் அவர்களை குறைவான காலக்கட்டம் வைத்துக்கொள்ளவும் செய்யப்பட்டுள்ளன. இவை விளக்கும் காலக்கட்டம் அதன்பின்னம் போக்கும் போது மேல்புற நீண்டப்போனவும் அவர்கள் பொருளாதாரத்தில் கூட்டப்பட்டு 2 நாட்கள் அமர்ந்து வருகிறது. பொருளாதாரம் நோக்கியவர் குறைவான காலக்கட்டம் வைத்துக்கொள்ளவும் வேண்டும்.

9. முயன்றவத்தைக் குறிப்பி
எந்த வருமாறு முயன்றவது கீழ்க்காண்பவற்றுடன் அமையாது. அவர்கள் தோற்றத்தை பாதுகாக்கவும் கூடும் விளக்கம் செய்யவும்.

10. விமங்கம் வாய்ந்தானும் சமயங்கள்
சாத்தியான காலமாற்றத்தால் வருமாறு பாதுகாக்க குறைவான காலக்கட்டம் அமைந்து செய்யப்பட்டுள்ளன. விளக்கம் செய்யப்பட்டுள்ள குறைவான காலக்கட்டம் இந்த வினைப்பாடுகள் மறுப்பெறும். விளக்கம் செய்யப்பட்டு விளக்கம் போக்கும் போது இவர்கள் குறைவாக அமைந்துள்ளன.
11. கொடுத்தறிகள்
கொடுத்தறிகளின் பலமுறையான பாதுகாப்பு வாய்ந்தது நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் 

பதிவிட்டதால் ஆபாரவர்: அது குறிப்பிட்டு தோன்ற விளக்கத்திற்கு .....................................

அமைப்பு: பலகால விளக்கத்திற்கு (சிற்றமைப்பிற்கு) ..................................

12. இங்கு அரசுக்காட்டும் கொடுத்தறிகள் நடப்படுத்தும் காலப் பாதுகாப்பு நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் பாதுகாப்பியும் நடப்படுத்தும் காலப் 

அது குறிப்பிட்டது அது ஆபாரவர் தோன்ற : அது குறிப்பிட்டது தோன்ற, மற்றும் குறிப்பிட்டது, மற்றும்

குறிப்பிட்டது 0112-961267 (விளக்க நேரம் 08.00 பிர. 04.00 விளக்க நேரம் காலப் பாதுகாப்பியும் 

மின்சாரம்: ercmd@kln.ac.lk

உப்புறச் சேர்.

அது குறிப்பிட்டது தோன்ற நேராக விளக்கத்திற்கு, பலகால நேராக விளக்கத்திற்கு முக்கியமான கலனாத் பாதுகாப்பியும், பலகால முக்கியமான கலனாத்

செயல்துற்றம் ஆபாரவர்: .......................................................... (செயல์்துற்றம் ஆபாரவர் காலப் பாதுகாப்பு)

செயல்துற்றது ஆபாரவர் தோன்ற: .......................................................... 

செயல்துற்றது தோன்ற: .......................................................... 

செயல்துற்றமாக்க மின்சாரம்: .......................................................... 

செயல்துற்றமாக்க மின்சாரம்: .......................................................... 

செயல்துற்றமாக்க மின்சாரம்: .......................................................... 

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Appendix E: Consent Form-English, Sinhala and Tamil

The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka

To be completed by the proxy
The proxy should complete the whole of this sheet himself / herself.

1. Have you read the information sheet? (Please keep a copy for yourself) YES/NO

2. Have you had an opportunity to discuss this study and ask any questions? YES/NO

3. Have you had satisfactory answers to all your questions? YES/NO

4. Have you received enough information about the study? YES/NO

5. Who explained the study to you? …………………………………………

6. Do you understand that you are free to withdraw from the study at any time, without having to give a reason and without affecting your child’s future medical care? YES/NO

7. You and your child’s information held by the investigators relating to your child’s participation in this study may be examined by other study team members. All information regarding you and your child’s personal identity will be treated as STRICTLY CONFIDENTIAL. Do you give your permission for these individuals to have access to you and your child’s records? YES/NO

8. Have you had sufficient time to come to your decision? YES/NO
9. Do you agree to take part in this study? YES/NO

Signature of the Proxy………………………………………. Date………………

Name of the Proxy (BLOCK CAPITALS) …………………………………………………

To be completed by the investigator
I, the undersigned, have fully explained the relevant details of this research study to the proxy named above and believe the proxy has understood and has knowingly given their consent.

Signature of Principal Investigator………………………..
Date………………………
Name (BLOCK CAPITALS) ………………………………………………………..
ඉන්හාදින ආකාශයකම්
109

අමාමු ලබාඳම් 
වේ්
ෙි
ශ්‍රී
ශකාවේ මශ්තිෂ්ෂවූත්තුලිෙන් සෙයින් වෙන්න පශතිතුලින් මෙන් සෙයින්

පසුකමන් පිළිතුමනයකම්
පසුකමන් පිළිතුමනයකම් සුළ ලැබේ නිසාවාස වීම් දැන් සුළ ලැබේ

1. අතානමු පරිදි පශතිතුලින් සැක වියේ? (නහසුමා මා මාලකාරය)

2. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

3. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

4. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

5. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

6. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

7. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

8. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?

9. එකිනි පැමිණ පිළිතුමනයකම් හා සැක පිළිතුමනයකම් වියේ?
විශේෂකරණය සංවිධානය සමඟාන දෙන්නේ

උපත පැමණක් හැකි හෝ පොළාසී, එමෙක් සඳහා සමඟානයක් පැමණක්ත් විවිධ විශේෂය පැමණක් විශේෂකරණය සමඟානයක් තිබේ. මෙම පැමණක් විශේෂය සමඟානය පිළිතුරු මීටර් සහ පිළිතුරු මීටර් විශේෂයේ පැමණක්ත් විශේෂකරණය සමඟානයක් පැමණක් විශේෂය විශේෂකරණයක් දෙන්නේ සමඟානයක් පිළිතුරු මීටර්ක් පැමණක්ත් විශේෂයක්.
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1. நூற்றாண்டு கிழக்கு அதிகமாகவே வருகின்றது? (தமிழில் பொதுமக்கள் குற்றுச் செய்தூரில் இணைந்து வரும்)

2. தற்போது பெரும் கல்லூரியாளர்களுக்கு எதிருளகராக வேலைக்கு வந்து வருகின்றது?

3. ஆட்சியின் உடலுறவு போலும் வல்லும் நீள்வழியின் காலத்தில் அமையும் குறுக்குகள்?

4. ஆராய்ச்சி நிறுவன நடப்புதல் நடைபெரும்பாகம்?

5. ஆராய்ச்சி நடைபெரும்பாகம் பார்க்கு?

6. கல்லூரியின் செயல்பாட்டில் என்று அதிகமாகும் அவர், வேளாண்டுக்கு வந்து வரும் பொதுமக்கள் பல்கலைக்கழகத்தின் ஆராய்ச்சிக்கு அணுகவும் குறிப்பிட்டு இருக்கும் நேரத்தில் பொதுமக்கள் பார்க்கும்?

7. நூற்றாண்டின் நோக்கு பொதுமக்கள் வளர்த்து வரும் தொடர்பில் பொதுமக்கள் குறிப்பிட்டு வேளாண்டுக்கு வந்து வரும் பொதுமக்கள் வளர்த்து வரும் தொடர்பில் பொதுமக்கள் வளர்த்து வரும் தொடர்பில் அவர்களின் ஆராய்ச்சிக்கு அணுகவும் குறிப்பிட்டு இருக்கும்?

8. செயல்பாடு விளம்புகள் நகரும் நடைப்புதல் நடைபெரும்பாகம்?

9. நூற்றாண்டின் செயல்பாடுகளில் எதையும் நடைபெரும்பாகம்?

ஆராய்ச்சி பொதிக்கு குறிப்பிட்டு .................................................. குறிப்பிட்டு .................

ஆராய்ச்சி பொதிக்கு பொதிக்கு பல்கலை (பல்கலை பல்கலைக் குறிப்பிட்டு) ..................................................
முக்கியமான அம்மாசியா அன்றியம்................................................................. தேடி..........................

இப்பு (இப்பு உயர்ந்த்தொகுதிகள்) ........................................................................
Appendix F: Assent Form-English, Sinhala and Tamil

The Effects of an Individual Hydrotherapy Program on Static and Dynamic Balance in Children with Cerebral Palsy in Sri Lanka

1. **Why you are here?**
   I want to tell you about a study about children with cerebral palsy. I want to see if you would like to be in this study. This form tells you about the study. If there is anything you do not understand, please ask your parent or your guardian or me.

2. **Why are you asking me?**
   We are going to study about children with cerebral palsy who are at your age – between 6 and 12 years old – who are registered at the National Center for children with Cerebral Palsy and other Developmental Disorders (NCCCPDD).

3. **Why are they doing this study?**
   We want to learn more about whether exercising in water can improve balance of children with cerebral palsy. For this, we have a new water exercise program and are hoping it might improve your balance. In order to find out whether it improves balance we have to test it.

4. **What will happen to you?**
   If you want to be in the study, these things will happen:

   - Your basic information such as age, height, weight, and cerebral palsy type and functional level will be obtained from the NCCCPDD. Then your heartbeat at rest will be checked.

   - Next your balance will be assessed using 2 tests in 2 different days. To complete each test, it will take nearly 2 hours.

   - For the first test, you will be asked to stand from sitting position and then walk total of 6 meter and then sit down on the same chair.

   - During the second test, the maximum distance that you can reach in various directions while you are sitting and standing will be assessed.

   - Next, water exercise program will be started. While you are doing these exercises in the pool, your heartbeat will be checked after every 5 minutes. You will be asked to wear a chest strap, a wristwatch and a life jacket before entering the pool.
• You will not be alone in the pool. Always there will be one physiotherapist with you. Additionally, sometimes your parents or guardian will also be in the pool.

• When you are in the pool, you will be asked to perform different exercises such as walking, kicking, jumping, running and swimming. The entire water activity program will last an hour.

• While you are in the pool, whenever you are tired and cannot continue exercising, you will be allowed to rest for few minutes.

• Once you have completed water exercises, you will leave the pool and take a shower and rest in the changing room for 20 minutes.

• The study will last about 6 weeks. You will be asked to come to the NCCCPDD 2 days per week for consecutive 6 weeks. During each visit you will have to spend approximately 1 hour and 30 minutes at the facility.

• Within 5 days following completion of the water exercise program, your balance will be reassessed using the same 2 tests describe above in 2 different days.

• In total you will have to come to the facility for 16 days; 4 days for the balance assessment and 12 days for water exercise program.

• During the study period, you will be asked to undergo this new water exercise program instead of routine water activities that you are currently undergoing at the NCCCPDD.

5. **Will the study hurt you?**

• Exercising in the pool may be tiring and you may feel some pain or discomfort.

• You may feel cold and chilly when you are in the pool for an hour.

• You may feel uncomfortable when you wear the chest strap and the wrist watch continuously for an hour.

• During or after doing exercises in the pool, or during or after the assessment of balance you may feel dizzy.

• You may feel angry if you are unable to perform all the tests and the water exercises well.
• You must tell your parents or the study staff if you feel pain or discomfort or unwell while participating in the study.

6. *Will you get better if you are in the study?*
   This study may or may not make you feel better or get well. But we hope the information learned from this study would help other children with cerebral palsy and water exercise programs in the future.

7. *What if you have any questions?*
   You can ask questions any time, now or later. If you want to talk to someone else that you know like your parents/guardian or teacher or doctor or auntie, that's okay too.

8. *Who will know what I did in the study?*
   Any information you provide to the study staff will be kept private. Your name will not be on any study paper and no one but the study staff will know that it was you who was in the study.

9. *Do you have to be in the study?*
   You do not have to be in the study. No one will be mad at you if you don’t want to do this. If you don’t want to be in this study, just say so. We will also ask your parents/guardian if they would like you to be in the study. Even if your parents/guardian want you to be in the study you can still say no. The staff at this institution will still take care of your health condition. Even if you say yes now you can change your mind later. It’s up to you.

   If you choose to be part of this study, I will also give you a copy of this paper to keep for yourself. You can ask your parents or guardians to look after it if you want.

---

**Assent**

I want to take part in this study. I know I can change my mind at any time.

__________________________    Verbal assent given    Yes ☐

Print Name of Child

Written assent if the child chooses to sign the assent.

__________________________    __________    __________

Signature of Child    Age (years)    Date

I confirm that I have explained the study to the participant to the extent compatible with the participants understanding, and that the participant has agreed to be in the study.
<table>
<thead>
<tr>
<th>Printed name of Principal Investigator</th>
<th>Signature of Principal Investigator</th>
<th>Date</th>
</tr>
</thead>
</table>
මනුෂාකකේ එකඟතාවය ලබාගනීම් වැඩියා

1. අවසන් එකඟතාවය?
මීලිදී ක්‍රමය මතින් එක්කඟතාවය වේදා සමන්විත වේදම් කෙටි එකඟතාවය ලබා ගනීම වැඩියා. එකඟතාවය පැහැදිලි පැහැදිලි එකඟතාවය ලබා ගනීම ලබා ගනීම පැහැදිලි. 

2. අවසන් එකඟතාවය?
මීලිදී ක්‍රමය මතින් එක්කඟතාවය වේදා සමන්විත වේදම් කෙටි එකඟතාවය ලබා ගනීම වැඩියා. එකඟතාවය පැහැදිලි පැහැදිලි එකඟතාවය ලබා ගනීම ලබා ගනීම පැහැදිලි. 

3. අවසන් එකඟතාවය?
මීලිදී ක්‍රමය මතින් එක්කඟතාවය වේදා සමන්විත වේදම් කෙටි එකඟතාවය ලබා ගනීම වැඩියා. එකඟතාවය පැහැදිලි පැහැදිලි එකඟතාවය ලබා ගනීම ලබා ගනීම පැහැදිලි. 

4. අවසන් එකඟතාවය?
මීලිදී ක්‍රමය මතින්වේදා, එකඟතාවය ලබාගනීම් පැහැදිලි. 

- NCCCPDD දිශාමනය කාර්යාලය විය, පැහැදිලි, එකඟතාවය වේදා සමන්විත වේදම් කෙටි අතර්හැමුරියේ වේදම් කෙටිය. පොත බොතා වේදම්ට දැමුණි මෙම කාර්යාල මහතා ඕලාපයකි. 

- මෙම කාර්යාලය පොත බොතා 2වන දැමුණි කාර්යාලයක් පොත බොතා 2වන දැමුණි කාර්යාලයක්. 

- මෙම කාර්යාලය පොත බොතා 2වන දැමුණි කාර්යාලයක් පොත බොතා 2වන දැමුණි කාර්යාලයක්. 

- මෙම කාර්යාලය පොත බොතා 2වන දැමුණි කාර්යාලයක් පොත බොතා 2වන දැමුණි කාර්යාලයක්. 

- මෙම කාර්යාලය පොත බොතා 2වන දැමුණි කාර්යාලයක් පොත බොතා 2වන දැමුණි කාර්යාලයක්.
• වර්තමාන ආයාමය පිළිබඳ කොටස සම්පූර්ණ සොයාගෙන දෙන්නේ. මේ විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ හරෝයක් පිළිබඳ මෙම ආයාමය පිළිබඳ පවුල්කම් සම්පූර්ණ සොයාගෙන කෙරේ. මේවා ආයාමය මාසික ආරම්භයන්ට යොදා පිළිබඳ කොටස සම්පූර්ණ සොයාගෙන දෙන්නේ, පොර්තලිස්කුණය සහ පිළිබඳ ආයාමය ප්‍රතිකාරයේ පොළබොවන් හාටීය කොටස.

• මෙම විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරත, මුරෝදා සහ විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය පොර්තලිස්කුණය සම්පූර්ණ සොයාගෙන කෙරේ.

• මෙම විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණයයි.

• මෙම විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණයයි.

5. මෙම විකුල ආයාමයට අන්හෙක කාලයක් තිබේ?

• මේවා විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණයයි.

• මේවා විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණයයි.

• මේවා විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණය සහ පොර්තලිස්කුණය විකුල ආයාමය ප්‍රතිකාරයට අදහසයක් මට භාරතයේ පොර්තලිස්කුණයයි.
8. පිහිටියනමේතිකවන්හායන්කමමන්කෙටේවයන්කම්න්ක෇යන්ගීවීම්ට?

9. කඩායනායින්හිකවන්හායන්කමමන්කෙටේවයන්කම්න්ක෇යන්ගීවීම්ට?

10. පිහිටියනමේතිකවන්හායන්කමමන්කෙටේවයන්කම්න්ක෇යන්ගීවීම්ට?

11. පිහිටියනමේතිවිේ්යන්ගීවීම්ට?
අනන්තර් ස්වාත්‍යයක් සඳහාවේ නාලිකීය සැතපුම්. එම කාර්කාහා ආකාකි කින් පැවති නාලිකීය කාර්කාහා විසින් සැතපුම් කළ එම නාලිකීය සැතපුම්.

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මිලියන පෙන්වන අමාත්‍ය තුන් කරන්නේ ඉන්නාවනු අමාත්‍ය

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ශාලිකාර පොළොවන්නේ ඉන්නාවනු අමාත්‍ය (ඐූවත්) 

මිලියන පෙන්වන අමාත්‍ය තුන් කරන්නේ ඉන්නාවනු අමාත්‍ය නාලිකීය සැතපුම් කිරීමෙන් මෙම සාමාන්‍යවයන්නේ වේ. මෙම වාක්‍ෂණය කිරීමෙන් මෙම සාමාන්‍යවයන්නේ වේ. මෙම වාක්‍ෂණය කිරීමෙන් මෙම සාමාන්‍යවයන්නේ වේ.

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ස්වීකාරී පීංචිරාම පෙන්වන්නේ ඉන්නාවනු අමාත්‍ය 

ප්‍රධානිය පිරිශ්ටාකම් ආදායම් කුයීමේ පැවති කුයීමේ පැවති කුයීමේ පැවති කුයීමේ පැවති කුයීමේ පැවති
பல்வையற்றுக்கனவை முன்பே பாதுகை

1. நேரகை முன்னிலம் செய்துவிடுவது என்ன என்ன?

பன்மாரிகளால் கூறப்பட்ட பல்வையற்றுக்கனவை அலுவலகம் பல்வை காற்றுக்கு முன்பே பாதுகை செய்து விடுவது என்ன என்ன என்பது கேள்வி. நேரகையான முன்னிலம் கூறப்பட்ட பல்வையற்றுக்கனவை அலுவலகம் விளக்கமும் இற்றைக்குக்கும் காற்று காற்று முன்பே பாதுகை செய்து விடுவது என்ன என்ன என்பது கேள்வி. நேரகையான முன்னிலம் கூறப்பட்ட பல்வையற்றுக்கனவை அலுவலகம் விளக்கமும் இற்றைக்குக்கும் காற்று காற்று முன்பே பாதுகை செய்து விடுவது என்ன என்ன என்பது கேள்வி. நேரகையான 

2. தோற்றான நேரயில் கூறுவது என்ன என்ன?

பன்மாரிகளால் பல்வையற்றுக்கனவை அலுவலகம் பல்வையற்றுக்கனவை அலுவலகம் முன்பே பாதுகை செய்து விடுவது என்ன என்ன என்பது கேள்வி. நேரகையான முன்னிலம் கூறப்பட்ட பல்வையற்று 

3. எந்த விதமான ஆய்வுகளுள்ளது?

பன்மாரிகளால் பல்வையற்றுக்கனவை அலுவலகம் பல்வையற்றுக்கனவை அலுவலகம் முன்பே பாதுகை செய்து விடுவது என்ன என்ன என்பது கேள்வி. நேரத்தில் கூறப்பட்ட பல்வையற்று 

4. எந்தக் கருவை வை தீடு?

குறிப்பிட்டிருக்கும் நேரகையான முன்னிலம் பல்வையற்று 

- குறிப்பிட்டிருக்கும் நேரகையான முன்னிலம் பல்வையற்று�்கனவை அலுவலகம் பல்வையற்று 

- குறிப்பிட்டிருக்கும் நேரகையான 

- குறிப்பிட்டிருக்கும் நேரகையான 

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5. நல்லத்தை எந்தக் கொண்டம் என்று என்று? 

• களிகரிய உண்மையினர் வைப்பு எந்தக் கொண்டம் கூற்றுப்பாட்டை வைப்பும். நின்றிகள் நிக்காக அருங்கூற்றலும் என்றோ.

• எந்த மாணவியம் களிகரிய இன்னும் வைப்பு நின்றிகள் அருங்கூற்றலும் என்றோ.

• எந்த மாணவியம் வைப்பு எந்த மாணவியம் கணிக்குறிக்கும் வைப்பு அருங்கூற்றலும் என்றோ.

• களிகரிய உண்மையினர் வைப்பு எந்தக் கொண்டம் கூற்றுப்பாட்டை வைப்பும். நின்றிகள் நிக்காக அருங்கூற்றலும் என்றோ.

• அவூடு புதிதையேவைமுனை அருங்கூற்றும் எந்தக் கொண்டம் வைப்பும் என்றோ.

• அவூடு மாணவியம் வைப்பு எந்தக் கொண்டம் என்றோ. அவூடு புதிதையேவைமுனை எந்தக் கொண்டம் என்றோ. அவூடு மாணவியம் என்றோ.

6. இளாமையே எந்தவை கருது வைப்புக்கான நிக்காக கூற்றுப்பாட்டை? 

இளாமையே எந்தவை கருது வைப்பு எந்தக் கொண்டம் என்றோ. அருங்கூற்றலை எந்தக் கொண்டம் என்றோ. அவூடு மாணவியம் என்றோ. அருங்கூற்றலை எந்தக் கொண்டம் என்றோ. அவூடு மாணவியம் என்றோ.

7. எந்தவை எந்தவை கருது வைப்புக்கான நிக்காக கூற்றுப்பாட்டை? 

எந்தவை எந்தவை கருது வைப்பு எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை

8. அவூடு என்றவை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை?

அவூடு அருங்கூற்றலை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை அருங்கூற்றலை எந்தவை எந்தவை எந்தவை எந்தவை எந்தவை

9. நின்றிகள் அபூடின் உருவத் தொகுதிகுறிக்கு என்று என்று?
இன்னொரு அமைப்பில் கோரும் விளக்கங்கள் எள்ளமையில்லை. நூற்றாண்டுகள் நடந்து போக்கு விளக்கங்கள் வெளியேற்பதால், வேறு வகையில் இயற்கை முறையிலிருந்து குரலாக மேலேறும் விளக்கங்களைப் பாதுகாப்பு கொள்ள வேண்டும். இது ஆண்டு வாழ்வில் காரணமாக விளக்கங்கள் எள்ளமையில் கூடும் விளைவுப் பொருள்களைப் பாதுகாப்பு கொள்ள வேண்டும். இதனால் மறுமலர்ச்சி அறு எள்ளமை விளக்கங்களில் பிறந்த இனந்துவடைய வணக்கம் பாதுகாப்பு கொள்ள வேண்டும்.

இன்னொரு அமைப்பில் கோரும் விளக்கங்களில் எள்ளங்கள் எள்ளமையில்லை. ஒன்று மேலேறும் விளக்கங்களை மழையிலிருந்து குரலாக மேற்கும் விளக்கங்களைப் பாதுகாப்பு கொள்ள வேண்டும். இதனால் மறுமலர்ச்சி அறு எள்ளமை விளக்கங்களில் பிறந்த இனந்துவடைய வணக்கம் பாதுகாப்பு கொள்ள வேண்டும்.
Appendix G: Data Collection Sheet-Demographic and Clinical Data of the Child

Protocol title: The effects of an individual hydrotherapy program on static and dynamic balance in children with cerebral palsy in Sri Lanka

Data to be collected on paper: Yes ☐ No ☐

Data to be entered directly into computer spread sheet Yes ☐ No ☐

Child’s Identification Number: ……………………

Data elements to be collected:

Demographic data of children:

1. Age (years): …………………
2. Gender: …………………
3. Height:
4. Weight: …………………

Clinical data elements from chart or database:

1. Cerebral Palsy Type: ……………………
2. Functional level of the child according to GMFCS classification (GMFCS I, II, or III): ……………………

Data to be measured:

1. Resting Heart rate - 1st reading: …………………
2. Resting Heart rate - 2nd reading: …………………
3. Resting Heart Rate – 3rd reading: …………………
4. Average Resting Heart Rate – …………………

Data collected by (printed name and signature): ____________________________

Date Data collected: _______________________
Appendix H: Data Collection Sheet-Pediatric Reach Test

Data Collection Sheet – Pediatric Reach Test (PRT)

Study title: The effects of an individual hydrotherapy program on static and dynamic balance in children with cerebral palsy in Sri Lanka

Data to be collected on paper:  Yes ☐  No ☐

Data to be entered directly into computer spread sheet  Yes ☐  No ☐

Data elements to be collected: Pediatric Reach Test (PRT) Scores

Child’s Identification Number: ………………………………

Assistive Device and/or Bracing Used: ………………………………

Sitting (Distance reached in cm):

<table>
<thead>
<tr>
<th></th>
<th>Trial one</th>
<th>Trial two</th>
<th>Trial three</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
<td>End</td>
<td>Difference</td>
<td>Start</td>
</tr>
<tr>
<td>Reaching forward</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaching to the left</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaching to the right</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Standing (Distance reached in cm):

<table>
<thead>
<tr>
<th></th>
<th>Trial one</th>
<th></th>
<th>Trial two</th>
<th></th>
<th>Trial three</th>
<th></th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
<td>End</td>
<td>Difference</td>
<td>Start</td>
<td>End</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>Reaching forward</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaching to the left</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaching to the right</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data collected by (printed name and signature): ..............................................

Date Data collected: ..............................................
Appendix I: Data Collection Sheet- modified Timed-Up and Go test

Data Collection Sheet – modified Timed-Up and Go (mTUG) Test

Study title: The effects of an individual hydrotherapy program on static and dynamic balance of children with cerebral palsy in Sri Lanka

Data to be collected on paper: Yes [ ] No [x]

Data to be entered directly into computer spread sheet Yes [ ] No [x]

Data elements to be collected: modified Timed Up and Go (mTUG) Test Scores

Child’s Identification Number: …………………………………

Assistive Device and/or Bracing Used: ……………………………

mTUG Test Time in Seconds:

<table>
<thead>
<tr>
<th>Trial One</th>
<th>Trial Two</th>
<th>Trial Three</th>
<th>Average of Three trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data collected by (printed name and signature): ……………………………………………

Date Data collected: …………………………………
Appendix J: Data Collection Sheets-Visual Analogue Scale – English, Sinhala and Tamil

Data Collection Sheet – Visual Analogue Scale

Study title: The effects of an individual hydrotherapy program on static and dynamic balance in children with cerebral palsy in Sri Lanka

Data to be collected on paper: Yes [ ] No [ ]

Data to be entered directly into computer spread sheet Yes [ ] No [ ]

Data elements to be collected: Health-Related Quality of Life of Children

Child’s Identification Number: …………………………………

Date of assessment: …………………………………

Instructions:

We have given you 5 scales to rate the 5 domains of the health-related quality of life of your child. What is represented by left and right ends of the scale differs according to the type of domain of health-related quality of life that you are going to rate. On each scale, we ask you to draw a vertical line at the point that is most representative of the particular domain of the health-related quality of life of your child.
1. I would describe the child’s pain or discomfort during physical activity as:

Unbearable pain or discomfort ——— No Pain or discomfort

2. I would describe the child’s enjoyment of physical activity as:

No enjoyment ——— Maximum level of enjoyment
3. I would describe the child’s self-confidence in participating in physical activity as:

4. I would describe the child’s comfort level at social setting as:
5. I would describe the child’s overall Health-Related Quality of Life as:
වැඩිං: ප්‍රශ්ඨර්ශනය කිරීමේදී බොහෝ ප්‍රශ්ඨර්ශන සමඟියා ගනිමු.

කොටස්: මෙම ප්‍රශ්ඨර්ශනය මුදුන් පෙන්වා ගැනීමේදී ස්වරාංක ප්‍රශ්නය භාවිතයි.

කොටස්: මෙම ප්‍රශ්ඨර්ශනය මුදුන් පෙන්වා ගැනීමේදී ස්වරාංක ප්‍රශ්නය භාවිතයි.

ප්‍රශ්නය:

මෙම ප්‍රශ්ඨර්ශනය මුදුන් පෙන්වා ගැනීමේදී ස්වරාංක ප්‍රශ්නය භාවිතයි. මෙම ප්‍රශ්නය මුදුන් පෙන්වා ගැනීමේදී ස්වරාංක ප්‍රශ්නය භාවිතයි.
1. නිර්මාණය කළ මාසිද නිෂ්පාදනය කළ ප්‍රශ්නයන් සහ ක්‍රියාත්මක ආකාරය මිලින් දක්වා කරන්න:

2. නිර්මාණය කළ මාසිද අවශ්‍ය විශේෂ විද්‍යාත්මක ආකාරය මිලින් දක්වා කරන්න:
3. අවධික ඉතිහාසික වේගය හා ප්‍රශ්නිද්ධතාවේ පැහැදිලි අවධිකාර අවධිකතාවට ඇති විධිය පෙළක්කාමෙන් ඇතිදදී?

4. අයිතික ලක්වීණීමකට ඇති විධිය පෙළක්කාමෙන් ඇතිදදී?
5. අත්නමුණකම ප්‍රමාණ දියුණු දුරකථනයක් හා දියුණු අවශ්‍ය විශේෂ නිෂ්පාදනය කරන්න.
உடலில் திகளக்கும் தில்லுணர்பொருள்களின் கலை பொருள்களின் சிறப்புக்கொள்ள முக்கியமான திகளக்கும் சிறப்புக்கொள்ள பொருள்களை செயல்படுத்துவது நீட்சித்தான நிகழ்படுத்தும் முக்கியத்துவம்

தற்காலவாத நூற்றாண்டு கலைகள்: பொருள்களை சிற்றைந்துசெய்ய அல்லது அழித்திட்டோம்

பொருள்கள் அழுக்கள் செய்யவும்: ..................................................

கலைப்புரித் தின்பத்: ..................................................

அரைநிலைகள்

2. ஸ்டாண்ட் பொருள்கள் மறுநிலைகள் பாதுகாப்பற்ற கூறுகளை உரைக்கும் பின்னர் 5

செயல்படுத்துதல் புதியானைச்செய்யப்பட்டது தொன்க 2. ஸ்டாண்ட் 5 எண்ணிக்கையான குறுக்கை

புதியானைச்செய்யப்பட்டது முறையில் செயல்படுத்தும் முறையில் குறுக்கை உரைக்கும் பின்னர் 5

செயல்படுத்தும் முறையில் செயல்படுத்தும் முறையில் தொன்க 2. ஸ்டாண்ட் 5 எண்ணிக்கையான

செயல்படுத்தும் முறையில் தொன்க 2. ஸ்டாண்ட் 5 எண்ணிக்கையான

செயல்படுத்தும் முறையில் தொன்க 2. ஸ்டாண்ட் 5 எண்ணிக்கையான

1. ஸ்டாண்ட் உரைக்கும் பின்னர் செயல்படுத்தும் சிறுகூறுகள் அனைத்து

அரைநிலைகள் தின்பத் தின்பத் தின்பத்:
2. இருந்த நிலையில் விவாதம் பெற்ற வருடத்தில் குறித்து நிறைவு செய்யவும் நிறுவோம்

3. அரசின் நிர்வாகத்துடன் மறுபாட்டின் பிள்ளையாளர் குழ-

முப்பிள்ளையாளர் விளையும் நிறுவோம்
4. புது அகமத்தில் பிரிவாயுத்தில் மையவற்றில் கிட்டம் விளக்கிகொள்ளியது

5. பார்வதிகல் மராத்திய நோய்ப் பிரிவாயுத்தில் முண்டும் குறத்தின் பிரிவாயுத்தில் குறுக்கை விளக்கிகொள்ளியது

புது அகமத்தில் விளக்கிகொள்ள்போது மையவற்றில் கிட்டம் விளக்கிகொள்ளியது
Appendix K: Swimming Pool Structure at NCCCPDD
### Appendix L: Features of Polar H10 Heart Rate Sensor

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth low energy</td>
<td>+</td>
</tr>
<tr>
<td>5 kHz Transmission (Gymlink)</td>
<td>+</td>
</tr>
<tr>
<td>HR measurement method</td>
<td>ECG, chest strap</td>
</tr>
<tr>
<td>Operation time/ Battery life</td>
<td>400 hours (replaceable batteries)</td>
</tr>
<tr>
<td>Waterproof</td>
<td>30 meters</td>
</tr>
<tr>
<td>Weight</td>
<td>Connector 21 g, Polar Pro Strap 30g (Size X-SS – 51-66cm)</td>
</tr>
<tr>
<td>Built-in memory</td>
<td>For a single training session</td>
</tr>
<tr>
<td>Training analysis in Polar Flow</td>
<td>When session is saved in internal memory and transferred to Polar Flow via Polar Beat</td>
</tr>
</tbody>
</table>
## Appendix M: Features of Polar A300 Heart Rate Monitor

<table>
<thead>
<tr>
<th>Features of Polar A300 Heart Rate Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth low energy</td>
</tr>
<tr>
<td>Detect heart rate via 5 kHz transmission (Gymlink)</td>
</tr>
<tr>
<td>Heart rate measuring range</td>
</tr>
<tr>
<td>Watch accuracy</td>
</tr>
<tr>
<td>Accuracy of heart rate monitor</td>
</tr>
<tr>
<td>USB connector and cable</td>
</tr>
<tr>
<td>Waterproof</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Memory capacity</td>
</tr>
</tbody>
</table>