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THE EFFECT OF HIPPOTHERAPY ON THE PHYSIOLOGICAL COST INDEX AND ON SCHOOL ACTIVITIES OF ADOLESCENTS WITH DIPLEGIA

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DECLARATION OF ORIGINALITY

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I, Ninette du Plessis, declare that this dissertation titled **THE EFFECT OF HIPPOTHERAPY ON THE PHYSIOLOGICAL COST INDEX AND ON SCHOOL ACTIVITIES OF ADOLESCENTS WITH DIPLEGIA** is my own work. It is being submitted in fulfilment of the degree, Master of Occupational Therapy, at the faculty of health sciences of the University of Pretoria. It had not been submitted before for any degree or examination at this or any other university.

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ABSTRACT

This study intended to examine the individual effect of hippotherapy on Physiological Cost Index and school activities in adolescents with diplegia. Ten adolescents with diplegia, aged 12 to 16 years, were studied. The results were not to be generalised to the broader cerebral palsy population.

A triangulation mixed method design was used. Within the quantitative part of the study, a single system multiple baseline design across subjects was implemented and in the qualitative part of the study, a semi-structured interview was used to determine effect of hippotherapy on school activities. Individual hippotherapy was conducted once a week over a 12-week period.

The effect of hippotherapy on physiological cost index was inconclusive, but the results obtained with regards to an increase in walking speed, were statistically significant.

Out of the qualitative research, three themes emerged as an effect of hippotherapy on school activities, namely improved rest and sleep, improved functional ambulation, and improved neuro-musculoskeletal functioning.

Key words: Hippotherapy, Physiological Cost Index, school activities, ambulation, diplegia, adolescents, equine assisted therapy, horse therapy, occupational therapy on horseback and effect of hippotherapy.

ABBREVIATIONS

Abbreviation	Meaning
CP	Cerebral Palsy
EATASA	Equine Assisted Therapy Association of South Africa
FMS	Functional Mobility Scale
GMFCS	Gross Motor Function Classification System
GMFM	Gross Motor Function Measure
HT	Hippotherapy
HPCSA	Health Professions Council of South Africa
PCI	Physiological Cost Index

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“There is nothing so good for the inside of a man as the outside of a horse.”

~ John Lubbock

CHAPTER 1

RESEARCH ORIENTATION

1.1. Introduction

Occupational therapists make use of activities to improve function in different areas of occupation (American Occupational Therapy Association 2014). Functional ambulation (within activities of daily living) and school activities are two of these areas of occupation (American Occupational Therapy Association 2014). In adolescents with diplegia, ambulation is affected (Rosenbaum 2003) which in turn affects participation in school activities (Broughton 2012). Hippotherapy (HT) is one of the activities used by occupational therapists as intervention in adolescents with diplegia (Engel and MacKinnon 2007; McGibbon, Andrade, Widener and Cintas 1998; Sterba 2007; Sterba, Rodgers, France and Vokes 2002).

The term “hippotherapy” is deducted from the Greek word “hippos”, meaning “horse”. Since the 1960s, the use of horses to treat individuals with disabilities has developed swiftly throughout the world. HT was started in Germany by horseback riders who saw positive changes in riders with disabilities. Today, HT is practiced in most countries (Engel et al. 2007; Sterba 2007), including South Africa, and focuses on medical treatment of clients with disabilities (Engel et al. 2007).

HT-training in South Africa is provided by the Equine Assisted Therapy Association of South Africa (EATASA), which was founded in 2010 in cooperation with the American Hippotherapy Association (De Villiers 2013). Currently, three of the five board members of EATASA are occupational therapists engaged in ongoing development of HT in South Africa.

HT-associations in various countries (including South Africa) all agree that one has to be qualified as an occupational therapist, physiotherapist or speech therapist, and be registered with the health professions council (or equivalent body) of the country in which they practice before taking part in a course on HT (Heine 1997). Although not enforceable by law, EATASA encourages occupational therapists who want to use HT as an intervention to first complete a course in HT (De Villiers 2013).

EATASA's courses are well established and HT is approved by the Health Professions Council of South Africa (HPCSA) as part of the occupational therapist's scope of practice as indicated in Annexure A.

Diplegia, within the group of cerebral palsy (CP), is one of the conditions treated by occupational therapists through HT (Engel et al. 2007; McGibbon, Benda, Duncan and Silkwood-Sherer 2009; Sterba 2007). Before HT within this group can be described, it is important to understand that CP is the most common physical disability in childhood (occurs in 2 to 2,5 per 1000 live births in the Western world), affecting all areas of functioning (Rethlefsen, Ryan and Kay 2010; Rosenbaum, Paneth, Leviton, Goldstein and Bax 2007). Rosenbaum et al. (2007) compiled the final version of the report on the definition and classification of CP after a workshop where extensive meetings, discussions and commentaries were all taken into consideration and concluded that the term CP refers to a group of permanent, but changing movement disorders causing activity and movement limitations. Other conditions such as epilepsy, learning difficulties, behavioural challenges and sensory impairments may accompany CP (Rosenbaum et al. 2007). These different comorbidities make treatment of a person with CP even more challenging (Broughton 2012; Rosenbaum et al. 2007).

As CP cannot be cured, and people with CP usually survive into adulthood, long-term support from professionals such as the occupational therapist and the family doctor is often sought (Rosenbaum 2003). During the high school years, adolescents with CP seem to tire from conventional therapy even though they might still need intervention. The horse and the surroundings at a stable-yard can be used to accommodate both the need for intervention and the need for independence from therapy (Debuse, Gibb and Chandler 2009; Engel et al. 2007). The occupational therapist has the ability to influence postural movements within the adolescent while the horse is walking, by changing the direction, speed and magnitude of the horse (El-Meniawy and Thabet 2012; Engel et al. 2007; Haehl, Giuliani and Lewis 1999). At the same time, the activity of horse riding might be personally meaningful to the adolescent, as it also addresses the need to take part in activities that they perceive as non-therapy (Debuse et al. 2009; Engel et al. 2007).

1.2. Background to the research problem

Diplegia, a subgroup of CP, is characterised by the involvement of corresponding parts on both sides of the body, typically affecting the legs more severely than the arms (Rosenbaum 2003). This form of CP accounts for about 44% of the total incidents of CP (El-Meniawy et al. 2012). Although individuals with diplegia experience unique problems that differ from other individuals with the same diagnosis, they all experience some form of limitation in their daily activities (occupations) and in their ambulation. School-related activities are among the most important activities in which adolescents engage (Gorodzinsky, Hainsworth and Weisman 2011) and limitations in school activities are often associated with ambulation (Broughton 2012). The tendency of gradual decline in ambulatory function in adolescent years (Gannotti, Gorton, Nahorniak, Gagnaire, Fil and Hogue 2008; Johnston, Moore, Quinn and Smith 2004), makes movement in the classroom and around the playground tiresome. Increased difficulty in movement leads to an increase in energy expenditure (Gage 1991), up to three times that of children with normal movement patterns (Liao, Jeny, Lai, Cheng and Hu 1997). This further affects other school activities, such as sitting upright and completing schoolwork. It is thus important for occupational therapists to be able to evaluate the outcome of therapeutic interventions on this population (Sterba 2007) with regards to both ambulation and school activities.

Adolescents with diplegia usually walk slower than unaffected adolescents (Johnston et al. 2004; Rodda and Graham 2001; Van der Krogt 2009). As walking speed can effectively be used to evaluate ambulation, it can also to be used to evaluate the effect of intervention on ambulation (Pasparakis and Darras 2009; Perry and Burnfield 2010). Another tool that was used to evaluate ambulatory interventions was Physiological Cost Index (PCI) (Plasschaert, Jones and Forward 2011; Raj, Mojazi Amiri, Wang and Nugent 2014; Raja, Joseph, Benjamin, Minocha and Rana 2007). Should either walking speed or PCI show a change after an intervention, a further concern was whether this change would still be present the next day or even the next week. The carryover of results therefore also needed to be investigated. Occupational therapists further view clients (in this study, adolescents) holistically (Roley, DeLany, Barrows, Brownrigg, Honaker, Sava et al. 2008) and therefore the opinions of adolescents with regards to the effect of HT on school activities were sought.

One previous study on the effect of HT on PCI (McGibbon et al. 1998) resulted in a statistically significant decrease in the PCI of all five the participants (McGibbon et al. 1998), but this study did not mention whether this decrease in PCI was carried over into every day functioning. Investigating the effect of HT on both the walking speed and PCI during ambulation (which is functionally significant), could provide a firm, scientific indication of the value of this treatment strategy, but more investigation in this regard was still needed. No study on the effect of HT on school activities could be found and likewise, investigation on the effect of HT on this occupation is needed.

1.3. Problem statement

HT seems to become more popular as a treatment strategy for children with CP all over the world (Debuse et al. 2009; Herrero, Asensio, Garcia, Marco, Olivan, Ibarz et al. 2010) and adolescents with diplegia are but one of the groups receiving HT.

Even though HT was indicated as an effective treatment with respect to PCI in younger children with diplegia (McGibbon et al. 1998) the effect thereof in adolescents was not yet established, neither was the carryover of results from the end of one session to the start of the next session. Documentation on the opinion of the adolescents that took part in HT was also lacking in available published research.

This not only led to the research question, but also to the formulation of the aims and objectives of this study.

1.4. Research question

Will HT on adolescents with diplegia affect their PCI during ambulation over a distance of 60 m and will HT affect their school activities?

1.5. Research aim and research objectives

The aim of this research was to determine the effect of 12 sessions of HT on the PCI during ambulation on a level surface over a 60 m distance and on school activities of adolescents with diplegia.

The research objectives were:

i. To determine whether hippotherapy improves walking speed over a distance of 60 m.
ii. To determine and describe the effect of hippotherapy on school activities, from the adolescent's own perspective.
iii. To determine the carryover of the PCI at the end of one session to the start of the next session.
iv. To describe the trend and level changes observed in the data patterns of PCI over the course of the study.

1.6. Definitions and clarification of concepts

i. Adolescent:

A young person in the process of developing from a child into an adult (Oxford Dictionaries 2015). For this study an adolescent was seen as a school-going person between 12 and 18 years of age.

ii. Ambulation:

The ability to move independently from one place to another place, with or without assistive devices (Elsevier 2009). These assistive devices include walking frames and reversed Kay-walkers used in walking as well as the use of a wheelchair in the school setting.

iii. Carry-over:

Carry-over occurs when a skill learned (or measurement taken) in one situation is still present in another similar situation. When a measurement is taken at the end of one HT session and remains the same as when taken before the next session, carry-over has taken place.

iv. Cerebral palsy:

"Cerebral palsy describes a group of permanent disorders of the development of movement and posture, causing activity limitations, that are attributed to non-progressive disturbances that occurred in the developing foetal 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).

v. Diplegia:

Cerebral Palsy is clinically described by the parts of the body that are affected most. Diplegia is a motor impairment that primarily affects the legs but the arms may be involved to a limited extent (Rosenbaum 2003).

vi. Gross motor function classification system (GMFCS):

This system provides a classification system based on a checklist for gross motor function in children with CP. It divides children with CP into one of five levels, based on their functional mobility or activity limitation (Rosenbaum et al. 2007). Children on Level I are the least affected and are able to walk independently and climb stairs without holding onto the rails, but their balance, speed and coordination are limited. Children on Level V, at the other end of the spectrum, are the most affected and limited in their ability to maintain head and trunk control against gravity (Rethlefsen et al. 2010).

vii. Hippotherapy:

HT is a treatment approach using the movement of the horse with the addition of the treatment principles that apply to occupational therapy, although HT can be applied by a physiotherapist, occupational therapist or speech therapist (Heine 1997).

HT is always individual therapy and in this study understood as therapy conducted by an occupational therapist that utilises equine movement to achieve functional outcomes.

viii. Terminology relevant to HT:

Side walker: A person who walks beside the horse to assist the participant according to the therapist's instructions and to ensure extra safety to the participant.

A horse handler/leader: The person leading the horse (not necessarily a horse trainer) while the therapy is conducted. The horse handler is present in each HT session.

ix. Horseback riding therapy, also refer to as therapeutic horseback riding:

Horseback riding therapy is conducted by riding instructors (who are not therapists) and assistants based on their training and knowledge of the participants' disabilities and of methods for safely using therapy-trained horses (Sterba et al. 2002). The terms 'horseback riding therapy' and 'therapeutic horseback riding' are both used in literature interchangeably. In this study, the term horseback riding therapy was used when referring to recreational horseback riding.

x. Occupations:

According to Practice Framework: Domain and Process III (2014) the word occupation refers to "… the daily life activities in which people engage. Occupations occur in context and are influenced by the interplay among client factors, performance skills, and performance patterns. Occupations occur over time; have purpose, meaning and perceived utility to the client and can be observed by others."

Occupations are further multidimensional and complex and contribute to health and well-being (American Occupational Therapy Association 2014).

The term occupation therefore also includes activities on horseback.

xi. Physiological Cost Index:

Physiological Cost Index (PCI) is the resting heart rate subtracted from the walking heart rate and then divided by the walking speed. The unit is the amount of heart beats per meter (Graham, Smith and White 2005; Ijzerman and Nene 2002; MacGregor 1981; Raj et al. 2014).

xii. Restichng heart rate:

Resting heart rate refers to the number of times a person’s heart beats per minute while at complete rest (McCoven 2012). In this study an average resting heart rate was calculated by using a polar RCX5 watch over the last 5 minutes of a 15-minute resting period while sitting.

xiii. School activities:

For the purpose of this study, the term school activities will be used as an umbrella-term for all activities at school such as completing homework and sitting upright in class and being able to listen to the teacher. Moving around the classroom and on the playground as well as activities within this context and environment such as sport is also included in this term.

xiv. Single-system design:

A single-system design is a research design that focuses on intra subject comparisons and uses repeated measures over time (De Vos, Strydom, Fouché and Delport 2011; Logan, Hickman, Harris and Heriza 2008; Tankersley, McGoey, Dalton, Rumrill and Balan 2006).

xv. Therapeutic horseback riding:

See horseback riding therapy.

xvi. Walking heart rate:

No official definition could be found during an online search. This term is, however, used in articles describing PCI (Nene and Jennings 1992; Raja et al. 2007; Thomas, Moore, Kelp-Lenane and Norris 1996). Walking heart rate refers to the heart rate that is measured during walking. For this study, the walking heart rate was the average heart rate from the beginning to the end of the second 30 m walk.

xvii. Walking speed:

In the context of PCI calculation, walking speed is the average speed in meters per minute that the participant walked over a designated distance.

1.7. Ethical considerations

Consideration was given to ethical principles as described in section 3.13 and they were implemented during this research in order to meet professional, legal and social obligations to both the research participants as well as the University of Pretoria.

The study protocol was approved by the Faculty Ethics Committee, Faculty of Medicine of the University of Pretoria. The certificate number that was obtained is 539/2013. (Annexure B)

To ensure that the researcher was competent and skilled to undertake the research, the researcher was supervised by competent occupational therapy lecturers. The treatment plan for the intervention was peer reviewed and approved by one of the board members of EATASA (De Villiers 2013).

1.8. Significance and contribution of the research

There is a need to provide evidence-based practice, effective intervention and maintenance for adolescents with diplegia (McGibbon et al. 1998). The study outcomes will add to the knowledge of occupational therapists and other professionals such as physiotherapists, who conduct HT with adolescents with diplegia.

As ambulation patterns of adolescents with CP cause high energy expenditure, it may become increasingly difficult for them to walk as they grow older and they may become non-walkers (Perry et al. 2010). This has an effect on the adolescent's occupational performance at school and at home, as well as their participation in leisure activities (Roley et al. 2008).

Although there is evidence for HT to be used as a treatment option for younger people with CP (MacKinnon, Noh, Laliberte, Lariviere and Allan 1995a; Sterba 2007; Sterba et al. 2002), no study could be found that focused on an adolescent population with diplegia. This study will further indicate whether the time and effort in achieving therapeutic outcomes through HT, has any effect on PCI and on school activities.

Last but not least, is the fact that this research is the first research in occupational therapy conducted on HT in South Africa. This study can contribute not only to the first occupational therapy literature on HT in South Africa, but also to the awareness of HT as a possible treatment strategy.

1.9. Scope of the study

Although limitations are dealt with in Chapter 3, it is important to understand that this study intended to examine individual changes in the participants as a result of hippotherapy, specifically with regards to PCI and school activities. The results can therefore not be generalised over the broader CP population and were also never intended for generalisation.

Another limitation to generalisation of the results was the small population, a reality that was also mentioned by authors like Backman, Harris, J-AM and Monette (1997) and MacKinnon (1995a).

1.10. Layout of this Research

Chapter 1: Presents an introduction and background to the research project.

Chapter 2: This chapter is an overview of the available literature that was relevant to the study in the following sequence:

- Hippotherapy
- Ambulation
- Physiological Cost Index
- School activities
- Overview on the research method

Chapter 3: Introduces the single-system design as well as a semi-structured interview. It then explains the methods used within this design to collect and analyse the data. Lastly the limitations fr the study is addressed.

Chapter 4: Explains the findings of the quantitative data for each participant according to the single-system design in relation to the aim as well as all the objectives applicable to the quantitative data.

Chapter 5: Explains the findings of the qualitative data for each question asked within the semi-structured interview.

Chapter 6: Analyses the results from Chapter 4 and Chapter 5, and then provides a discussion of the research findings. A summary of the research limitations, contributions as well as opportunities for future research on HT is provided.

1.11. Conclusion

There is a need to provide evidence-based practice within the field of HT as well as effective intervention and maintenance for adolescents with diplegia (McGibbon et al. 1998). The study outcomes will add to the knowledge of professionals who conduct HT with adolescents with diplegia.

Should HT contribute to better ambulation in adolescents with diplegia, the effect thereof will also contribute to occupational performance at school, at home and in leisure activities.

1.12. Summary

In this chapter, the background leading to the research is given. The research aims and objectives are listed and the concepts used in this research clarified. An indication of how the research results would contribute is given.

Chapter 2 deals with a literature review relating to HT, CP, ambulation, PCI and school activities as well as an overview of the research method.

Wherever man has left his footprint in the long ascent from barbarism to civilization we will find the hoof print of the horse beside it.

~ John Moore

CHAPTER 2
LITERATURE REVIEW

2.1. INTRODUCTION

This section reviews the available literature relevant to the main components of the study, i.e. HT, ambulation, PCI, school activities and the research method. This is the first study to the researcher's knowledge to examine the effect of HT on PCI of adolescents and the effect on their school activities. In fact, this is the first study (to the researcher's knowledge) that focuses on the effect of HT exclusively on adolescents in any regard. It is also the first study in occupational therapy on HT in South Africa and therefore the availability of literature in this regard is still limited.

Since HT is not a well-known occupational therapy strategy in South Africa, it will be described first. As there is limited primary information on HT, the researcher made use of the different key words that could imply the therapeutic use of horses by an occupational therapist. Key words that were used were: hippotherapy, equine assisted therapy, equine therapy, horse therapy, horseback riding therapy, therapeutic horseback riding and the American Hippotherapy Association. These key words were also used in association with other topics within this study such as HT and pelvic movement, HT and normal gait, normal movement on a horse and how a rider's pelvis moves. These key words were used in the following search portals: Library of the University of Pretoria, PubMed, Google Scholar, National library of New Zealand, Google.com and Medscape. The searching for information on HT for the purpose of this study started in 2012 and continued into 2015. The key words and portals used in other sections of the study will be given in each of these sections.

The available literature on HT and its effect on children and/or adolescents with CP will be discussed first. The literature about HT and its effect on ambulation will then be reviewed after that, and lastly, a discussion will follow on the only study that was found on HT and PCI (McGibbon et al. 1998). Horseback riding therapy is included in the literature review to render a broader perspective of the effect of the movement of the horse (Davis, Davies, Wolfe, Raadsveld, Heine and Thomason 2009; Sterba et al. 2002).

In this study, the term client will be used for people taking part in an HT session and the term participant will be used to describe people who took part in a particular study.

Secondly, an overview on ambulation will be given as HT seems to have an influence on ambulation. Therefore, previous studies on ambulation and HT are described first, and then an overview on normal ambulation and ambulation in diplegia is provided.

Thirdly, PCI will be explained, not only why it was chosen for this study, but also how it was developed historically. The discussion will include the parameters within and related to PCI-testing, namely resting heart rate, walking heart rate and walking speed. As ambulation has already been discussed, it will not be repeated in this section.

Fourthly, the term “school activities” and its meaning will be discussed as well as available literature on this subject as a dependent variable.

Fifthly, the research method will be clarified. Within this study, a triangulation-mixed method design was used. For the quantitative measurements, a single-system design was implemented. A semi-structured interview was used to record qualitative observations. All these aspects need clarification and explanation that will be given within this chapter.

2.2. Hippotherapy (HT)

2.2.1. Description of HT done by occupational therapists

To clarify the process of HT, a short description of HT is given. The examples of HT do not provide a comprehensive account of treatment. The sole purpose is to better the reader’s understanding of HT and not to teach and train future therapists in the art thereof. Literature on how the movement of the horse can be used to treat underlying movement problems of the client is scarce and the researcher relied heavily on her own clinical reasoning, peer revision and the course notes of the fundamental HT course of 2014 (Equine Assisted Therapy Assosiation of South Africa 2014).

The core of HT is that the movement of the horse facilitates changes in the client in sensory integration, neurodevelopment and perceptual-motor skills (Engel et al.

2007; MacKinnon et al. 1995a; Sterba 2007; Sterba et al. 2002). The core of occupational therapy is that active participation in meaningful activities leads to change in all spheres of life (American Occupational Therapy Association 2014; Engel et al. 2007). So strictly speaking, when a client is sitting (passively) on a horse, it is not occupational therapy (Engel et al. 2007), but when a client is actively involved in riding or other activities on horseback, it becomes therapeutic (Engel et al. 2007). Thus, more is needed both from the therapist and from the client to apply HT as part of occupational therapy treatment. How a session is presented and structured distinguishes any therapy with therapeutic value from activities that are just activities and nothing more (American Occupational Therapy Association 2014).

An occupational therapist presenting HT needs to have a thorough knowledge of both the movement of the horse and the effect thereof on the client (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Sterba 2007). This forms the basis of the therapy and may be used both as preparation and facilitation of the movement needed to actively take part in the therapy session (Engel et al. 2007). An example of this would be to engage abdominal muscles by altering the horse's speed with the goal to build better core stability, and free the client's hands to hold the reins and not to hold onto the saddle for stability (De Villiers 2013; Equine Assisted Therapy Assosiation of South Africa 2014). As each client is an individual person with individual needs, the occupational therapist needs to evaluate and adapt the movement of the horse within the session to ensure maximum gain from it (Sterba 2007). Therefore, sound clinical reasoning must take place throughout each session and no set programme can be followed (De Villiers 2013; Equine Assisted Therapy Assosiation of South Africa 2014).

A whole team is involved in an HT session and consists of a trained occupational therapist, a side walker and a person leading the horse (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Sterba 2007). A side walker is a person who walks beside the horse to assist the client according to the therapist's instructions and to ensure extra safety to the client. A horse handler/leader is the person leading the horse (not necessarily a horse trainer) while the therapy is conducted. The side walker and the horse handler need to be well-trained within their specific tasks. With the aid of a well-trained horse, the HT-team conducts therapy in such a way that the movement of the horse is used to specifically address the client's diagnostic problems while involving the client in activities that are meaningful to the client (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Sterba 2007). These activities can be as simple as holding the reins, or as complex as guiding the team according to a treasure map or sport activities such as lifting tins from poles or hitting balls with a bat.

To ensure the best possible movement from the horse, choosing the correct horse for each client is one of the most important decisions in this process (Engel et al. 2007). For example, a client with unstable balance reactions will need a broader horse as it provides a wider base of support. On the other hand, if a petite client with poor range of motion at the hip joints (due to spasticity or muscle tightness) is placed on a broad horse, the result will be internal rotation of the hips, a posterior pelvic tilt and asymmetric posture – not a posture that is desired (De Villiers 2013). A client with low tone in his trunk will need a horse with more impulsion and proprioceptive input through his spine, and a client with little dissociation of the pelvis needs a horse that provides more active movement and more up and down movement of the horse’s hindquarters (De Villiers 2013). This will tend to increase lateral pelvic tilt and lateral trunk flexion in a client. A horse with a naturally large over-track (hind hoof prints stepping over front hoof prints) tends to increase pelvic rotation in the participant (De Villiers 2013).

After the best available horse is matched with a client, the best movement patterns and figures for the horse’s movement must be determined. These movements of the horse are graded from session to session to match the needs of the client. Activities suitable for each client and the type of movement patterns are then chosen and applied.

2.2.2. Clarification of terms in HT

In literature, the terms HT and horseback riding therapy and/or therapeutic horseback riding are often used interchangeably within the same article (Engel et al. 2007; MacKinnon et al. 1995a; Sterba 2007; Sterba et al. 2002; Zadnikar and Kastrin 2011). For the purpose of this study the following is understood:

The main aim of HT is always to affect function such as ambulation, neurological function and sensory processing (Engel et al. 2007; Rigby 2009; Sterba 2007). This is done by an occupational therapist, speech therapist or physiotherapist with further knowledge of HT (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Heine 1997).

Horseback riding therapy and therapeutic horseback riding are seen as two terms for the same thing. Horseback riding therapy refers to recreational horseback riding that is conducted by a non-therapist (Equine Assisted Therapy Assosiation of South Africa 2014; Heine 1997). Horseback riding therapy may be conducted with a group of participants or as individual riding. Most often, the goal of horseback riding therapy is to teach persons with special needs to ride a horse, but in some instances an occupational therapist or physiotherapist altered some of the exercises within such a setting to render more therapeutic value to a session (Heine 1997; Sterba et al. 2002).

2.2.3. Review of existing literature on HT

Besides being used in the treatment of children with CP (Engel et al. 2007; MacKinnon, Noh, Lariviere, MacPhail, Allan and Laliberte 1995b; Sterba 2007; Sterba et al. 2002; Zadnikar et al. 2011), HT is widely used on other diagnostic groups as well (MacKinnon et al. 1995a). Studies were conducted on older people with balance impairments (Homnick, Henning, Swain and Homnick 2013), multiple sclerosis (Silkwood-Sherer and Warmbier 2007), adults after cerebrovascular accidents (Sunwoo, Chang, Kwon, Kim, Lee and Kim 2012) and spinal cord injury (Lechner, Kakebeeke, Hegemann and Baumberger 2007). The findings of these studies are beyond the scope of this research and will not be discussed.

Both Sterba (Sterba 2007), and Zadnikar and Kastrin (2011) performed a meta-analysis of HT and horseback riding therapy in children with CP. Zadnikar et al. (2011) compared eight studies on the effect of HT on postural control or balance accumulated from a total of 84 children with CP. In 76 of these children, an improvement in postural control and balance was reported. This indicated a significant statistical effectiveness of HT as well as horseback riding therapy on postural control (Zadnikar and Kastrin, 2011).

Sterba (2007) evaluated 11 studies on the effect of HT on different aspects such as postural control, weight bearing, gross motor development, energy expenditure, mobility, symmetry, range of movement and functional performance.

Studies were chosen that met Sterba's (2007) criteria for research design, methodological quality, therapy regimen, internal/external validity, results and authors' conclusions. The systematic description of the studies provided significant insight on what has been studied in this field and opportunities for further studies (Sterba 2007). The author did not compare HT and horseback riding therapy, but divided the studies into two different groups (Sterba 2007). Six of these studies involved horseback riding therapy and five involved HT. Only one study in the horseback riding therapy-group that used the Gross Motor Function Measure (GMFM) was inconclusive. On the other hand, all the studies in the HT-group had an outcome that indicated HT as an effective intervention (Sterba 2007). The outcomes of five HT studies used by Sterba (2007) were:

- Bertoti's (1988) study on postural changes for the head, neck, shoulders, trunk, spine and pelvis. HT was done on 11 children with spastic CP over a period of 10 weeks. The conclusion was that posture improved during the intervention phase (Bertoti 1988; Sterba 2007). This study was also included within the meta-analysis of Zadnikar et al. (2011).
- Bertoti's (1991) study on weight-bearing of arms and legs and weight shift in a two-and-a-half year-old child with hemiplegia over a six-week period. Enhanced weight bearing in both arms and legs was noted as outcome, but more so on the affected side (Bertoti 1991; Sterba 2007).
- The study of McGibbon et al (1998) on gross motor functioning, energy expenditure and stride length in five children with CP over an eight-week period. The conclusion was that HT improved gross motor function and energy expenditure in these five participants with CP (McGibbon et al. 1998; Sterba 2007). McGibbon's (1998) study will be discussed in more detail at the end of the literature review as this is the only study that could be found with similarities to this particular study.
- The study of Haehl et al (1999) on trunk coordination and mobility used kinematic measurements that was obtained from videos. The participants in

the study were two children with spastic CP. Improvement in trunk coordination of both these children and improvement of functional mobility after 12 weeks of HT were reported (Haehl et al. 1999; Sterba 2007).

- Casady and Nichols-Larsen's (2004) study on gross motor function and functional performance on 10 children with CP, between the age of two years and seven years. The GMFM and the Paediatric Evaluation of Disability Inventory (PEDI) were used as measurement scales (Casady et al. 2004; Sterba 2007). Improvement on the total GMFM and PEDI-score were noted. Most changes occurred in crawling and kneeling (Casady et al. 2004; Sterba 2007).

A pilot study done by Benda, McGibbon and Grant (2003) that also formed part of the meta-analysis of Zadnikar et al (2011), used a pre-test and post-test. This study investigated muscle symmetry of postural muscle groups in 15 children (four to 12 years of age) with spastic CP, after a once off, eight-minute session of HT (Benda et al. 2003). Seven children received HT and eight children sat on a stationary barrel. The children were randomly assigned to each group. The same test was done before and directly after the 8-minute HT-intervention (Benda et al. 2003). Readings of two children in the control group were inaccurate and could not be taken into account. In the children participating in HT, more symmetry was noted in those muscle groups that displayed the highest asymmetry during the pre-test (Benda et al. 2003). This was not the case in the control group that sat astride a stationary barrel (Benda et al. 2003). This study did not investigate the sustainability of the improvement of the symmetry, neither was the number of participants large enough to render significant statistical power to the study (Benda et al. 2003) but it did suggest that HT may have an effect on posture.

In an earlier study, Sterba (2002) studied the effect of horseback riding therapy on gross motor function and functional independence in 17 young children with CP within the spastic group. Their mean age was nine years and 10 months. They used the GMFM and the children's functional independence measure (WeeFIM). A pre-test was done six weeks before the intervention. During the intervention, they rode once a week for one hour per session (Sterba et al. 2002). After the first six weeks of the intervention, a retest was done and no changes were noted in any of the tests.

After 12 weeks, yet another test was done and running, walking and jumping showed significant progress in the GMFM. After all 18 weeks of horseback riding therapy, they showed an overall improvement of 7,6% on the GMFM, but no changes in the WeeFIM were reported (Sterba et al. 2002). According to Sterba (2002), the GMFM-results are more than a significant improvement. The score returned to the baseline level within six weeks post horseback riding therapy when yet another GMFM-test was performed (Sterba et al. 2002).

A randomised control trial on horseback riding therapy by Davis et al. (2009) was inconclusive. The aim was to establish quality of life as measured by the CP Quality of Life Questionnaire for Children and the KIDSCREEN, as well as health and functions as measured by The Child Health Questionnaire (Davis et al. 2009). Both these questionnaires showed no statistically significant difference between the control and experimental group after the HT-period (Davis et al. 2009). The researchers further used the GMFM-test that showed no improvement in gross motor functioning. The researchers included a larger population of 99 children (aged between four years and 12 years) with CP. Ten weekly sessions were conducted (Davis et al. 2009). Half of the participants did not attend all 10 sessions of therapy and an outbreak of equine influenza led to the use of up to three different horses for some of the participants (Davis et al. 2009). The authors mentioned that the participants who did not attend all the therapy sessions reflect the reality of therapy in real-life (Davis et al. 2009). They also concluded that it was uncertain whether the instrument used was sensitive enough to detect a real change in a child's quality of life (Davis et al. 2009). In view of all these difficulties, the outcome of this study does not appear contradictory to other studies, but rather as inconclusive. One would like to see this study repeated over a longer period of time, and with fewer problems in the execution thereof.

In the book *Enhancing human occupation through hippotherapy: A guide for occupational therapists (*Engel et al. 2007*)* a study done by MacKinnon et al. (1995b) described a horseback riding programme on 19 children with CP. Ages of the children ranged between four years and 12 years. The study was divided into a quantitative and qualitative part and the participants took part in the horse riding programme once a week over a six-month period. Within the quantitative part of the study, pre- and post-tests were used to determine posture, gross motor functioning, fine motor functioning and ADL-functioning. These results were inconclusive. Within the qualitative part of the study, the journals of the riding instructor, reports from the physiotherapist and reports from the parents were studied. Improvements of riding skills and improved self-confidence with regard to riding skills were reported. The overall report in the qualitative part of the study was positive towards the effect of the horse riding programme, even though it was not confirmed by the quantitative results. The authors pointed out that sensitive tests to measure the influence of the movement of the horse are lacking and need to be developed (Engel et al. 2007).

McGibbon (1998) conducted the only study that was found by the researcher that dealt with the effect of HT on PCI. The same formula (as used in the current study) for PCI (walking heart rate minus resting heart rate divided by the walking speed) was used, but it was called the energy expenditure index. The researchers (McGibbon et al. 1998) reasoned that this index indicates energy expenditure due to the relation between heart rate and energy consumption (McGibbon et al. 1998). Due to disagreement in other literature (Graham et al. 2005; Ijzerman et al. 2002; Plasschaert et al. 2011; Raj et al. 2014) whether PCI is indeed an indication of energy expenditure the researcher in the current study only used PCI as indicator of ambulatory functioning (Plasschaert et al. 2011). McGibbon's (1998) study formed part of Sterba's (2007) meta-analysis and five participants, four with diplegia and one with hemiplegia, took part in this study. Their ages ranged between nine years and 11 years (McGibbon et al. 1998), a much younger population than the adolescent population in the current study. The hypothesis was: "children with CP would show greater improvement in gross motor function, energy expenditure and stride dimensions after an eight-week HT programme than during a non-treatment period." (McGibbon et al. 1998:755) They called the research design a "repeated-measure within subject's design" (McGibbon et al. 1998:755). Their methods, such as two baseline measurements taken eight weeks apart followed by an eight-week intervention phase (two HT sessions per week) and then a re-test, all correlate with principals of the single-system design as used in the current study. But the current study also added measurements during the intervention phase to observe when change (if any) started to occur. In McGibbon's (1998) study two baseline measurements were taken and only one measurement was taken after the intervention phase. No measurements were taken during the intervention phase. McGibbon (1998) found a statistically significant improvement in the energy expenditure values (PCI-values) and in the GMFM scores for walking, running and jumping of all the participants after HT. Changes in stride dimensions were not found to be significant, yet individual changes such as changes in stride length and cadence in some of the participants were noted (McGibbon et al. 1998). A small sample was used, making the possibility of generalisation over the larger CP population difficult; nonetheless, the study showed that HT had a positive influence on the PCI and gross motor development of the five participants that took part in the study (McGibbon et al. 1998).

There is a lack of literature on qualitative studies on HT and searches with the keywords and phrases such as: qualitative studies on hippotherapy, client's perspective on HT, and self-reporting on HT, resulted in only one study. A qualitative study on the view of 17 participants ranging between four years of age and 63 years of age on HT was done by Debuse, Gibb and Chandler (2009). Without exception, all the participants as well as their parents said that HT was enjoyable and that they perceived it as riding rather than therapy. According to the participants, the main effects of HT were that HT facilitates motor learning and delivers better results than conventional therapy. The specifics of this statement were not given in the article. The participants thought that people of all ages benefit from HT as HT addresses function on impairment, activity and participation level. The participants reported that self-esteem and self-efficacy developed as a result of improvement in function and that quality of life is boosted both physically and psychologically (Debuse et al. 2009). Some of the participants also reported that they were tired after HT and others noted that they were afraid of horses at first, but that the fear deceased as the programme progressed. Qualitative studies that confirm the findings of this study influenced the decision of the researcher to include a qualitative aspect into this study on the perceived influence of HT on school activities.

These studies suggested that HT improves balance and postural control (Bertoti 1988; Sterba et al. 2002; Zadnikar et al. 2011), weight bearing (Bertoti 1991), trunk coordination and functional mobility (Haehl et al. 1999).

The majority of participants with CP that were included in these studies were from the spastic group. One of the most significant limitations of all the studies was the small sample sizes (Davis et al. 2009; Sterba 2007; Zadnikar et al. 2011). MacKinnon et al. (MacKinnon et al. 1995a) pointed out that because there are only a small number of children with CP, it is difficult to obtain a homogeneous sample within this population. Another problem that Sterba (2007) noted was the frequent lack of a non-riding control group.

HT appears to be an exciting activity to take part in as it is executed in a non-clinical setting. Adolescents might be more willing to participate in this form of therapy. Yet research on how adolescents experience HT is scarce.

2.3. Ambulation

Different terms are used for ambulation, such as locomotion (Gollhofer, Taube and Nielsen 2012; Rosenbaum 2010), gait (Perry et al. 2010) and walking (Bogey 2012; Rosenbaum 2010). Therefore, these words were used as key-words in search portals such as PubMed, Google scholar and within the search portals used by the library of the University of Pretoria. Key words used to retrieve information on ambulation in people with diplegia were: ambulation in diplegia, diplegic gait, pelvic movements in diplegia, abnormal walking patterns, walking patterns in CP and gait in CP.

The third edition of Occupational Therapy Practice and Framework includes functional ambulation under activities of daily living, which is one area of occupation (American Occupational Therapy Association 2014). Ambulation is also included under performance skills and client factors to enhance participation in occupation (American Occupational Therapy Association 2014). In this study, the term ambulation will be used in the quantitative part of the study to describe walking from one place to another with or without an assistive device such as a walker, crutch or walking frame. In the context of school activities, the term will be used in its broader sense to include the use of wheelchairs.

Studies on how HT influences ambulation will now be discussed, followed by a discussion of normal ambulation. Lastly, ambulation in people with diplegia will be described.

2.3.1. HT and its effect on ambulation

Occupational therapists that conduct HT believe that the movement of a horse promotes active responses in the client and that the moving horseback offers a dynamic treatment surface (El-Meniawy et al. 2012; Heine 1997; Rigby 2009). Research, although limited, appears to reinforce the theory that the multidimensional movement of the horse causes pelvic movement in the client that is similar to normal movement in the pelvis during normal human ambulation (Engel et al. 2007; McGibbon et al. 1998; Rigby 2009).

Rigby (2009) conducted a quantitative study to compare the pelvic movements of children during walking to their pelvic movements on a horse. Six able-bodied children between eight and twelve years of age and three therapy horses took part in the study (Rigby 2009). All six participants rode on all three the participating horses and completed walking trials as well. The data were collected by using an external marker system and six video motion capture cameras (Rigby 2009).

Although the timing between the pelvic movements in riding and the pelvic movements in walking differed, Rigby (2009) obtained results that provide evidence to validate the theory that the type of pelvic movement on a walking horse resembles pelvic movement in physically unaffected walking humans (Rigby 2009). Therefore, HT might provide the sensation of normal pelvic movements in people with diplegia who experience difficulties during ambulation (Rigby 2009).

A more recent study on the effect of HT on ambulation showed clinical changes in ankle, knee, hip and pelvic movements with low statistical significance (Fízková, Krejčí, Svoboda*, Elfmark and Janura 2013). In this study, the term ambulation was used to refer to walking without assistive devices. Eleven participants between the ages of nine and 19 years of age took part in daily HT and physiotherapy interventions over a week-long period. Movement of the ankles, knees, hips and pelvis were recorded with seven infrared cameras (Fízková et al. 2013). The changes observed in the ankle were negative to walking. Changes in the knee joints demonstrated improved forward motion and less flexion during standing (Fízková et al. 2013). Changes in the hip joints were most significant with regards to lessened internal rotation (Fízková et al. 2013). Lastly, more stability occurred in pelvic movement (Fízková et al. 2013). As HT was combined with individual physiotherapy for each participant, a conclusion on the observed results cannot be drawn on the effect of HT alone. One can only say that HT might have played a role in observed changes in walking (Fízková et al. 2013).

2.3.2. Normal Ambulation

Specific systems contribute or influence ambulation. These include the central nervous system (Rosenbaum 2010), sensory feedback (Gollhofer et al. 2012; Rosenbaum 2010), muscle activity (Perry et al. 2010), range of joint movement, postural control and balance reactions (Woollacott, Burtner, Jensen, Jasiewicz, Roncesvalles and Sveistrup 1998). When one system is affected, it affects the other systems too, as all these systems interact with one another during the complex activity of ambulation (Pasparakis et al. 2009; Woollacott et al. 1998). The role of these systems will be mentioned within the description of ambulation, but will not be addressed in detail as such a detailed description is beyond the scope to this study.

During each stride or step, one leg provides support (the stance period), while the other leg moves forward (the swing period). This is called a gait cycle (Bogey 2012; Pasparakis et al. 2009; Perry et al. 2010). The gait cycle needs normal functioning of both the musculoskeletal and the nervous system (Pasparakis et al. 2009). Each period is then further divided into phases. There are eight phases in each step (Perry et al. 2010). To enable one leg to change from the stance period into the swing period, weight must be shifted. The leg that is carrying the weight cannot swing at the same time. Shifting of weight is first needed and happens during the phases of double support at the beginning and end of the stance period (Pasparakis et al. 2009).

During normal ambulation, the gait cycle should be the same for both sides of the body (Pasparakis et al. 2009) as fluent symmetrical motion patterns follow one after another (Perry et al. 2010). When sensory feedback is adequate, these motion patterns are able to stay fluent and the person will easily adapt even to a changing environment such as an uphill or uneven ground (Rosenbaum 2010).

Human ambulation is more unstable than animal movement (on four legs) (Pasparakis et al. 2009). With each step a human takes, the alignment between the body and the lower extremities changes (Pasparakis et al. 2009; Perry et al. 2010), and challenges stability. This process of staying stably in space is called postural control (Brogren, Hadders-Algra and Forssberg 1998). To be more specific: the centre of mass needs to be kept over the base of support which is quite narrow in upright ambulation (Pasparakis et al. 2009). Different systems such as the visual system and vestibular system gives feedback to obtain postural control (Brogren et al. 1998; Woollacott et al. 1998). As the centre of mass (located in front of the second sacral vertebra) is kept over a narrow base of support (Pasparakis et al. 2009) the head and neck, as well as the trunk, travel as the passenger unit, moving up and down (Pasparakis et al. 2009; Perry et al. 2010).

During normal ambulation, the passenger unit must maintain its postural control, while the locomotor unit carries it from point A to point B (Pasparakis et al. 2009; Perry et al. 2010). The legs and the pelvis form the locomotor unit (Perry et al. 2010). When a leg accepts the weight, it has to be stable even though the posture changes. It also has to act as a shock absorber and has to use as little muscular effort as possible (Perry et al. 2010).

As pelvic movement is essential in HT (Engel et al. 2007; Rigby 2009), normal pelvic movement and function in ambulation will be now be discussed in further detail.

In ambulation, the role of the pelvis is twofold. It is part of both the locomotor and the passenger units (Perry et al. 2010). As part of the lower fragment of the passenger unit, the pelvis rides on the hip joints that move. On the other hand, its role as part of the locomotor unit is to be mobile and to link the two legs (Perry et al. 2010). An example of this movement is how the pelvis moves with the swinging leg by rotating forwards. The pelvis moves in all three planes (Kirkwood, Franco Rde, Furtado, Barela, Deluzio and Mancini 2012; Perry et al. 2010) with small motion arcs (Perry et al. 2010).

In the sagittal plane, the pelvis tilts anteriorly and posteriorly. In the upright position, the pelvis is already tilted 10^{o} anteriorly, even though it appears to be neutral. In walking, a further anterior tilt of 4^{o} occurs (Perry et al. 2010). Early in the gait cycle, the task of single limb support occurs and the pelvis tips slightly in the posterior direction (Perry et al. 2010) to be over the supporting leg. Posterior tilt is explained only from the perspective of one leg and occurs during initial swing as well (because that is when the opposite leg moves into the task of single limb support) (Perry et al.

2010). The opposite movement to posterior tilt is anterior tilt and in the sagittal plane, the pelvis tilts anteriorly during terminal swing as well as during terminal stance (Perry et al. 2010).

In the frontal (coronal) plane, the pelvis moves more or less 4^{o} (Kirkwood et al. 2012; Perry et al. 2010). Lateral movement is seen during weight bearing, as the contralateral side of the pelvis drops when weight is accepted, and in mid-stance (Kirkwood et al. 2012; Perry et al. 2010). When the pelvis drops, it helps to adjust the length of the supporting leg; this prevents too much downward movement of the centre of mass (Kirkwood et al. 2012). When the pelvis drops and that leg enters into the terminal stance and pre-swing phases, abduction will be easier. Abduction is needed as part of the swing phase and for the body to move forward (Kirkwood et al. 2012).

In the transverse plane, the pelvis moves from a backward rotated position in the terminal stance to a position of forward rotation in terminal swing (Perry et al. 2010). The pelvis rotates 5^{o} forwards and 5^{o} backwards (Perry et al. 2010). The forward rotation of the pelvis plays a role in step length, whereas backward rotation plays a role in the positioning of the leg (Perry et al. 2010).

When ambulation is described from a biomechanical point of view, aspects such as walking speed, stride length and force also need to be taken into consideration (Pasparakis et al. 2009). The swing period in ambulation does not change significantly when walking speed changes; it is the stance period that becomes shorter or longer (Rosenbaum 2010). Another influence on walking speed is sensory feedback (Rosenbaum 2010). Without sensory feedback, walking speed tends to be slower (Rosenbaum 2010). As walking speed is a reliable indicator of walking ability, it can be used as an assessment tool for ambulation (Pasparakis et al. 2009) and will be described further in the section on PCI.

2.3.3. Ambulation in diplegia

According to Fairhurst (2012), any injury to the central nervous system can lead to disorders of the development of movement and posture, such as diplegia (Pasparakis et al. 2009). Diplegia can disrupt the balance between muscular system, the lever system (bones and joints) and nervous system, resulting in diminished ambulation efficiency (Perry et al. 2010). The muscles are often weak, even though they are spastic (Bogey 2012; Perry et al. 2010). Spasticity and contractures of leg muscles that affect the movement patterns in ambulation are common features in this group (Bogey 2012; Perry et al. 2010; Rodda et al. 2001). Other aspects that may affect ambulation are pain and/or an abnormal sensory system (Perry et al. 2010).

Even though each person with diplegia demonstrates a personalised mixture of these problems, they exhibit common movement patterns (Perry et al. 2010; Rodda, Graham, Carson, Galea and Wolfe 2004). Sutherland and Davids (1993) named the following ambulation patterns in diplegia: true equinus, jump gait, apparent equinus, crouch gait and the stiff knee gait (Perry et al. 2010; Rodda et al. 2001; Sutherland et al. 1993).

The movement patterns mentioned above are viewed in the sagittal plain. In the coronal plane, thigh adduction at the hip interferes with ambulation (Kirkwood et al. 2012) causing a scissoring gait seen on its own or as part of crouched ambulation (Bogey 2012). These abnormal movement patterns cause limitations in functional ambulation (Bogey 2012; Pirpiris, Trivett, Baker, Rodda, Nattrass and Graham 2003).

The transverse plane might reveal problems such as excessive pelvic rotation, inward rotation of the femur, outward rotation of the tibia and other foot deformities (Rodda et al. 2001). Occupational therapists take movement patterns (in all three planes) in diplegia into consideration when HT treatment is planned (Equine Assisted Therapy Assosiation of South Africa 2014).

Since HT has a direct influence on pelvic movement (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Rigby 2009), the pelvic movements in each client with diplegia is evaluated to direct the movements of the horse in such a way that the pelvic deviations in the client can be addressed successfully (Equine Assisted Therapy Assosiation of South Africa 2014). Clinical reasoning is used to determine the underlying mechanism for abnormal movement patterns. The lower limbs are mostly indirectly influenced by the pelvis and trunk, but not directly through HT, as saddles and stirrups are seldom used within a HT setting. The reason for not using saddles is that saddles tend to limit the movement that is carried over from the horse to the participant.

Common pelvic movement patterns in diplegia will now be described in combination with possible underlying reasons for abnormal movement patterns. Limited literature on detailed movements in the pelvis of people with diplegia was available.

When the pelvic tilt is described from a sagittal plane, both anterior and posterior tilting can be present (Perry et al. 2010). The pelvis is already tilted 10^o anteriorly in a standing person, thus anterior tilt means an even further tilt than 10^o. Such an anterior tilt of the pelvis is often seen in the crouch gait of people with diplegia and may be accompanied by lumbar lordosis (Perry et al. 2010). This combination of anterior pelvic tilt and lumbar lordosis may lead to back pain. This tilt may be used as compensation for limited hip extension, especially during the terminal stance. Other reasons to adopt an anterior pelvic tilt might be a flexion contracture and/or spasticity in the hip muscles, weakness of the abdominal muscles (Perry et al. 2010) or weak hip extensors (Wangjam, Singh and Singh 2005).

Posterior pelvic tilt in the sagittal plane occurs when the pelvis is tilted further backwards than the normal 10^o anterior tilt in standing (Perry et al. 2010). Posterior tilt may occur during any phase of the ambulation cycle (Perry et al. 2010). Some of the underlying causes may be hip extensor weakness, tightness of the hamstrings, lower back pain or limited extension range of the lumbar spine (Perry et al. 2010). Due to the variety of possible factors influencing anterior and posterior pelvic tilt, careful evaluation is needed to determine the underlying problems in an individual person.

In the coronal plane, mainly two pelvic deviations may occur: the pelvic hike and the pelvic drop (Perry et al. 2010). The definition for pelvic hike is: "Elevation of one side of the pelvis above the neutral horizontal plane." (Perry et al. 2010:263). Pelvic hike is mostly seen during the swing period of ambulation when there is a limitation on knee flexion or hip flexion and plantar flexion is present at the ankle (Perry et al. 2010). The functional reason for pelvic hike is to move the leg through the swing period and place the foot on the ground, but it also may increase energy expenditure (Perry et al. 2010).

Pelvic drop may occur in either side of the pelvis and is thus either called contralateral pelvis drop or ipsilateral pelvis drop (Perry et al. 2010). The definition of contralateral pelvic drop is: "Contralateral iliac crest is lower than the ipsilateral iliac crest" (Perry et al. 2010:263). During loading response, mid-stance or terminal stance contralateral pelvic drop may be observed (Perry et al. 2010). The underlying causes may be ipsilateral hip abductor weakness (DeLuca 1991; Perry et al. 2010), ipsilateral hip adductor contracture or spasticity (resulting in a scissoring gait) (DeLuca 1991), and contralateral hip abductor contracture (Perry et al. 2010). The functional effect is that there is less stability on the supporting leg and the opposite leg seems to be longer due to the lower pelvis (DeLuca 1991; Perry et al. 2010) leading to an unsymmetrical posture.

The definition of ipsilateral pelvic drop is the other way around, namely: "Ipsilateral iliac crest is lower than the contralateral iliac crest" (Perry et al. 2010:265). Scoliosis and a short leg may be observed. Other underlying problems might again be abductor weakness on the contralateral side and/or ipsilateral calf muscle weakness. Again, the lower pelvis increases the relative length of that leg (Perry et al. 2010).

In the transverse plane, normal rotation is only 5^{o}, which is not easily observed. Thus, whenever the rotation is observed with the naked eye, there is too much rotation, called excessive rotation. Excessive forward pelvic rotation may occur during the loading response, mid-stance, mid-swing and terminal swing phases. Excessive forward rotation, especially when seen during terminal swing, may be used to increase step length should the hip flexors be weak (Perry et al. 2010). On the other hand, excessive backward pelvic rotation may occur during mid-stance, terminal stance, pre-swing, initial swing and mid-swing. Again, step length is increased, but in this case due to weak calf muscles that do not allow the heel to rise during push off. Excessive backward pelvic rotation may also be a compensation for hip flexion contractures (Perry et al. 2010).

When a stiff movement with shorter step length is seen at the pelvis, it might indicate a lack of pelvic rotation (Perry et al. 2010). People with limited pelvic rotation will visually appear to have a stiff trunk too. Limited pelvic rotation might be due to a lack of motor control in the trunk or pelvis. Spasticity in the spine with or without back pain may also lead to limited rotation in the pelvis (Perry et al. 2010). Just as postural control is needed in normal ambulation and is influenced by the other systems, postural control is needed and influenced by the ambulation pattern in people with diplegia (Woollacott et al. 1998). Postural deviations occur in children with diplegia

(Brogren et al. 1998; Woollacott et al. 1998) when there is muscle weakness at the hip, knee or ankle (Perry et al. 2010; Rodda et al. 2004). Because one of the main components of postural control is normal postural tone, spastic muscles may also cause postural deviations (Brogren et al. 1998). Individuals with diplegia often show weakness in the trunk and spasticity of the extremities. Thus, a mixed picture is observed when muscle tone is considered (Brogren et al. 1998). When the trunk deviates from the natural upright posture, it is called a trunk lean (Perry et al. 2010). Trunk lean may occur in any of the three planes and is most commonly dynamic (Perry et al. 2010). It usually has little functional effect on ambulation other than an increase in energy expenditure (Perry et al. 2010). The trunk and the pelvis influence one another (Perry et al. 2010).

2.3.4. Summary on ambulation

Normal ambulation is influenced by many systems interacting with one another (Pasparakis et al. 2009; Woollacott et al. 1998). Describing how a person moves does not explain why the movement occurs in a certain way, neither does it explain how movement will change should any system be impaired.

In normal ambulation, the pelvis forms part of both the locomotion and passenger units and moves in all three planes (Kirkwood et al. 2012; Perry et al. 2010). Even though these movements are small, it has a large impact on functional ambulation. When normal movement patterns are changed, it has an influence on all joints and muscles (Perry et al. 2010). Movement in the pelvis might be restricted or changed due to a number of systems that may be impaired. These abnormal movement patterns may lead to decreased walking speed, pain in other areas (all systems influence one another) and problems with both postural control and balance. Abnormalities in ambulation make movement from place to place time consuming and high in energy expenditure (Gage 1991; Thomas et al. 1996). In individuals without pathology, the oxygen consumption decreases as they grow older, but in people with diplegia the opposite is true (Perry et al. 2010). Adolescents therefore become less motivated to move and more reliant on wheelchairs for ambulation. They thereby become less functional due to the amount of effort involved in moving around (Johnston et al. 2004; Perry et al. 2010).

Interventions that will result in an increase in the efficiency of ambulation should decrease energy requirements and may decrease dependency on a wheelchair or other walking aids (Bogey 2012; Johnston et al. 2004). Improved ambulation may also have a positive influence on other gross motor activities such as running, jumping and stair climbing (Abel and Damiano 1996). HT influences movements in the pelvis by mimicking pelvic movements during ambulation in all three planes (Rigby 2009). Although sensory feedback is believed to have an influence and a carryover effect from the HT to ambulation, other influences such as stretching of muscles, influencing of muscle tone and the influence on postural control cannot be ignored (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014).

To measure the impact of any intervention on ambulation is thus no simple task. An attempt to describe what to measure and how will be discussed in the next section.

2.4. Physiological Cost Index (PCI)

2.4.1. Introduction

Raja et al. (2007) investigated several aspects of PCI and found a definite association between the PCI values and the scores of the Functional Mobility Scale (FMS)(Graham, Harvey, Rodda, Nattrass and Pirpiris 2004) that was used. Raja et al. (2007) therefore conclude that PCI is an indication of ambulatory function. The FMS is a scale that rates functional mobility in children (from four to 18 years of age), over 5 m, 50 m and 500 m. The FMS cater for different assistive devises to be used in different environments and is assessed by the answers given by participants or their parents (Graham et al. 2004; Rethlefsen et al. 2010).

PCI will now be described with regard to the development of PCI, what PCI indicates; the reliability, validity, sensitivity and critique of PCI, and the parameters required for calculating PCI (Graham et al. 2005; Ijzerman et al. 2002; MacGregor 1981; Raja et al. 2007).

2.4.2. Historical development of PCI

MacGregor (1981) developed the calculation of PCI by incorporating both heart rate and walking speed. He viewed heart rate as indicator of the amount of effort needed for ambulation and self-selected walking speed as indicator of ambulatory problems

(MacGregor 1981). He then formulated PCI as indicator of ambulatory performance when calculated over a 24-hour period (Ijzerman et al. 2002; MacGregor 1981; Raja et al. 2007). MacGregor (1981) later also introduced a 200 m figure-of-eight track for shorter clinical trials that was more readily used by researchers to measure ambulatory performance.

2.4.3. PCI as indicator of ambulatory performance

PCI was used as measurement in various studies and on various diagnostic groups such as stroke (Danielsson, Willen and Sunnerhagen 2007; Maeshima, Osawa, Nishio, Hirano, Takeda, Kigawa et al. 2011), amputations (Hagberg, Tranberg, Zugner and Danielsson 2011; Visser, McCarthy, Marks and Davis 2011), spinal cord injuries (Hood, Granat, Maxwell and Hasler 2002; Leung, Wong, Wong and Hutchins 2009; Nene et al. 1992) and polio (Hachisuka, Makino, Wada, Saeki and Yoshimoto 2007).

Researchers such as Bratteby Tollerz (2011), Raja (2007), Baily (1995) and Nene (1993) used PCI in relation to energy expenditure but due to contention in other research (Graham et al. 2005; Ijzerman et al. 2002; Plasschaert et al. 2011; Raj et al. 2014), energy expenditure was not considered in this study.

Raj, Amiri, Wang and Nugent (Raj et al. 2014) studied physically unimpaired persons and concluded that PCI links walking speed with physiological stress which is seen through measurement of heart rate. Such studies on physically unimpaired persons (Butler, Engelbrecht, Major, Tait, Stallard and Patrick 1984; Graham et al. 2005; Raj et al. 2014) were conducted to evaluate the reliability and validity of PCI (Butler et al. 1984; Graham et al. 2005) as well as the repeatability of PCI (Raj et al. 2014), as will be discussed shortly.

Studies on persons with CP were mainly conducted on persons who are minimally to moderately affected by CP (Bratteby Tollerz et al. 2011; Raja et al. 2007; Rose, Gamble, Medeiros, Burgos and Haskell 1989). In a comparison study between physically unimpaired children and children with CP in relation to PCI, participants fell within Level I and Level II of the GMFCS (Rose et al. 1989). This classification indicates that the participants were able to ambulate independently in most settings, even though some of them might have used a hand held assistive device (Rethlefsen et al. 2010).

Plasschaert et al. (Plasschaert et al. 2011) compared the measurement of resting heart rate taken in different positions during a walking test in both unimpaired children and in children with diplegia. One of the conclusions of this study was that PCI does indeed give an indication of ambulatory performance in children with diplegia (Plasschaert et al. 2011) and therefore PCI was selected in this study as indication of how ambulation is affected by HT.

2.4.4. Reliability of PCI

In physically unimpaired individuals, PCI was found to be reliable (Graham et al. 2005; Raj et al. 2014). Such a study was done by Raja et al. (2007) who compared PCI values over 50 m, 100 m and 150 m in 50 physically unimpaired children. Fifty children without any disability walked 50 m on day one, 100 m on day two and 150 m on day three. The PCI was calculated and the mean value for each distance was 0,21 beats per meter over all, indicating reliability in the calculation of PCI (Raja et al. 2007).

Raja (2007) further investigated the reproducibility of PCI in 15 children with CP and 15 children without physical impairment both indoors and outdoors over a 15 m distance. The distance was walked twice indoors (three days apart) and repeated one week later on an outdoor surface, partly asphalt and partly pebbles. The two PCI mean values for indoor walking for children without physical impairment differed with 0,01 beats per meter (0,11 and 0,12 beats per meter) for outdoor walking it was the same reading in both trials, namely 0,14 beats per meter. For children with CP the mean PCI was 1,57 (test 1) and 1,53 beats per meter (test 2) indoors. Outdoor readings were lower at 0,88 and 0,95 beats per meter. Intra-class correlation coefficient, which is often used to show reproducibility, varied between 0.80 and 0.88, making the reproducibility acceptable. Yet, these indoor PCI values for children with CP differ significantly from the other indoor test that was done.

Raj, Amiri, Wang and Nugent (2014) studied 61 adults and found satisfactory intra-class correlations under non-steady state heart rate conditions. A steady-state heart rate is reached when the heart has adjusted to the new activity. This is usually accomplished within 3 to 4 min during walking (Bailey et al. 1995; Bratteby Tollerz et al. 2011; Heyward and Gibson 2014). Note that the correlations between different tests for walking speed as well as for heart rate were higher than for PCI (Raj et al. 2014). Graham, Smith and White (2005) found inter and intra reliability for PCI scores on different tracks in 40 physically unimpaired adults.

The heart rate of 133 individuals with CP, who were more severely affected (information was not given on what the GMFCS of the participants were) kept rising during a 10 min walking trial conducted by Boyd et al. (Boyd, Rodda, Olesch, Starr, Cullis, Gallagher et al. 1999). The heart rate did not reach steady-state (Boyd et al. 1999). According to Boyd et al. (1999), not reaching steady-state poses problems for calculating PCI with regards to walking heart rate. Consequently, Boyd et al. (1999) concluded that evidence for the reliability of PCI is lacking.

An earlier study by Baily and Ratcliffe (1995) on 15 physical unimpaired individuals found that raw data taken during steady-state conditions were much closer to one another during the two different trials than the data taken during non-steady-state conditions, but no statistical differences between PCI calculated under steady-state and non-steady-state could be found (Bailey et al. 1995).

Therefore, it was concluded that even though heart rate and walking speed (which form part of the measurement for calculating PCI) seem more reliable than PCI, PCI under steady-state conditions is considered a reliable outcome measure in physically unimpaired people (Raj et al. 2014). This is also true for people who are minimally to moderately affected by diplegia (Raja et al. 2007). When steady-state conditions are reached, the reliability of PCI seems to be higher (Boyd et al. 1999; Raja et al. 2007), therefore the researcher decided to calculate PCI under steady state conditions.

2.4.5. Validity of PCI

Studies vary in their findings about the validity of PCI as measurement tool (Graham et al. 2005). This might be due to the fact that some studies see PCI as measurement of energy expenditure (Bailey et al. 1995; Nene 1993; Raja et al. 2007; Rose et al. 1989) and others see it as an indicator of change in ambulation (Plasschaert et al. 2011; Raj et al. 2014).

The reason for the different findings might also be the different populations themselves and whether they were able to reach a steady-state walking heart rate or not (Graham et al. 2005). Oxygen cost (that is obtained by dividing VO_2 by walking speed) did not show significant correlations with PCI in people without physical impairment on different tracks (Graham et al. 2005). These findings indicated that PCI was not valid as measurement of energy expenditure in this population (Graham et al. 2005).

Plasschaert, Jones and Forward (2011) found a definite correlation between PCI and non-dimensional net oxygen cost (an oxygen consumption test) in 31 children with CP and concluded that PCI may be a valid test to use in assessing ambulation in CP (Plasschaert et al. 2011).

2.4.6. Sensitivity of PCI

Other than reliability and validity, it is also important that a test is sensitive to changes within subjects (Ijzerman et al. 2002). In a study of Ijzerman and Nene (2002) on 12 children with CP (only 4 with diplegia), they let the children walk twice with shoes and once without shoes to determine if the PCI would differ. They measured PCI, VO2 and oxygen cost. They concluded that the reliability of PCI was moderate, but that oxygen cost was better in detecting small differences in a population (Ijzerman et al. 2002). The raw data showed higher measurements (except for resting heart rate) on all the collected data for the second walk with shoes. The measurements were higher than the first walk with shoes and also higher than the barefoot walk. Because only one trial was done with bare feet, there is no average between trials or a way to generalise whether bare-foot walking took more energy than shoe walking (which had two trials). Therefore, this study might not be the best indication of the sensitivity of PCI.

Another study (Jones, Alves, de Oliveira, Saad and Natour 2008) compared PCI (they again used it as indication of energy expenditure) between people with osteoarthritis that ambulate with canes of different lengths. Although the goal was comparing ambulation with different cane lengths, the statistically significant changes that were found (Jones et al. 2008) indicate a sensitivity of PCI in picking up small changes. Thus, the studies of Ijzerman et al. (2002) and Jones et al. Jones et al. (2008) appear to be in conflict with one another.

Thomas, Moore, Kelp-Lenane and Norris (1996) simulated gait patterns found in people with diplegia by impairing joint movements of physical unimpaired people and found statistically significant differences between normal ambulation and the simulated gait patterns, again indicating the ability of PCI to pick up changes in ambulation.

Raja et al. (2007) compared PCI of 105 children with CP before and after intervention and found that most interventions resulted in a reduction of PCI.
Children (n=100) with no disabilities walked 50 m indoors and 50 m outdoors while PCI was calculated. The median PCI values were 0.10 and 0.11 beats per meter. Children (n=227) with CP walked the same distance indoors while PCI was calculated and 101 Children with CP walked outdoors as well. The mean PCI were 0.58 and 0.86 beats per meter respectively, making the PCI value for outdoor walking 100% more than for indoor walking in the CP group. Within this group, the PCI values for the children with diplegia was the highest, with the 112 children with crouch gait at the top with 0.89 beats per meter indoors and 1.26 beats per meter outdoors.

2.4.7. Critique to PCI

Criticisms of PCI include that the tracks on which the participants walk are not standardised for PCI testing. One study used a wider figure of eight-track and an elongated tear-drop figure-of-eight track (Graham et al. 2005). Graham's results indicated that the tracks cannot be used interchangeably (Graham et al. 2005). The study of Bailey et al. (1995) used a treadmill. For this particular study, a straight 30 m track was used. The participants then turned and walked back for a second 30 m. The calculations of both heart rate and walking speed excluded the turn at the end of the first 30 m distance.

The distances for walking are also not standardised. Yet according to Raja et al. (2007), walking over different distances does not impact the PCI values (Raja et al. 2007). Yet, different distances might have an influence on the PCI values of children with CP.

Different factors influence resting heart rate, making recording thereof difficult and may add variability between subjects (Bratteby Tollerz et al. 2011). Whether they reach a steady-state condition also plays a vital role.

2.4.8. Heart rate

No sophisticated equipment is needed to measure heart rate. However, heart rate can be affected by many factors such as anxiety or blood glucose levels (Rose et al. 1989), even medication (Heyward et al. 2014; Raj et al. 2014).

2.4.9. Resting heart rate

For calculating PCI, MacGregor (1981) used a resting heart rate that was taken in a seated position. Authors such Bailey et al. (1995) and Plasschaert et al. (2011) suggest that resting heart rate can be taken at the end of a five-minute sitting period, as long as the heart rate has stabilised. This is then called a steady-state resting heart rate (Bailey et al. 1995).

The resting heart rate in people with CP seems to be higher than that of people without physical impairment (Plasschaert et al. 2011). This might partly be due to factors such as anxiety in some hospital settings (Bratteby Tollerz et al. 2011; MacGregor 1981; Plasschaert et al. 2011). Resting heart rate also varies among individuals with CP (Plasschaert et al. 2011). In a study conducted by Rose et al. (1989) the mean resting heart rate of 13 children with CP varied from 73 beats per minute to 127 beats per minute. Eighteen children without physical impairment had resting heart rates between 65 beats per minute to 95 beats per minute (Rose et al. 1989). Thus the resting heart rates of physical unimpaired children were more stable than those of the children with CP, but statistically the values of these two groups were similar. Such a variation between subjects was also noted by Bratteby Tollez et al. (2011), who suggested that measurements that do not include resting heart rate must be sought.

For this study using PCI as measurement, resting heart rate was taken for each participant during the last 5 minutes of a 15-minute sitting period.

2.4.10. Walking heart rate

According to MacGregor (1981), who developed PCI, heart rate reveals the physical effort needed in an activity because physiological stress is seen through changes in heart rate (Raj et al. 2014). Therefore, walking heart rate should give an indication of the amount of effort that is needed to travel from point A to point B (Raj et al. 2014; Suzuki, Oshimi, Shinohara, Kawasumi and Mita 2001). To measure PCI, people are directed to walk at a self-selected walking speed which is always slower than their maximum walking speed (MacGregor 1981; Suzuki et al. 2001). The walking heart rate in children without any impairment (at maximum walking speed) is significantly lower than the heart rate of children with CP (with a much lower maximum walking speed) (Rose et al. 1989; Suzuki et al. 2001). The study of Rose et al. (1989) did not only indicate higher values but also more variation; statistically, the values were not significantly different.

In measuring PCI, the resting heart rate is subtracted from the walking heart rate so that only the increase of heart rate (due to the walking) would be used (Ijzerman et al. 2002; MacGregor 1981). If a participant in a study does not have a normal heart rate response in walking conditions, and PCI calculations will not be reliable (Raj et al. 2014).

MacGregor (1981) is of the opinion that the biggest variation in walking heart rate is due to different fitness levels of people. Another consideration is whether the walking heart rate was taken under steady-state or non-steady-state conditions, as was explained in 2.4.2. Therefore the conditions under which walking heart rate is measured should be monitored and planned carefully (Suzuki et al. 2001).

2.4.11. Walking speed

People without physical impairment tend to select a comfortable walking speed (velocity) that is energy efficient (Bell and Davies 2010; Johnston et al. 2004; Perry et al. 2010; Suzuki et al. 2001). They walk in such a way that the centre of mass is displaced as little as possible (Donelan, Kram and Kuo 2002; Johnston et al. 2004). When step length alone increases, more energy is used due to the amount of mechanical work that is needed to redirect the centre of mass (Donelan et al. 2002). People therefore tend to walk faster not only by increasing their step length, but step rate (cadence) as well (Donelan et al. 2002; Perry et al. 2010). Factors (beyond the scope of this study) such as step width (Donelan et al. 2002), muscle movement (Perry et al. 2010), joint mobility (Perry et al. 2010), the environment (Johnston et al. 2004), neural control (Perry et al. 2010) and accelerations of different parts of the body (Johnston et al. 2004) also contribute to energy expenditure during ambulation.

Children with CP walk slower than children without physical disability (Johnston et al. 2004; Rodda et al. 2004; Suzuki et al. 2001; Van der Krogt 2009). In a study done by Rose et al. (1989) 13 children with CP (four with hemiplegia and nine with diplegia) walked statistically slower than 18 children without physical impairments. Clinically, the group with diplegia was even slower than the group with hemiplegia, but due to the large range of values, no statistic conclusions could be made (Rose et al. 1989). Joint involvement decreases walking speed: if more joints are affected, walking speed is further reduced (Thomas et al. 1996), resulting in increased energy expenditure and a reduction in functional ambulation (Bell et al. 2010; Johnston et al. 2004; Rodda et al. 2004). In contrast to people without physical impairment, people with diplegia tend to walk slower as they grow older, use more energy in walking (Gannotti et al. 2008; Johnston et al. 2004; Suzuki et al. 2001) and may rely more on wheelchair use (Johnston et al. 2004).

Walking speed as indicator of walking ability can be used as an assessment tool for ambulation (Pasparakis et al. 2009; Perry et al. 2010; Raj et al. 2014; Thomas et al. 1996). Usually, walking speed is measured in meters per second (Perry et al. 2010), but when PCI is calculated, it is measured in meters per minute because heart rate is measured in beats per minute too (Graham et al. 2005). When walking speed is measured, the walking distance does not seem to make a difference (Bohannon 2008), but factors such as age (Bohannon 2008; Perry et al. 2010), gender (Perry et al. 2010), knee extension force, waist circumference and stature did have an influence on walking speed (Bohannon 2008).

Thus, the measuring of walking speed during ambulation assessments will render valuable information. As it is part of measuring PCI as well, no extra tests are being done and measurement can easily be interpreted.

2.4.12. Conclusion on PCI

Different aspects of ambulation are affected differently in people with diplegia. To date there is no measurement tool to measure every system involved in ambulation simultaneously. Interventions that aim to improve ambulation, measure gait itself through kinematic or kinetic gait analysis with sophisticated equipment (Raja et al. 2007).

Energy consumption of ambulation can be calculated by measurement of oxygen consumption (Plasschaert et al. 2011; Raja et al. 2007). Yet again, this needs sophisticated and expensive equipment (Raja et al. 2007)

PCI is a practical, low cost test to use for measurement of functional ambulation. The aim is to detect changes in ambulation irrespective of which system changed. Although PCI was not found to be the most reliable measurement tool (Raj et al. 2014), different researchers did conclude on the reliability of PCI (Bailey et al. 1995; Graham et al. 2005; Raj et al. 2014; Raja et al. 2007) especially under steady-state conditions (Bailey et al. 1995; Raja et al. 2007).

Validity of PCI was reported by Plasschaert et al. (2011) and sensitivity to change was reported by Jones et al. (2008).

Walking speed is part of the measurements needed to calculate PCI, but in itself is a good indicator of ambulation (Pasparakis et al. 2009; Perry et al. 2010; Raj et al. 2014; Thomas et al. 1996). Walking speed was therefore also analysed in this particular study.

2.5. School activities

2.5.1. Introduction

Living with diplegia involves much more than a medical condition; it affects all areas of life (Simeonsson, Carlson, Huntington, McMillen and Brent 2001; World Health Organization 2001). The period from early childhood right through to the adolescent years is one of fast development and growth often spent in a school environment (Simeonsson et al. 2001). Being part of the school environment comprises more activities than merely learning and participating in the classroom. It includes being part of the environment during break time, cultural activities and during sport periods, physically, socially and emotionally (American Occupational Therapy Association 2014; Simeonsson et al. 2001). It further includes moving around on the school premises (Schenker, Coster and Parush 2005). Participating in activities plays an important role in health and wellbeing (World Health Organization 2001). Treatment that enhances participation in school activities should be investigated and sought. Therefore, literature that explored and recommended participating in different school activities will be described in this section.

Within the South African context, school activities such as playing with friends, eating and socializing with friends during break time, occur in an outdoor environment. This in itself presented physical challenges to the participants that were explored in the semi-structured interviews.

The researcher found no articles on the influence of an intervention on school activities, let alone the influence of HT on school activities. Key words used in the search for literature were school activities, school functioning, taking part in school, and school functioning of adolescents with diplegia.

2.5.2. Participation in school activities

Disabilities such as diplegia have an influence on all spheres of life, but do not necessarily lead to dysfunctional participation in life. Involvement in different spheres of life means that such a person is highly functional (World Health Organization 2001). Schools can be seen as a micro cosmos reflecting the broader community and therefore reflect participation elsewhere (Simeonsson et al. 2001). This was stated in a study by Kuijper, Van der Wilden and Gorter (2010) that revealed a correlation between functional school activities and self-care activities at home. Simeonsson et al. (2001) conducted a study to explore the involvement in school activities of children and adolescents with impairments such as diplegia. Physical, social and psychological aspects of school activities were described by 1180 teachers, but not by the children and adolescents themselves. By the end of the study, Simeonsson et al. (2001) recommended that the opinion of the children with impairments must be sought directly in future. Another valuable conclusion was that active participation in school activities enhances quality of life (Simeonsson et al. 2001). Schenker, Coster and Parush (2005) agreed and added that participation is essential for psychological and emotional development. Therefore, one can assume that children and adolescents can experience a healthy, meaningful lifestyle by developing life skills through school activities (Kuijper et al. 2010; Schenker et al. 2005; Simeonsson et al. 2001).

Simeonsson et al. (2001) found that the use of assistive devices did not limit the involvement in school activities, but rather made participating easier. Environmental aspects such as heavy equipment on the other hand made participation more difficult (Simeonsson et al. 2001) along with the severity of disablement that each child or adolescent experiences (Hilderley and Rhind 2012; Schenker et al. 2005; Simeonsson et al. 2001).

Schenker et al. (2005) studied, among others things, the level of participation of primary school children with CP in the classroom, on the playground, with transportation, in the bathroom, with transitions and at mealtime or snack time. The area where the children with CP had the lowest level of participation was on the playground, with the highest participation during meal/snack times. The researchers indicated that environmental factors such as difficulty in mobility might have played a role in the findings on the playground. Physical demands on the playground seemed to be high (Schenker et al. 2005). When physical tasks in the classroom were compared between children with CP and children without physical impairment, there were no differences in their level of performance (Schenker et al. 2005).

One study that sought the perception of three adolescents with CP on sport-related activities was done by Hilderley and Rhind (2012). They reported psychological benefits such as feeling positive about their bodies after taking part in sport activities and they mentioned enjoyment and a feeling of freedom. Social benefits such as being a team member, interpersonal relationships and social skills were mentioned, while improvement in mobility was reported as the primary physical benefit. They also reported problems such as inadequate equipment and their individual needs with regard to the use of assistive devices (Hilderley et al. 2012).

A study on the relation between pain, fatigue and school functioning showed that different ratings were given by adolescents with CP and parents (Berrin, Malcarne, Varni, Burwinkle, Sherman, Artavia et al. 2007). Parents reported a more severe influence of pain and fatigue than what their children reported. Yet pain and fatigue do have an influence on school functioning. Adaptation to their disability might explain the lower rating of the influence of pain and fatigue by the adolescents (Berrin et al. 2007).

2.6. Overview of research method

Mixing of quantitative and qualitative research methods in one study allow more comprehensive conclusions on a topic (Creswell and Plano Clark 2011; De Vos et al. 2011). As occupational therapists are concerned with functional outcome and how the client experiences these outcomes, qualitative research such as interviews might be the best way to gather information. Yet, pressure to deliver outcome-based treatment necessitates quantitative research as well. Combining the two methods addresses both these needs.

There are many ways to mix research methods (Creswell et al. 2011) but for the purpose of this study only the triangulation mixed method design will be described.

2.6.1. The triangulation mixed methods design

The triangulation mixed methods design, also called the convergent parallel design (Creswell et al. 2011), is the best known and most popular mixed method design (Creswell et al. 2011; De Vos et al. 2011). This design combines quantitative and qualitative aspects of research (De Vos et al. 2011; Jick 1979; Rauscher and Greenfield 2009). Both parts of the study are viewed as equally important (De Vos et al. 2011; Rauscher et al. 2009). The design seeks confirmation and agreement between the different methods to strengthen findings (Creswell et al. 2011; Jick 1979; Rauscher et al. 2009) and allows more accurate interpretation (Jick 1979; Rauscher et al. 2009) drawing on the strengths of both quantitative and qualitative research designs (Rauscher et al. 2009). Quantitative and qualitative parts of the study are conducted within the same time frame, but collected and analysed separately before comparisons are made (Creswell et al. 2011; De Vos et al. 2011; Rauscher et al. 2009).

Collecting the data is less time consuming than a sequential design. The amount of data that needs to be analysed and interpreted separately can put strain on the researcher, both skill- and time-wise (Creswell et al. 2011; De Vos et al. 2011). Differences in results can be seen as a dilemma (Creswell et al. 2011; De Vos et al.

2011) or as a benefit that points out discrepancies that could have been missed if only one design was used (Jick 1979).

2.6.2. Single-system design

Research designs such as a randomised controlled trial (Graham, Karmarkar and Ottenbacher 2012) focus on inter-subject comparisons (Tankersley et al. 2006) that need large numbers of participants, which is not always feasible (Logan et al. 2008). Effective, alternative designs must therefore be used to evaluate the outcome of interventions (Backman et al. 1997; Graham et al. 2012).

One such an alternative design is the single-system design, which focuses on intra-subject comparisons (Backman et al. 1997; Logan et al. 2008; Tankersley et al. 2006). Repeated measurements (both before and after intervention) taken over time is characteristic of the single-system design (Backman et al. 1997; De Vos et al. 2011; Logan et al. 2008). As all healthcare disciplines demand evidence-based practice (Graham et al. 2012; Logan et al. 2008), this design (when correctly applied) can link research with clinical practice (Backman et al. 1997; De Vos et al. 2011; Graham et al. 2012).

A single-system design provides concrete data and thus implements assumptions of the quantitative research design (Backman et al. 1997). The single-system design helps to validate existing theories in rehabilitation and may even help to formulate new theories (Backman et al. 1997). It might also motivate occupational therapists to include evaluation and research in clinical practice (Graham et al. 2012), enhancing evidence-based rehabilitation (Graham et al. 2012).

As in all research designs, the single-system designs also have limitations that must be addressed. The first limitation is limited ability to generalise, especially when only one participant is studied (Backman et al. 1997; Graham et al. 2012). Limited generalisability leads to limited external validity. Adding more participants or settings to a study lessens this limitation. Random selection also enhances generalisability (Backman et al. 1997).

Should the researcher only implement visual analysis of the data, valuable statistical contributions can be lost (Backman et al. 1997). Even when visual results give a clear picture, a statistical or semi-statistical technique can add further strength to a study's outcome (Backman et al. 1997).

2.6.3. Interviews

Interviews are often used in qualitative research (De Vos et al. 2011; Dicicco-Bloom and Crabtree 2006; Gill, Stewart, Treasure and Chadwick 2008) and can either be very structured or less structured according to the need of the study (Dicicco-Bloom et al. 2006).

In this study, it was decided to make use of the semi-structured interview, as described in more detail in Chapter 3.

2.7. Conclusion

Research on HT is limited. It is limited with regards to sample size (Davis et al. 2009; MacKinnon et al. 1995b; Sterba 2007; Zadnikar et al. 2011), studies on adolescent populations and available standardised tests to measure the effect of HT on participants (Engel et al. 2007; MacKinnon et al. 1995a).

Literature does show that HT has an influence on pelvic movement of physically unaffected people in resembling the same pelvic movement patterns needed for normal ambulation (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; McGibbon et al. 1998; Rigby 2009). As diplegia affects the lower extremities (and the pelvis), more than the upper extremities (Rosenbaum et al. 2007), difficulty in ambulation is a direct result of diplegia (Pasparakis et al. 2009; Perry et al. 2010) that in turn affects participation in school activities (Simeonsson et al. 2001; World Health Organization 2001).

Movement patterns in the pelvis of adolescents with diplegia are influenced by HT (Fízková et al. 2013) but little statistically significant evidence was found by the researcher to strengthen this claim. It is also postulated that a change in pelvic movement will affect ambulation and may affect participation in school activities. To measure the effect of HT on ambulation, PCI was selected as a dependent variable in this study. Literature did not show that PCI had the highest reliability in comparison with other variables (Boyd et al. 1999; Raj et al. 2014) or the highest validity in other studies (Graham et al. 2005), but the combination of reliability, validity, sensitivity and convenience with regards to affordability, equipment needed and limited effort to test repeatedly, made PCI the best variable as an indication of influence of HT for this particular study. To the researcher's knowledge, PCI was only used in relation to HT once before in a study with five participants with CP (McGibbon et al. 1998).

Literature on semi-structured interviews is readily available, but literature on participation of adolescents in school activities is scarce. No literature could be found by the researcher on the effect of HT on participation in school activities.

2.8. Summary

In this chapter, all six different components of the study were introduced to the reader. This includes HT, ambulation both in physically unaffected people and in people with diplegia, PCI, school activities, and background on the research methods. As HT, PCI or the single-system design are not commonly found in occupational therapy, clarification was needed and thus previous research was discussed and compared.

Chapter 3 describes the research process that was followed by the researcher. How the single-system design and the semi-structured interview were implemented within the same time frame will be described, as well as the intervention, namely HT.

In riding a horse we borrow freedom. ~

~ Helen Thomson

CHAPTER 3
RESEARCH DESIGN AND METHOD

3.1. Introduction

This chapter will provide an in-depth discussion of the research process followed by the researcher. To link this process to the purpose of the study, the aims and objectives of the research that were discussed in Chapter 1 will be recalled in this chapter.

A triangulation mixed methods design (Creswell et al. 2011; De Vos et al. 2011; Jick 1979) was implemented in this study. Within this triangulation mixed methods design, both quantitative measurements and qualitative observations were used. To obtain quantitative measurements, a single system-design was used. Semi-structured interviews were used to record qualitative data. The theory of each aspect within the design was discussed in Chapter 2, including its strengths and weaknesses. In this chapter, specific factors that influenced the decision to use the design within this specific study will be discussed.

This chapter further describes the methodology used in the study, the pilot study and the implementation of the intervention will be described.

3.2. Research aim and research objectives

The aim of this research was to determine the effect of 12 sessions of hippotherapy on PCI during ambulation, on a level surface, over a 60m distance and on school activities of adolescents with diplegia.

The research objectives were:

i. To determine whether hippotherapy improves walking speed over a distance of 60 m.

ii. To determine and describe the effect of hippotherapy on school activities from the adolescent's own perspective.

iii. To determine the carry-over of the PCI at the end of one session to the start of the next session.

iv. To describe the trend and level changes observed in the data patterns of PCI over the course of the study.

3.3. Study Sample

3.3.1. Population studied

Adolescents (between 12 and 18 years of age) with diplegia were the population chosen for this study. According to the official list (Gauteng Department of Education 2013) of schools for learners with special needs, there are two schools in Pretoria (South Africa) for learners with CP. The 16 adolescents with diplegia, enrolled in these two schools during the 2014 and 2015 academic years, constituted the population for this study. This population was considered for both the quantitative as well as qualitative prats of the study.

3.3.2. Sample studied

According to the single-system design, sample size may include any number of participants from one to as many as the circumstances (such as availability of participants) allow (De Vos et al. 2011; Kinugasa, Cerin and Hooper 2004). It was a pragmatic decision in collaboration with the statistician to include 14 participants, more or less seven from each school. This also allowed for drop-out and unforeseen circumstances.

Only three participants could be accommodated at the stable-yard per afternoon. Another consideration was that the research was self-funded. After all these practical considerations were taken into account, the decision was made to include 14 participants in the study. The same 14 participants took part in both phases of the study. Detail on how the participants and the schools were selected will be given in the next section.

3.4. Selection of participants

The information of the participants known to the occupational therapists at the schools as well as information from the school files formed part of the screening process. Other professionals in the multi-disciplinary teams at both schools, such as physiotherapists, were also contacted to make sure the participants met the inclusion and exclusion criteria.

3.4.1. Inclusion criteria

- Medical diagnosis of diplegia. A medical practitioner must have made the diagnosis or confirmed the suspected diagnosis from the occupational therapists at the schools. Clear diagnoses were available for all the participants in their school records.

- Participants were to be older than 12 years of age and younger than 18 years of age during the full duration of the study.

- The participant must have had passive hip abduction more than 20 degrees bilaterally as measured with a goniometer in the supine position.

- The participant must have been able to walk. Walking could be achieved with any assistive device. Participants that used a wheelchair at school must have been able to walk the 60 m distance required for the PCI-test.

3.4.2. Exclusion criteria

- Adolescents with hip subluxation; as confirmed by a medical practitioner.

- Adolescents who had one or more seizures during the past year; as either reported by the parents, therapists or teachers at the schools, school nurse or medical practitioner.

- Adolescents with known osteoporosis; as seen in the medical file at the school or as reported by parents or confirmed by a medical practitioner.

- Allergies to horse hair or dust. If the potential participant indicated that he or she was allergic to dust, they were excluded. This question was asked during the interview with the parent or guardians. Unfortunately, allergies to horse hair were only noticed when the intervention started and the researcher had to terminate one participant's participation in the study due to allergic reactions.

- An adolescent heavier than 65 kg, as it may become too difficult for the researcher to help the participant to mount and dismount safely. The occupational therapists who completed the screening at the schools weighed all the potential participants in order to determine their weight.

3.4.3. Sampling method

Aspects of target sampling (De Vos et al. 2011) were used to list potential participants in the two schools. The process of sampling is explained in Figure I and will be discussed further here. The inclusion and exclusion criteria (as was described above) were explained to the occupational therapists at the schools. Occupational therapists at these schools then screened the adolescents and provided the researcher with a list of all the potential participants. The potential participants were then randomly ordered on a list for each school by using the randomised-numbering function in Microsoft Excel. Because one school had only five potential participants, all of them were contacted. The first nine participants (so that there would be a total of 14 participants as described under sample size) on the computer list of the other school were contacted. Each participant who was contacted as well as their parents agreed to take part in the study. The planned procedure was to contact the next potential participant should any participant (during the selection phase) decide not to take part in the study. Should a participant (who entered the study) decide or be compelled (for any reason) to withdraw from the study, the process will stop due to a time limitation on the duration of the study.

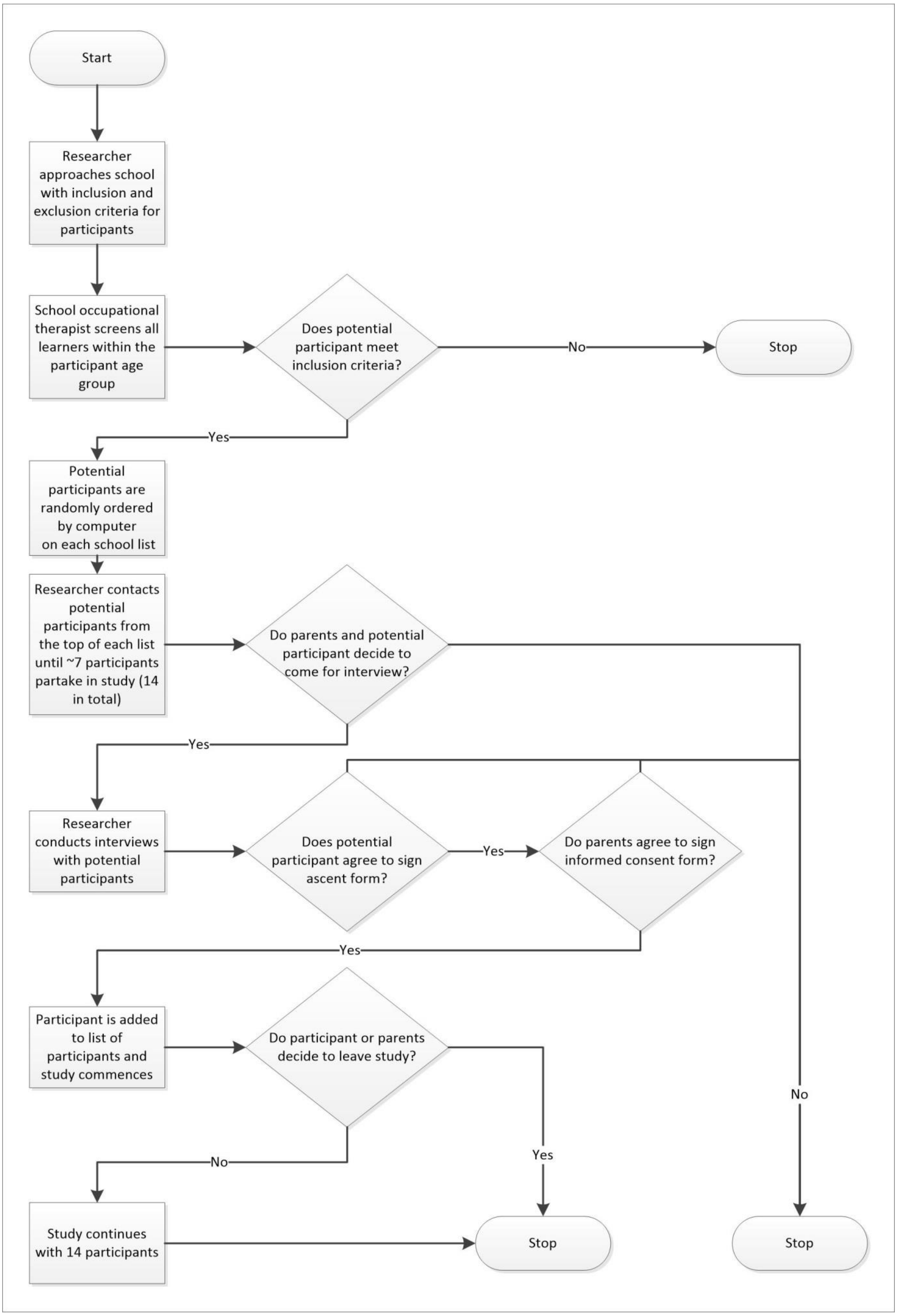


Figure I: Sampling Method

3.5. Triangulation mixed research design

Within the triangulation mixed methods design both quantitative and qualitative research are incorporated and are seen as equally important (Creswell et al. 2011; De Vos et al. 2011; Rauscher et al. 2009). As both quantitative and qualitative research was needed to fulfil the purpose of the study, a triangulation mixed method design was therefore the research design of choice (Creswell et al. 2011; De Vos et al. 2011; Rauscher et al. 2009).

Time efficiency further influenced the decision as this design allowed simultaneous collection of both sets of data (De Vos et al. 2011; Rauscher et al. 2009). It was thus possible to collect all the data during the first two school terms. These school terms were only separated by a week-long holiday. This design was described in more detail in Chapter 2 section 2.6.1.

Within this design the single-system design was incorporated for the quantitative part of the study and the semi-structured interview was the design of choice for the qualitative part of the study. These two designs will be discussed under separate headings to enable the reader to understand the methodology followed within this study.

3.6. Chronological sequence of the study

After ethical clearance was obtained, the pilot study commenced during the last term in 2013 as described in section 3.10 of this chapter. Thereafter, meetings were held with the head-masters and occupational therapists in both schools to plan for the study in 2014 as well as to schedule the baseline sessions to be held at the schools.

Early in 2014, the information sessions were held with the parents as well as with the potential participants in accordance with the sampling method as described in Figure I.

Once 14 participants and their parents signed informed consent, the baseline testing was done once a week at each school. This included PCI measurements as well as semi-structured interviews. Each participant entered the intervention phase in accordance to the schedule in Table 1. They entered it at different times because a single-system design with prolonged baseline over subjects was used.

Table 1: Planned time table for baseline and intervention

Week:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Participant 1	Baseline			12 weeks hippotherapy																	
Participant 2	Baseline			12 weeks hippotherapy																	
Participant 3	Baseline			→	12 weeks hippotherapy																
Participant 4	Baseline			→	12 weeks hippotherapy																
Participant 5	Baseline			→	→	12 weeks hippotherapy															
Participant 6	Baseline			→	→	12 weeks hippotherapy															
Participant 7	Baseline			→	→	→	12 weeks hippotherapy														
Participant 8	Baseline			→	→	→	12 weeks hippotherapy														
Participant 9	Baseline			→	→	→	→	12 weeks hippotherapy													
Participant 10	Baseline			→	→	→	→	12 weeks hippotherapy													
Participant 11	Baseline			→	→	→	→	→	12 weeks hippotherapy												
Participant 12	Baseline			→	→	→	→	→	12 weeks hippotherapy												
Participant 13	Baseline			→	→	→	→	→	→	12 weeks hippotherapy											
Participant 14	Baseline			→	→	→	→	→	→	12 weeks hippotherapy											

→ Prolonged Baseline

Each participant had 12 intervention sessions and the study was concluded for each participant with a final interview and measurement session at the schools one week after the last intervention session.

3.7. The quantitative part of the study

The effect of HT on ambulation was assessed because the lower limbs of adolescents with diplegia are more affected than the rest of their bodies (Rosenbaum 2003), resulting in difficulties during ambulation (Bogey 2012; Perry et al. 2010). The effect of HT on ambulation patterns therefore needed to be measured to evaluate the success or failure of the HT in this regard (Raja et al. 2007).

3.7.1. Single-system design in the quantitative part of the study

The single-system design strives to find evidence for whether an outcome can be linked to an intervention or not. The design is suitable for small sample sizes (De Vos et al. 2011; Graham et al. 2012; Logan et al. 2008) and does not prescribe the number of participants that may be included in a study (Backman et al. 1997; Tankersley et al. 2006). Consequently, the number of participants was determined by practical considerations such as the quantity of available participants, funding and research time available at the stables.

The next step was to decide upon the type of single-system design (Backman et al. 1997; Logan et al. 2008) to be used. According to Backman et al. (1997) there are four basic single-system designs: the AB design, the withdrawal design, the alternating treatment design and the multiple baseline design (Backman et al. 1997). To understand the decision of which design to use in this study, all four of the designs must be described.

The AB design is the most basic single-system design (Backman et al. 1997; Graham et al. 2012). In the AB design, the baseline is established first and indicated by A. Then intervention follows, indicated by B while measurements are still taken continuously (Backman et al. 1997; Graham et al. 2012). Baseline data and intervention data are then analysed and compared (Backman et al. 1997). The researcher decided against the basic AB design as this design has too little control over internal validity (Graham et al. 2012) and factors such as sport activities might influence the results. Thus more control was needed than within the basic AB design.

The withdrawal design adds at least one other baseline phase and/or another intervention phase to the basic AB design (Backman et al. 1997). A baseline (A) is established and an intervention (B) is applied and then withdrawn again while a second baseline is established (second A) (De Vos et al. 2011; Graham et al. 2012; Tankersley et al. 2006).

As it is not ethical to withdraw vital treatment that might benefit the participant, the withdraw design cannot be used in clinical trials (Backman et al. 1997; Graham et al. 2012). This design is also not preferred if a long-lasting effect to function is expected (Backman et al. 1997; Graham et al. 2012) and for that reason, the researcher decided against the withdrawal design (Backman et al. 1997; Graham et al. 2012).

In the alternating treatments design, the effects of two or more interventions on a single participant are compared with one another (Backman et al. 1997; De Vos et al. 2011). Firstly, a baseline is established (Backman et al. 1997; De Vos et al. 2011). Then two interventions are implemented alternatively (De Vos et al. 2011). The effects of the interventions are compared with one another and can also be compared to a baseline condition (Backman et al. 1997). As in other single-system designs, the participants serve as both the control and the intervention group (De Vos et al. 2011). As hippotherapy was the only intervention in this study, the alternating treatment design was also not suitable.

The fourth single-system design is the multiple baseline design where there is an emphasis on the length of the baseline. The baseline length can vary across participants, across settings or across outcome behaviours (Backman et al. 1997; Graham et al. 2012). The researcher decided upon the multiple baseline design across participants (Backman et al. 1997; Graham et al. 2012) where each participant has their own number of baseline measurements (Backman et al. 1997; Graham et al. 2012). For example: participant one may have three baseline measurements and then enter into the intervention phase while participant two then has four or five baseline measurements before entering into the intervention phase of the study. Some participants continue to be measured in baseline phase while one after the other enters into the intervention phase (Backman et al. 1997). Data are then compared across participants. If change in each participant only occurs at the time that the intervention is introduced, a strong connection between intervention and outcome can be assumed (Backman et al. 1997; Graham et al. 2012). Backman et al. (1997) and Graham et al. (2012) state that this design controls for threats to internal validity. The number of replications of measurements is a strength of this design and aids in some generalisation of results (Graham et al. 2012). The multiple baseline design across subjects was thus the design of choice in this study (Backman et al. 1997; Graham et al. 2012).

In this study each participant was treated as if that participant was the only one taking part in the study. As 10 participants completed the study, the study was in effect repeated 10 times. Replication is important in establishing generalisability in all group-comparison studies (Graham et al. 2012; Logan et al. 2008).

3.7.2. Research procedure within the quantitative part of the study

At the school (during the baseline phase) or on arrival at the stables (during the intervention phase) as well as after each intervention, the participants sat on a chair for 15 minutes to allow the heart rate to stabilise. The heart rate measurement during the last five minutes of sitting was used as the resting heart rate in the calculation of PCI.

Walking heart rate was another measurement taken to calculate PCI. After the 15 minutes of being seated the participants walked to the starting point. No measurements were taken during this walk, but cardiovascular adaption started to take place in order to calculate steady-state heart rate (Bailey et al. 1995; Raj et al. 2014; Raja et al. 2007). Each participant walked for at least three minutes before the official measurements of walking heart rate was taken.

As part of the official test of walking speed (the third measurement needed for the calculation of PCI), participants walked 30 m on a flat surface while the side walker walked behind them. The participants then turned and walked back on the same 30 m track. The starting line and the finish line were clearly marked. The instructions were: “Walk at your own pace, as you always walk, from this line on the ground, past the line on the other side, and back.”

During the intervention phase the above mentioned procedures were followed with a HT session on horseback. The measurement process was then repeated after the HT session.

3.7.3. Measurement techniques within the quantitative part of the study

a. PCI as measurement tool

As described in Chapter 2, the test-retest reliability of PCI is high in physically unaffected as well as in minimally to moderately affected subjects and easy to measure repeatedly (Bailey et al. 1995; Graham et al. 2005; Raja et al. 2007). PCI is deemed valid to evaluate ambulatory performance (Plasschaert et al. 2011) and suitable for frequent use in outside conditions such as a stable-yard, making it a convenient test in this study.

PCI was calculated by obtaining the difference between the participant’s resting heart rate and walking heart rate (beats per minute), divided by the walking speed (meters per minute) (Bailey et al. 1995; Graham et al. 2005; Raja et al. 2007). The PCI was expressed in beats per meter (Bailey et al. 1995; Perry et al. 2010; Raja et al. 2007).

b. Resting heart rate

A Polar RCX5 Heart Rate Monitor was used to calculate resting heart rate. The monitor consisted of a transmitter belt worn by the participant, and a receiver-watch worn by the side-walker (see definition of side-walker in section 1.6). There is a wireless connection between the two devices.

The transmitter belt (that measured heart rate) was placed on the participant's chest and the wrist watch receiver on the side walker's wrist. The side walker was thus able to monitor the participant's heart rate throughout the intervention period. The side walker's receiver watch always stayed within one metre of the participant's transmitter belt, according to the manufacturer's specifications.

The Polar RCX5 Heart Rate Monitor lessened potential human errors that could threaten reliability of the results.

c. Walking heart rate

The walking heart rate was also measured with the Polar RCX5 Heart Rate Monitor that stayed in place for the full duration of each session.

The average walking heart rate was only calculated on the second 30 m stretch, because cardio-vascular adaptation was still taking place during the first 30 m.

To further ensure reliability during the baseline phase, the participants walked in the same corridor at the schools during each calculation of PCI, so the environment did not change. Although the setting had to change to the stable-yard once the intervention started, measurements were again taken in the same place (at the stables) and manner each time during the intervention phase. Great care was taken to ensure a level surface for walking without external destructions. According to Perry, the type of walking surface has little effect on energy expenditure unless the surface is extremely rough (Perry et al. 2010).

d. Walking speed

The final measurements needed to calculate PCI was walking speed, and this measurement in itself also answered the first study objective. During both 30 m distances of walking, the participant's average walking speed was calculated on the straights (turn excluded) by using two stopwatches. Two watches were used to add reliability to the measurement by rendering inter-observer reliability to the measurements. When the reading on the two watches differed with more than three seconds, the test was repeated when the participant was able to repeat the test. Some participants walked with so much difficulty that this was not a feasible option. When such a problem occurred, the time walked was compared to the time marks on the Polar RCX5 Heart Rate Monitor and an average walking speed was then calculated.

Walking speed was calculated by measuring the time between the markers with the two stop watches, and then dividing 60 m (the total distance walked) by the average walking time (calculated from the two time measurements).

To add reliability to the testing of walking speed, two stop watches were used by two team members to determine the time a participant walked over the total distance of 60 m.

e. Validity of measurement techniques

In quantitative research, validity is the term used in concluding whether the research question was answered truthfully (Golafshani 2003).

In this study, care was taken to select the participants according to aspects related to target sampling as explained in section 3.4.7.

Each participant acted as their own control by first entering into the baseline phase when PCI was calculated weekly without any intervention. Then the same participant entered into 12 sessions of HT (intervention) and the same measurements were taken and recorded before and after each intervention session. The measurements in baseline phase were compared to measurements in the intervention phase. The prolonged baseline added control as each client entered the intervention at another time and external variations such as the influence of sports programmes at the schools would have been seen in children still in baseline phase. Thus, internal validity was rendered to the study by following the steps of the single-system design diligently.

Different extraneous variables, such as rain and illness, occurred during the intervention phase of the study. These events will be discussed in Chapter 4. There is no doubt that these events influenced the results of the study and the only way to deal with this, was to explain each and every one within the single-system design. This description of events was consistent with the principle that each participant was treated as a system to be studied on its own.

3.7.4. Data collection within the quantitative part of the study

The quantitative data that was collected during the both the baseline phase and the intervention phase was recorded by the heart monitor and manually on record sheets. During the test, the heart rate was recorded during each interval (namely resting periods and walking periods) and the average was calculated by the heart rate monitor. The researcher started and stopped the heart rate monitor at the beginning and end of each interval. The start and stop time and date of each interval, as well as the heart rate information and averages, were downloaded daily from the heart monitor receiver watch and converted to Microsoft Excel format.

The walking times measured with the two stop watches were recorded on paper, and transferred daily onto the same Microsoft Excel spreadsheet. Microsoft Excel was then also used to calculate the walking speed and PCI, and these values were electronically plotted on graphs on the same spreadsheet. One Microsoft Excel file contained all the data collected and calculated during the research, and was submitted for analysis by the statisticians.

Whenever any extraneous variable occurred, such as rain or illness, it was recorded. These will be further described in Chapter 4.

During the data analysis phase of the study, the Microsoft Excel data were audited for correctness by comparing the start and stop times and dates for each participant, sessions and intervals with the sheets used to record the walking times. This process was completed before statistical analysis took place, and therefore added to the reliability of the study.

3.7.5. Data analysis within the quantitative part of the study

Graphs were used as the first level of analysis in the single-system design and were strengthened by additional statistical techniques (Backman et al. 1997; Graham et al. 2012; Tankersley et al. 2006; Wolery and Harris 1982).

Where the plotted data during the intervention phase differed from the data that was plotted during the baseline phase it suggested that the intervention had an effect on that participant (Backman et al. 1997; Graham et al. 2012; Tankersley et al. 2006; Wolery et al. 1982). Changes that occurred in the level, trend (Backman et al. 1997; Tankersley et al. 2006; Wolery et al. 1982) or variability of the plotted data points

(Backman et al. 1997; Wolery et al. 1982) were sought by the researcher and reported.

A level change was seen on the y-axis (representing the dependant variable, namely PCI and walking speed) when the data points plotted on the y-axis during the baseline phase changed to another level on the y-axis during the intervention phase (Tankersley et al. 2006; Wolery et al. 1982). See Figure II.

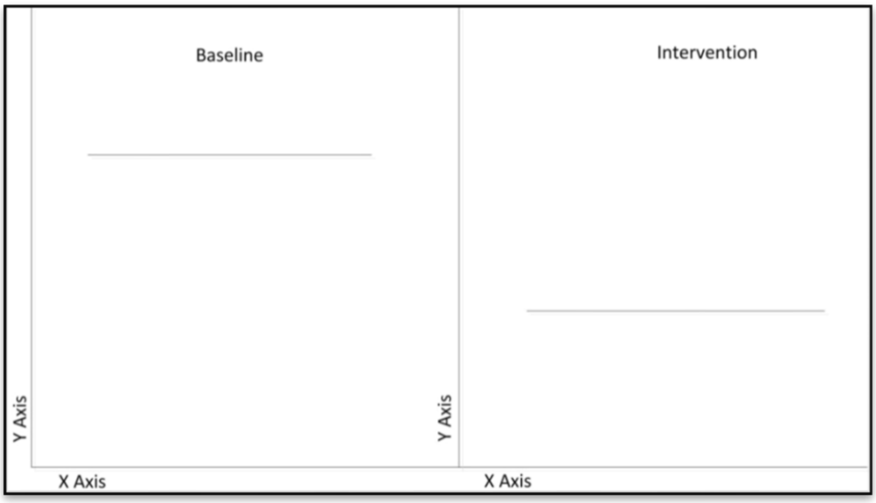


Figure II: Level Changes (Backman et al. 1997)

Further analysis of how significant the changes in each level were and how many intervention sessions were needed to achieve this change added value in the understanding of the specific intervention and its effect on a participant (Tankersley et al. 2006). Such an analysis of the results for each participant was done where a level change was noted.

Another change that was noted in some participants was a change in trend. The trend can also be called slope (Graham et al. 2012) or direction (Tankersley et al. 2006; Wolery et al. 1982) of the graph. When the direction of the graph of the baseline phase changed to another direction in the intervention phase, it is called a trend change (Graham et al. 2012). Thus the data pattern moved (Wolery et al. 1982). See Figure III.

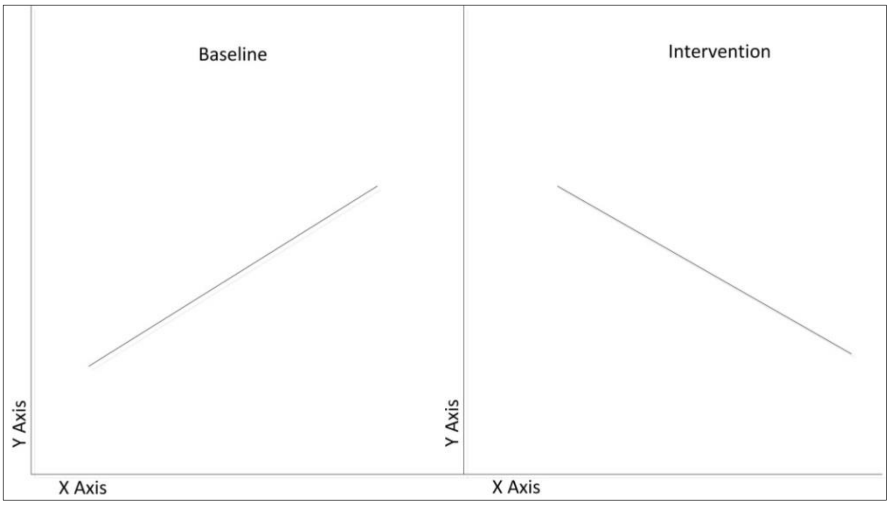


Figure III: Trend Change (Backman et al. 1997)

A change in trend also occurred when the plotted data during the baseline phase formed a horizontal line and then during the intervention phase went upwards or downwards (Wolery et al. 1982). Statistical analysis of the change in trend was then done to confirm whether such a change was significant or not.

Variability in data points was noted when there were wide fluctuations in a series of data points (Wolery et al. 1982). When the width of fluctuations changed between the base line phase and the intervention phase, it was seen as a change in variability. See Figure IV. Ideally, variability should be minimised as much as possible and a stable baseline should be present before intervention starts (Wolery et al. 1982). When a stable baseline was not achieved, it was recorded and fewer conclusions were drawn from the results.

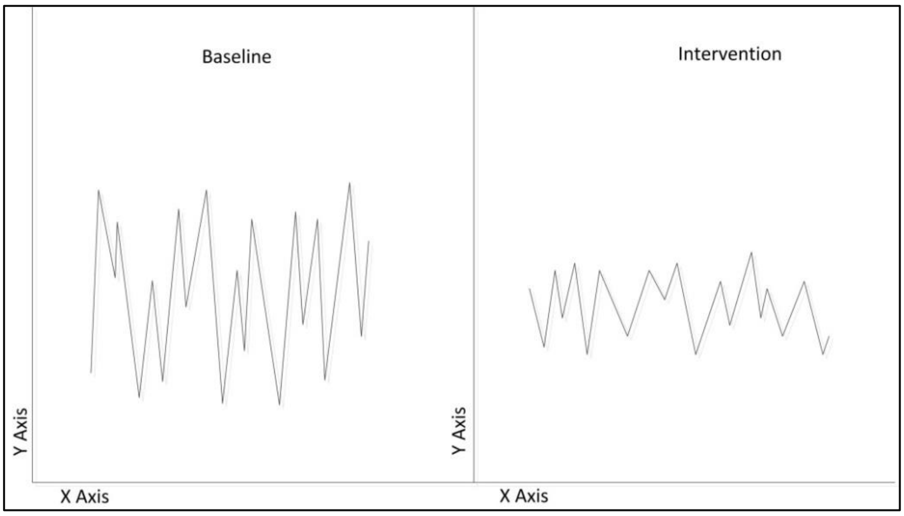


Figure IV: Variability Change (Backman et al. 1997)

In this study a change in trend was expected to occur in most participants and a mixed-effects regression (Drager and Hay) was done using the restricted maximum likelihood to verify these trend changes statistically. This was done for each participant's PCI as well as walking speed. In addition, the Wilcoxon Signed Rank Test was administered to demonstrate the difference between the average baseline session, each intervention session and post-intervention session. The Wilcoxon Signed Rank Test is a non-parametric hypothesis test used to compare two paired groups to assess whether their population mean ranks differed (Stats to do 2015). Furthermore, an exploratory data analysis (Gelman 2004) was conducted.

3.7.6. Limitations to the quantitative part of the study

As mentioned in section 2.6.2 there is limited amount of generalisation that could be done when a small sample is studied within the singe-system design.

A shorter baseline for some participants (within the single-system design with multiple baseline) render less baseline measurements for these participants and less information during the baseline phase. Thus, even though this design strengthens the study results if change only occur during the intervention phase, irrespective of when the intervention was introduced, it is also a limitation with regards to the number of measurements available to reach a stable baseline.

The complexity of functional ambulation as occupation and the different client factors that all contribute to effective ambulation makes both intervention and measurement of the success of intervention difficult. This study was no exception and PCI was chosen as indication of ambulatory performance and was never intended to indicate change in specific client factors.

3.8. The qualitative part of the study

As school activities is the occupation that adolescents engage in during the better part of their daily life (American Occupational Therapy Association 2014), it was important to evaluate the effect of HT in this regard. This section describes the research methodology applied to evaluate school activities.

3.8.1. Semi-structured interviews in qualitative part of the study

To evaluate the participants' school activities, the researcher required information on the opinion of participants' on change in school activities throughout the study. This information had to be evaluated in the baseline phase, as well as during and after the intervention phase. The design also used the single system design structure of comparison between baseline and intervention phases for each participant, on a qualitative basis.

The method selected to extract qualitative information on school activities that can be evaluated throughout the study, is the semi-structured interview (Bratteby Tollerz et al. 2011; Dempster 2011). The researcher considered using the structured interview technique, but the disadvantage of this technique is that the researcher will not be able to explore new themes that could emerge from participant responses during the course of the study (De Vos et al. 2011). The semi-structured interview method has this flexibility, while it also provided the required structure for the researcher to question and therefore investigates specific identified areas of school activities (De Vos et al. 2011; Dicicco-Bloom et al. 2006). The unstructured interview method aims at extracting information regarding the participants' subjective emotional experiences (De Vos et al. 2011), which does not entirely meet the objectives of this study.

As all interviews seek knowledge about the participant (Dicicco-Bloom et al. 2006), five semi-structured interviews were conducted with each participant during the qualitative part of the research. These interviews were done to obtain the participant's own perspective on their school activities throughout the different stages of the study. The participants were encouraged to share their experience on their participation in school activities and reflect on it (De Vos et al. 2011; Dicicco-Bloom et al. 2006), while the researcher interpreted the answers given by the participants (De Vos et al. 2011; Dempster 2011).

The semi-structured interviews were structured with open-ended questions that related to the research topic (De Vos et al. 2011; Dicicco-Bloom et al. 2006; Gill et al. 2008). When other questions arose from a participant's answers, the researcher explored them in more depth and thus diverged from the original questions or even omitted some of the original questions (Dempster 2011; Dicicco-Bloom et al. 2006). The aim of this type of interview was to gain insight into the participant's perspective

and perception on participation in school activities (De Vos et al. 2011; Dempster 2011). The researcher kept in mind that wrong phrasing of questions could render inappropriate answers (De Vos et al. 2011; Dempster 2011). The researcher also remained aware of the participant's cultural background (De Vos AS, 2011).
The setting in which the interviews were conducted had external distractions that were considered and recorded (Dempster 2011).

3.8.2. Research technique within the qualitative part of the study

The semi-structured interview was done on a one-on-one basis after the researcher established report with the participants. Where applicable the researcher reflected on remarks made by the participants to encourage further explanation of the remark.

The researcher also asked direct questions as to why certain answers were given.

The same environment was used for all the interview sessions at the schools and at the stables the quietest setting possible was used during the interviews.

3.8.3. Research procedure within the qualitative part of the study

Collection of qualitative data was repeated by conducting two interviews, in baseline phase, two during the intervention phase, and one interview a week after the last intervention session.

The initial interviews were scheduled (Dicicco-Bloom et al. 2006) on the same day as the initial baseline measurement of PCI at the various schools. The second interview was conducted the week before each participant started the intervention phase. The intervention is described in 3.12. Thereafter, one interview was scheduled in the same week as the fifth HT session, which was close to halfway through the interventions phases, yet still allowed three sessions before the next interview. Interview four was conducted during the same week as intervention session nine, again allowing three intervention sessions before the final interview. This final interview took place one week after the last intervention session.

3.8.4. Measurement techniques within the qualitative part of the study

The background information such as the demographic information, diagnose of the participants and other medical conditions, was obtained from the school files as well as from the occupational therapy records at the schools.

The interview guides for both the baseline phase and the intervention phase was compiled by the researcher. She relied on her experience of the difficulties that adolescents with diplegia had during school activities. She was further influenced by her knowledge of the Child Health Questionnaire (Landgraf, Abertz and Ware 1999), Canadian Occupational Performance Measure (Law, Baptiste, Carswell, McColl, Polatajko and Pollock 2000) and the Paediatric Evaluation of Disability Inventory (Haley, Coster, Ludlow, Haltiwanger and Andrellos 1992).

3.8.5. Data collection within the qualitative part of the study

Five semi-structured interviews were used for each participant in order to gain information on the participants' perceptions on their participation in school activities. Each interview was recorded on video to be transcribed verbatim by the researcher after the interviews. See Annexure C for consent of parents/guardian for their child to be recorded on video and Annexure D for assent from participants to be recorded on video.

The semi-structured interview was repeatable due to the interview schedules as shown in Annexure E and Annexure F. This repeatability rendered credibility (reliability) (Golafshani 2003). Each individual participant brought their own perspective to the table (Golafshani 2003). To make the answers more credible, two semi-structured interviews were conducted during the baseline phase. Although there was an interview guide for the baseline phase and another interview guide for the intervention phase as seen in Annexure E and Annexure F, these semi-structured interviews were flexible and allowed the researcher to follow up on comments made by participants (De Vos et al. 2011; Gill et al. 2008). The participants were regarded as the experts on their experience of their participation in school activities, and were therefore encouraged to share their own stories in response to the structured questions (De Vos et al. 2011).

The initial tests (data collection sessions) to establish a baseline, were conducted at the two different schools for learners with CP in Pretoria. The intervention and the data collection for each session took place at the stable where the researcher worked.

The answers to each of the questions were carefully analysed to determine if any change had already occurred without intervention. In the same manner, the answers given during the intervention phase were analysed. These answers were then documented.

3.8.6. Data analysis within the qualitative part of the study

The data analysis of the semi-structured interviews started to take place during the interviews by means of field notes (Creswell et al. 2011; De Vos et al. 2011; Dicicco-Bloom et al. 2006) taken by the researcher. Comments made by the participants while they were on horseback as well as comments from parent were written down by the researcher.

The video recording of each interview was transcribed verbatim (Creswell et al. 2011; Dicicco-Bloom et al. 2006; Oliver, Serovich and Mason 2005) by the researcher. By transcribing the data herself, the researcher gained valuable insight into the data (De Vos et al. 2011). The identity of the participants stayed confidential by using the participant number allocated to each participant. Thereafter the different answers to each question were summarised without interpretation.

A table was compiled to categorise the data according to the different questions that were asked during each interview. Short phrases summarised each answer within this table and served as first-order thematic coding of the interviews (De Vos et al. 2011). To enhance the trustworthiness (Golafshani 2003) of data, changes noted from one interview to another, were reported by using direct quotations or explanations of the content of the answer. The direct quotations prevented the researcher from drawing premature conclusions (De Vos et al. 2011) from the information. This lengthy process for each answer from each participant in each interview give an accurate account of what each participant experienced and reported throughout the study and lessened bias by the researcher.

During further analysing of the answers, more themes of change emerged (Creswell et al. 2011; De Vos et al. 2011) within the answers to the questions. This led to second-level coding (De Vos et al. 2011). Similarities in answers as well as differences were noted and discussed with special attention to changes in answers from the baseline phase of the study to the intervention phase that occurred due to HT. Thus constant comparisons between answers were made (De Vos et al. 2011).

The semi-structured interview in this study differed from the usual method of interviewing until saturation has been reached, as coding ended after the last interview. This interview took place one week after the last intervention session. It is important to note that no new information was mentioned by any of the participants during the last interview and this could be interpreted as saturation even though it was not planned as such.

3.8.7. Limitations to the qualitative part of the study

As the interview guide was structured to obtain the opinions of participants about change in school activities from one session to the other, it represented a more concrete data collection and thus collected less qualitative information such as underlying motivations and emotions.

Not all parents could accompany the participants to HT and therefore only the opinion of the participants was sought through semi-structured interviews. This limited the qualitative information to only the opinion of the participants.

3.9. Variables

3.9.1. Independent variables

Even though the potential participants were randomly ordered on a list as explained in section 3.4.3, five out of the 10 participants were 13 years of age or turned 13 during the course of the study. This similar age added consistency to the study.

All the participants were diagnosed with diplegia within the broader group of CP by a medical examiner. That did not change the fact that each participant was affected differently and needed different treatment goals. As the study investigated the influence of HT (not the influence of an HT-programme) as the main independent variable, it is important to note that the HT was personalised for each participant as would be the case in a normal therapy setting. This approach lessens generalisability of any results to the broader CP-population.

3.9.2. Dependent variables

Dependent variables that could be influenced by the independent variables are resting heart rate, walking heart rate and walking speed. As these dependent variables are measured to calculate PCI, changes in these are reflected in the calculated PCI value.

3.9.3. Extraneous variables that could have an influence on the study

Extraneous variables are undesirable variables that could influence the relationship between the independent and dependent variables. Extraneous variables were recorded by the researcher as they occurred throughout the study and was mainly managed through the single-system design that was used were each participant was measured against him/herself.

Unexpected illness or health problems in participants might have a direct impact on the PCI of participants. Because a single-system design was used, intra-subject comparisons were made, reducing the effect of this extraneous variable across the study.

Participation in sport activities had a direct influence on the dependant variables and was described within the description of the results of each participant when it was applicable.

No effort was made in this study to limit other therapeutic input, such as physiotherapy, which some participants received during the research period. These other therapeutic inputs might have had an influence on PCI; therefore, each participant was measured against him or herself by using the single-system design as well as a multiple baseline. Generalisation of the results is thus limited.

Two weeks of unexpected rain caused the intervention of some participants to be postponed and is described in Chapter 4. This was managed by still conducting 12 HT sessions with each participant even though the sequence was interrupted.

Illness of participants and the researcher also influenced the continuous flow of hippotherapy sessions. As far as possible, sessions that were missed due to illness were conducted during the same week to minimise the effect of varying treatment frequency.

3.10. Assumptions

3.10.1. Pelvic movements

The prevailing theory (supported by Rigby's study) (Rigby 2009) is that sitting astride a horse provides sensory stimulation and movement patterns to the participant that mimics natural movements of the pelvis during normal walking (Rigby 2009). It was thus assumed that the pelvic-movement experienced while riding a horse would influence the sensory promoter (Engel et al. 2007) in walking of the participants when they attempt walking on the ground after riding a horse.

3.10.2. Ambulatory performance

According to Perry (Perry et al. 2010), measurement of energy expenditure provides information on overall performance during ambulation (Perry et al. 2010). Measurement of PCI can also quantify the physiologic penalty resulting from pathological ambulation (El-Meniawy et al. 2012).

3.10.3. Different settings

The measurement of PCI during the baseline phase at the schools and the measurement of PCI during the intervention phase were conducted in exactly the same manner and over the same distance; it was assumed that the different settings did not influence the measurement once the participants were familiar with the surroundings at the stables.

3.10.4. Ability of self-evaluation

It was assumed that the participants, given their age, were able to identify improvements with regards to their participation in school activities during a semi-structured interview that was conducted in accordance to the interview schedules in Annexure E and Annexure F.

3.10.5. Gender

As each participant was measured individually through the single-system design, it was assumed that gender differences did not influence the study outcome.

3.11. Pilot Study

3.11.1. Purpose of the pilot study

The researcher undertook a pilot study in order to assess the feasibility of the research processes and the measurement tools used (Leon, Davis and Kraemer 2011; Thabane, Ma, Chu, Cheng, Ismaila, Rios et al. 2010). The heart rate monitor and PCI measurements as well as the suitability of the interview schedule were tested to verify and improve these tools prior to the study (Thabane et al. 2010). Another objective of the pilot study was to familiarise the research team with the methodology with less participants (Leon et al. 2011). The pilot study was performed on three adolescents with diplegia, who were not included in the study.

3.11.2. Selection of the pilot study's participants

The same inclusion and exclusion criteria as for the actual study were applied in the pilot study (Thabane et al. 2010). The only difference was that the participants that took part in the pilot study, were participants known to the researcher and familiar with horses. This was done to save time that would otherwise be needed to familiarise the participants with the horses.

3.11.3. Procedure

Appointments were made and the study was explained to parents and participants selected for the pilot study. The purpose of the pilot study, procedure of the pilot study and time frames were discussed according to the information and informed consent form. The parents were required to provide informed consent by signing the information and informed consent form for the pilot study as seen in Annexure G. In addition, the participants were required to sign the information and assent forms as seen in Annexure H.

One baseline PCI measurement and calculation and one baseline semi-structured interview were then conducted in exactly the same manner that was planned for the study. See Annexure E for interview guide during baseline of the pilot study. Separate appointments were made with each participant to perform these baseline tests. The semi-structured interviews were only conducted with the participants, not with the parents, as the study aimed to obtain the perception of the effect of HT on school activities of the participants themselves.

Thereafter, five HT intervention sessions followed at the stables. The PCIs were calculated before and after each HT intervention session and the results of the PCIs were graphically depicted. These graphs were constructed in the same manner as for the results during the research. One final measurement of PCI and one more semi-structured interview followed one week after the intervention sessions ended. This was needed to determine the participant's experience of the process. See Annexure F for the interview guide after the intervention phase of the pilot study.

In addition, informal feedback on the pilot study was obtained from the parents to find opportunities to improve the research that would follow. Such feedback was therefore not required during the actual study.

3.11.4. Direct feedback from the participants

During the semi-structured interviews, one of the participants was uncertain about the meaning of the word "interferences". The word "interferences" was used in the question: "What interferences made school more difficult during the past week?" The researcher therefore changed the question to: "What made school more difficult during the past week?" The participant agreed that the change to the question made it easier to understand. This was the only direct feedback from any of the three participants in the pilot study.

3.11.5. Indirect feedback from the participants

During the intervention phase of the pilot study, the participants walked through the stables while the PCI was calculated. When there were horses present, their attention was distracted and walking speed was influenced. The presence of horses may also lead to increase in heart rate, should the participants be unfamiliar with horses. In turn, this may have an influence on the PCI as well.

These observations made the researcher aware that walking through the stables may lead to unreliable measurements. Therefore it was decided to use an area outside the stables for the calculation of PCI. To ensure no problems occurred with walking aids such as rolators (walking frame with wheels) getting caught up in the brick pavement, the area was covered with a 30 m long strip of industrial rubber.

3.11.6. Feedback from the parents

The parents of all three pilot study participants were positive and reported small changes that were noticed both on their part, as well as on the part of their children. However, fitting the pilot study into the normal time frame of each household was no easy task and parents commented on the difficulty of practical considerations such as transport to and from the stables. The researcher was made aware of how well the practical planning of this aspect would need to be for the study with 14 participants. Therefore, special attention was given to this aspect during the information session with the parents of the participants of the study.

3.12. Hippotherapy intervention

All the treatment strategies in this intervention summary have been based on the course notes for the fundamental HT course that was presented by the EATASA in 2014 (Equine Assisted Therapy Assosiation of South Africa 2014) and the only known occupational therapy book on HT (Engel et al. 2007). As the researcher relied heavily on personal experience, the proposed intervention plan was peer reviewed by another member of EATASA to ensure reliability of the information (De Villiers 2013).

As this research was not about a set programme, but about HT (the sensation of the movement of the horse), these were only examples of typical activities and each participant's progress and movement were assessed and documented throughout the treatment, with adjustments being made accordingly.

The therapy team consisted of a trained occupational therapist (the researcher), a side walker and a person leading the horse (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Sterba 2007).

Only well-trained horses were included in the intervention programme. These horses were selected for true movement, which means straight, rhythmical, symmetrical and elastic movements (Engel et al. 2007). The horses had a suitable temperament and were familiar and comfortable with a variety of sounds, occurrences and equipment presented in the HT sessions (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014). The horses were all older than five years of age and were trained to be mounted at the mounting ramp. The horses were (and still are) used for sessions with participants with various diagnoses. The horses were familiar and comfortable with side walkers on either side.

3.12.1. Matching a horse to each participant

HT is primarily about the horse's movement and how it influences the participant's movement, thus the correct horse for each participant was one of the most important decisions in this process (Engel et al. 2007; Equine Assisted Therapy Assosiation of South Africa 2014; Sterba et al. 2002). After the best available horse was matched with each participant, the best movement patterns and figures (prescribed paths a horse is ridden on in a riding arena) for the horse's movement in the arena was determined.

An independent therapist who is trained in HT was consulted to help the researcher evaluate and select the horses that were used in the study. A video recording of the participants sitting, standing and ambulation was shown to her to help her pair the right horse to each participant. The independent therapist added reliability to the process of matching a horse to each participant. The participants were each recorded once during baseline and one week after the final HT session. The role of the independent therapist was to render a more objective perspective on the pairing of horses to participants. Consent for these video recordings was obtained. See Annexure C for consent of the parents/guardians for their child to be recorded on video and Annexure D for consent of the participant to be recorded on video.

3.12.2. Tack used (equipment put on the horse)

Each participant rode on a saddle with stirrups and a granny strap (a strap attached to the saddle to hold unto for safety) during the first session. This was done to give more stability to the participants and put them at ease in the new environment. After the initial session, the tack/equipment for the rest of the intervention for each participant was decided upon. The tack was chosen with the aim of allowing the most beneficial transfer of the horse's movement to the participant's body. Therefore, most of the participants rode only on a numnah (a horse blanket) attached to the horse with a surcingle (strap that goes around the horse's body) from session two onwards. Stirrups were taken away as participants with diplegia tend to fixate with their feet and legs. Without stirrups, they became more relaxed in their legs and therefore sat more symmetrically. More pelvic mobility was thereby facilitated (Equine Assisted Therapy Assosiation of South Africa 2014).

3.12.3. The first therapy session

The first session was spent familiarising and introducing each participant to their horse. This was extremely important, as anxiety affects muscle tone negatively (Perry et al. 2010). At this early stage, another assessment was made on the match between participant and horse. It was preferable that each participant rode on the same horse for all the therapy sessions, therefore the researcher wanted to ensure the correct match had been made.

3.12.4. Familiarising the participant with the horse

The following steps were followed to familiarise participants with the horse. The researcher:

- Walked the participant through the stables and introduced all the horses to the participant.
- Walked outside and showed the participant the mounting ramp and the horse that was going to be ridden.
- Let the participant hold out a hand to the horse, rubbed the horse and told the horse the participant's name and told the participant the horse's name.
- Introduced the team (the horse leader and the side walker) to the participant.
- Showed the participant how an able-bodied rider (with a safety helmet) mounted the horse from the mounting ramp and how this rider was led around the arena.
- Fitted a safety helmet to the participant.
- Assisted the participant to mount the horse and led the horse and participant around the arena.
- Ensured that the horse walked mostly in straight lines so that the participant can get use to the movement of the horse without needing to make use of excessive correcting reactions.
- Helped the participant to dismount the horse, thanking the horse and assisted the participant in giving the horse a carrot in a safe manner.

3.12.5. Sessions 2 to 4

In these sessions, the horse walked in long straight lines most of the time. During the first two rounds in the arena (one clock-wise and the other counter-clock-wise), the participant was encouraged to make big circles with one arm at a time in one direction and then in the opposite direction. This exercise was called a warm-up exercise and helped the participant to be more at ease as the same routine was used week after week. The warm-up exercise also challenged balance, enhanced body awareness and awareness of position in space. To let go with one hand and swing one arm around was challenging for most of the participants, both emotionally and physically.

After the warm-up exercise, the horse continued to walk in long straight lines to achieve alignment and passive mobility on the horse. The primary response to the horse's movement in a straight line was anterior-posterior trunk control of the participant and the secondary response was pelvis rotation (De Villiers 2013). While riding, the participants were encouraged to look around the arena at pictures, numbers and letters. This built confidence to move on the horse and helped with dissociation between the participant's head and trunk (Equine Assisted Therapy Assosiation of South Africa 2014). As the participant started to relax on the horse, the tempo and speed of the horse was altered and controlled acceleration and deceleration, with lengthening and shortening of stride or change of speed, was introduced during the walk. These movements activated abdominal muscles and co-contraction of back muscles. This phase also included transitions in the pace of the horse – walk to halt and halt to walk. Midline crossing, rotation of the trunk, as well as flexion or extension were encouraged by activities such as putting tins or hats on poles while riding past them.

3.12.6. Sessions 5 to 7

The sessions were started in straight lines and the participants were asked to do the warm-up exercise and then to reach forward to touch the horse's ears. The participants were encouraged to reach back to touch the tail of the horse and to reach down and touch their own toes (Engel et al. 2007). As the participants were adolescents who needed excitement and a sense of achievement, a slow trot on the straight, for no more than 10-12 steps, was attempted (only if they were ready). They then progressed to walking in big 20 m circles, three-loop serpentines and 20 m figure-of-eights as well as zigzag through poles (Equine Assisted Therapy Assosiation of South Africa 2014). This elicited weight shift across the midline and stimulate the lateral flexors. More trotting was introduced to maintain symmetry and trunk alignment (Equine Assisted Therapy Assosiation of South Africa 2014).

3.12.7. Sessions 8 to 9

Straight lines as well as school figures were used. The school figures (Riding figures are prescribed patterns that a horse is ridden on in a riding arena usually used by dressage riders), became smaller (10 m circles) and were graded according to the participant’s response. Horses were circled to both the left and right side so that the same stimulation was given to both sides of the participant’s body (De Villiers 2013). If, however, the participant had a decidedly worse side, that side was targeted more in these sessions – for example, the horse was then circled to one side more than the other side to work more specifically on the participant’s weaker side. Alternative positions, namely side-sitting and half side-sitting, were used in the session if appropriate for the participant (Engel et al. 2007). These positions facilitated retraction of the scapulae. When one side of the participant’s trunk was shortened, that side was placed in such a way that it faced the horse’s head and this then facilitated trunk symmetry (De Villiers 2013; Equine Assisted Therapy Assosiation of South Africa 2014). Again, different games were included in the therapy to keep the participant’s interest.

3.12.8. Sessions 10 to 12

When participants were ready, a saddle and stirrups were reintroduced and the participants worked on standing up in the stirrups, as well as playing games like hitting balls thrown toward them while the horse was walking. This further improved balance and made use of all the trunk stability that was gained up until this point in the intervention. Trunk rotation was required as well. A treasure map was given to the participants and they instructed the horse handler where to lead the horse according to the map. Accomplishing specific tasks that challenged the participant’s balance and trunk stability were part of the instructions on the map. When the participant accomplished this activity, more challenging maps were given. Yet again, trotting was included for the participants who were ready to do it.

3.12.9. Session 12

Positive aspects of the HT done in the previous session were reinforced and repeated in this session. At the end of the last session, time was given for the participants to say goodbye to the horses. A strong emotional bond was formed by each participant with the horse that they rode. They needed the time to say their goodbyes.

3.12.10. Other aspects

For the first six sessions, the horses were mounted from the side that was easiest to achieve for each individual participant. During the next six sessions, they mounted from the opposite side. The mounting process for each participant was graded according to their progress. This activity in itself facilitated more normal movement patterns and dissociation between body parts. A great amount of motor planning was also involved in this.

Each session included a mounted riding time of no more than 30 minutes.

3.12.11. Cross-validation of results

Quantitative and qualitative data were analysed separately (Creswell et al. 2011; De Vos et al. 2011). How each participant experienced their participation in school activities was then compared to the change or lack of change in PCI of the same participant (De Vos et al. 2011), thus exploring the relation between the quantitative results and the qualitative results (Creswell et al. 2011). Effort was made to understand the participant's view on school activities and how it changed throughout the study in relation to PCI changes.

3.13. Ethical principles

Ethical principles were taken into consideration in this study. Firstly, participation in the study was voluntary and therefore potential participants and their parents needed information to be able to decide whether they wanted to participate in the study or not. Secondly, informed consent was needed and thirdly, their anonymity needed to be ensured. Fourthly, safety principles were addressed and fifthly, ethical considerations regarding the horses were needed.

Ethical clearance to conduct the research was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria, certificate number 539/2013. See Annexure B for the certificate of ethical clearance.

The necessary permission to conduct the study was also obtained from the Department of Education as well as from the headmasters of the two schools for children with CP in Pretoria. See Annexure I for permission from the department of education.

3.13.1. Voluntary participation

Possible participants and their parents first needed to be informed on what the study entailed. Therefore, information leaflets and informed consent letters were sent out according to the process described in the sampling method in section 3.4.3. See Annexure J for information leaflet and informed consent. Thereafter, an information session to explain the sampling method and the intervention was conducted. This information session was conducted in accordance to the information guide for the information session. See Annexure K for information guide for information session.

The expectations parents or guardians' had of the HT might have differed greatly from one another and from the researcher's expectations. To overcome these differences in expectations, the process, risks, and what HT is all about, was explained in the initial information session. All the parents or guardians understood English or Afrikaans,herefore no arrangement for interpretations or translations was needed.

3.13.2. Informed consent

Informed consent to take part in the study was obtained from parents or guardians who agreed to take part in the study as well as assent from the participants. See information leaflet and informed consent in Annexure J. Adolescents who wanted to take part in the research signed an information leaflet and assent form for intervention research. See Annexure L for the information leaflet and assent form for intervention research.

3.13.3. Anonymity

After written consent was obtained, participants' names were entered into a database that was electronically and password protected. A study number was allocated to each participant. All research data was also later entered into this secure database. There were no personal identifiers on any of the forms, other than study numbers, used during the research.

The treatment and research team all signed confidentiality agreements. See Annexure M for the confidentiality agreement. They were informed at regular intervals that information related to the participants was confidential. As the team members knew the participants by name, they were reminded that these names should also stay confidential. Only treatment principles and client information necessary to perform the therapy was made known to team members to further ensure confidentiality.

On conclusion of the research, the research data will be stored securely at the University of Pretoria for a period of 15 years. See Annexure N for the declaration for storage of research data/documents.

During the research period, the researcher kept all the informed consent and assent forms confidential.

3.13.4. Safety principles

All the participants had to wear horse riding safety helmets. There was at least one person at the side of each participant at all times during each HT session.

During the baseline phase, each participant's maximum heart rate was calculated by using Karvonen's formula. The formula is 220 minus the age of the participant = maximum heart rate. An additional 10 beats per minute was added for stress levels during the first three sessions. The participant's heart rate was measured throughout each HT session. The side walker specifically verified the heart rate each time that the therapy team and participant passed the gate of the arena, as the side walker wore the receiver watch. No participant's heart rate exceeded their maximum heart rate and therefore the planned termination of the session in such an event was never necessary.

3.13.5. Safety considerations at the stables

The stables where the research was conducted complied with the minimum requirements laid down by the EATASA. This included a fire extinguisher and the availability of a fully equipped first aid kit.

The stable manager has completed the required courses from the South African Equestrian Association in stable management. This ensured that the horses were well kept and their needs were met in every possible way.

3.14. Conclusion

By using a triangulation mixed method design, both PCI and the adolescent's perception on their performance in school activities were studied simultaneously. Combining the single-system design with the semi-structured interviews doubled the work load during the analytical part of the study. This effort, however, added value to compare the data obtained in one method with the data obtained in the other. Both research designs and their influence on one another were equally important, but had to be tested and analysed separately before comparisons could take place.

Due to small sample size in this particular study, the PCI was calculated within a single-system design (Backman et al. 1997; Logan et al. 2008; Tankersley et al. 2006). This allowed the participants to act as their own control group. As the single-system design has several sub-designs that are not well-known, it was briefly described. Self-reporting on their participation in school activities within repeated semi-structured interviews, added a qualitative aspect to the study and was also explained and described.

3.15. Summary

The complexities within this triangulation mixed-method design were dealt with one by one within this chapter as well as the reasons for choosing each sub-design within it. The implementation procedures were discussed in detail.

Measurements of PCI and conduction of the semi-structured interview were also described. The amount of baseline measurements differed for each participant in accordance to the multiple baselines, single-system design across subjects. Baseline measurements were followed by 12 intervention sessions and one measurement one week after intervention. During the research time-frame, 5 semi-structured interviews were conducted. A description of this process was given.

The participants that took part in the study were selected from the two schools in Pretoria for learners with CP. The sampling process was illustrated in Figure II.

Aspects of reliability and validity in this study were mentioned as well as the steps taken by the researcher to ensure trustworthy results.

The pilot study proved that the proposed study was feasible and rendered valuable feedback from participants as well as their parents. This feedback was taken into account during the execution of the study.

HT was conducted as intervention and was described in detail from the therapy team right through to examples of sessions that were administered to participants. Lastly, data analysis and ethical considerations were described.

The following chapter, Chapter 4, deals with the results of this study.

The wind of heaven is that which blows
between a horse's ears.

~Arabian Proverb

CHAPTER 4

RESEARCH RESULTS FOR QUANTITATIVE PART OF STUDY

4.1. Introduction

In this chapter the results of the quantitative part of this study will be relayed with regards to PCI, walking speed, carry-over of PCI and observed trend and level changes between the baseline phase and the intervention phase.

To contextualise the results, the sample characteristics and composition of the participants will be given first. Extraneous variables that occurred during the study and how they were addressed will be described thereafter.

Thirdly, the researcher will report on the combined results of the 10 participants that completed the study but as the single-system design regards each participant as the only participant in the study and implements multiple measurements (De Vos et al. 2011; Graham et al. 2012) the results of each participant will be described separately as well. The results with regards to the aim and to the quantitative objectives will be given and the extraneous variables that were present will be named.

4.2. Sample characteristics and composition

A total of 14 participants entered in the study. School One had five participants taking part and School Two had nine participants taking part in the study. A total of four participants were unable to complete the study as mentioned in Table 2. Thus, four participants from School One and six participants from School Two completed the study. Of the 10 participants that completed the study seven were male and three were female.

Table 2 includes the grades for those participants that were enrolled in the full academic programme at the schools. When participants were enrolled in other programmes at the schools, these were labelled as *skills class* because practical life skills are taught in these classes rather than a full academic curriculum.

The GMFCS, a classification system of activity limitation that divides adolescents with CP into one of five levels based on their functional mobility or activity limitation (Rethlefsen et al. 2010; Rosenbaum et al. 2007), was also listed. There are two versions, one for children from six to 12 years of age and one for adolescents from

12 to 18 years of age. In short, Level I describes adolescents that are able to walk without limitations, Level II describes adolescents that walk with limitations, Level III describes adolescents that hold a handheld assistive device for mobility, Level IV describes adolescents that are able to move around (self-mobility) with limitations such as making use of a powered wheelchair, and Level V describes adolescents that are transported by other people in a manual wheelchair (Rethlefsen et al. 2010). This is not a separate tool that was used, but a general classification that was available in the files of each participant.

Ten participants completed the study. In Table 2, the sample characteristics and composition of the individual participants in the study sample are summarised.

Table 2: Sample characteristics and composition

School	Participants	Age at the time of study	Grade or skill class	GMFCS-classifi-cation	Completed the study?	Reason for termination
School 1	Participant 1	Turned 13 during the study	Grade six	II	Yes	
	Participant 3	16 years of age	Grade eleven	II	Yes	
	Participant 5	13 years of age	Grade six	III	Yes	
	Participant 7	13 years of age	Skills class	III	No	Hip subluxation
	Participant 9	12 years of age	Skills class	III	Yes	
School 2	Participant 2	17 years of age	Grade eight	III	No	Hospitalised for high blood pressure
	Participant 4	15 years of age	Skills class	II	Yes	
	Participant 6	13 years of age	Skills class	II	No	Transport problems
	Participant 8	13 years of age	Grade six	II	Yes	
	Participant 10	Turned 15 during the study	Grade seven	III	Yes	

School	Participants	Age at the time of study	Grade or skill class	GMFCS-classifi-cation	Completed the study?	Reason for termination
	Participant 11	Turned 14 during the study	Grade six	I	Yes	
	Participant 12	Turned 13 during the study	Skills class	III	Yes	
	Participant 13	Turned 13 during the study	Skills class	III	Yes	
	Participant 14	13 years of age	Grade seven	II	No	Allergic to horse hair

4.3. Extraneous variables

Many different extraneous variables occurred throughout the course of the study and influenced the regularity of the intervention sessions (disrupted the therapy program) as depicted in Table 3 where a record of the intervention sessions of the study is given. Extraneous variables that occurred included rain, illness, transportation difficulties, holidays and an election. Whenever a session could not take place, and it was possible to move the session to another day within the same week, it was done. When this was not possible, the sessions were postponed to the following week, until each participant completed 12 HT sessions.

During the week of the 2014 national election, the management of the residence of School Two decided to close for the week. This was not communicated beforehand. As this election week followed immediately after one week of school holidays, boarding school-participants could not return to school. This also meant that they were unable to attend the HT. As each participant was influenced in a different manner, these extraneous variables will be described for each participant.

Transport arrangements of some participants were of such a nature that they could still attend the intervention sessions during the school and public holidays. Other participants had to rely on arrangements made by their parents for public or private transport or private arrangements made by their parents that were not always reliable, therefore not all participants were influenced by transport contingencies in the same manner.

The researcher fell ill and was unable to continue with the research on 14 May 2014. This affected two of the participants as will be described in under each participant's number.

In the intervention session record in Table 3, the sequence of the study for each participant is given, including the times within the study where extraneous variables occurred.

Table 3: Intervention session record

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8	Participant 9	Participant 10	Participant 11	Participant 12	Participant 13	Participant 14
week 1	21-Jan	23-Jan	21-Jan	23-Jan	21-Jan	23-Jan	21-Jan	23-Jan	21-Jan			23-Jan		
week 2	28-Jan	30-Jan	28-Jan	30-Jan	28-Jan	23-Jan	28-Jan	06-Feb	28-Jan	30-Jan		30-Jan	30-Jan	30-Jan
week 3	04-Feb	06-Feb	04-Feb	11-Feb	04-Feb	23-Jan	04-Feb	13-Feb	04-Feb	06-Feb	06-Feb	06-Feb	06-Feb	06-Feb
week 4	10-Feb	10-Feb	11-Feb	13-Feb	11-Feb	23-Jan	11-Feb	18-Feb	11-Feb	13-Feb	13-Feb	13-Feb	13-Feb	13-Feb
week 5	17-Feb	17-Feb	18-Feb	17-Feb	18-Feb	23-Jan	18-Feb	06-Feb	18-Feb	20-Feb	20-Feb	20-Feb	20-Feb	20-Feb
week 6	24-Feb	24-Feb	25-Feb	24-Feb	25-Feb	end	27-Feb	13-Feb	25-Feb	27-Feb	27-Feb	27-Feb	27-Feb	27-Feb
week 7		ill					end		04-Mar	06-Mar	06-Mar		06-Mar	06-Mar
week 8		ill								13-Mar	11-Mar	11-Mar	13-Mar	13-Mar
week 9	17-Mar	end	18-Mar	17-Mar				17-Mar	18-Mar	19-Mar	13-Mar	19-Mar	20-Mar	20-Mar
week 10	24-Mar		25-Mar	24-Mar	25-Mar			19-Mar	25-Mar	24-Mar	20-Mar	26-Mar	27-Mar	27-Mar
week 11	01-Apr			28-Mar	01-Apr			26-Mar	01-Apr	28-Mar	26-Mar	02-Apr		
week 12	07-Apr		08-Apr	07-Apr	08-Apr			02-Apr	08-Apr		02-Apr	10-Apr	10-Apr	09-Apr
week 13			15-Apr		15-Apr			09-Apr	15-Apr	07-Apr	09-Apr	17-Apr		16-Apr
week 14	21-Apr		21-Apr		22-Apr			16-Apr	21-Apr		16-Apr		22-Apr	23-Apr
week 15			29-Apr	29-Apr	25-Apr			23-Apr		22-Apr	23-Apr	30-Apr		
week 16	05-Mei		06-May	08-May				30-Apr			30-Apr	08-May		
week 17	12-May		13-May	15-May	06-May			08-May	13-May			15-May	12-May	15-May
week 18	19-May		20-May	22-May	09-May				20-May			22-May		end
week 19	26-May			29-May	13-May			21-May	27-May	22-May	21-May	29-May	21-May	
week 20	Post test		03-Jun	05-Jun	20-May			28-May	03-Jun	26-May	28-May	05-Jun	26-May	
week 21			Post test	Post test	27-May			06-Apr	10-Jun	29-May	04-Jun		28-May	
week 22					03-Jun			Post test	17-Jun	02-Jun	09-Jun	17-Jun	04-Jun	
week 23					Post test				Post test	05-Jun	11-Jun	Post test	09-Jun	
week 24										09-Jun	19-Jun		12-Jun	
week 25										14-Jun	Post test		17-Jun	
week 26										Post test			19-Jun	
week 27													23-Jun	
week 28													Post test	

Baseline
Hippotherapy
Second Hippotherapy in the same week
Rain
Other extrainious variables

4.4. Influence of HT

4.4.1. Introduction

The influence of HT on PCI of all 10 participants that completed the study was analysed in different ways and two statistical analyses were performed. All of these analyses were then repeated with regards to walking speed.

As the single-system design aims to describe each participant separately, separate descriptions of each participant's PCI, walking speed, carry over and observed trend and level changes will be given.

4.4.2. Combined results

Firstly, the average PCI was calculated for the baseline phase for each participant. This was then compared to the last PCI (post-intervention) that was calculated one week after the last intervention session. A visual illustration of this comparison is given in Figure V. Four of the participants visually demonstrated a decrease in PCI (i.e. Participant 5, 8, 9 and 12) while half of the participants demonstrated an increase in the post-intervention of PCI (i.e. Participant 1, 3, 4, 10 and 13). The average baseline of Participant 11 and post-intervention PCI is practically unaffected.

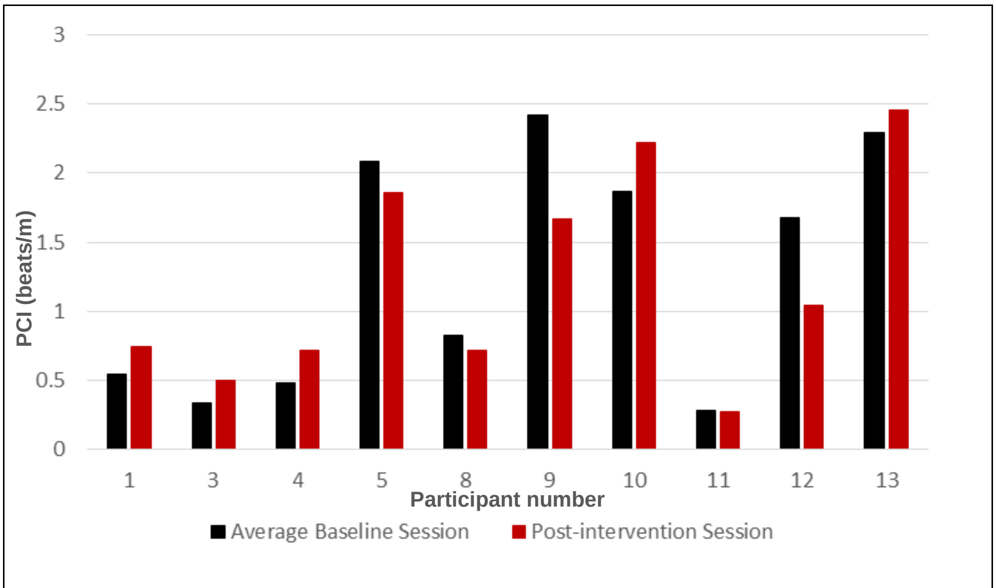


Figure V: PCI (beats/m) response per participant

When an average PCI (across all participants) was calculated for each intervention session a slight decrease in the PCI was noted as illustrated in Figure VI:

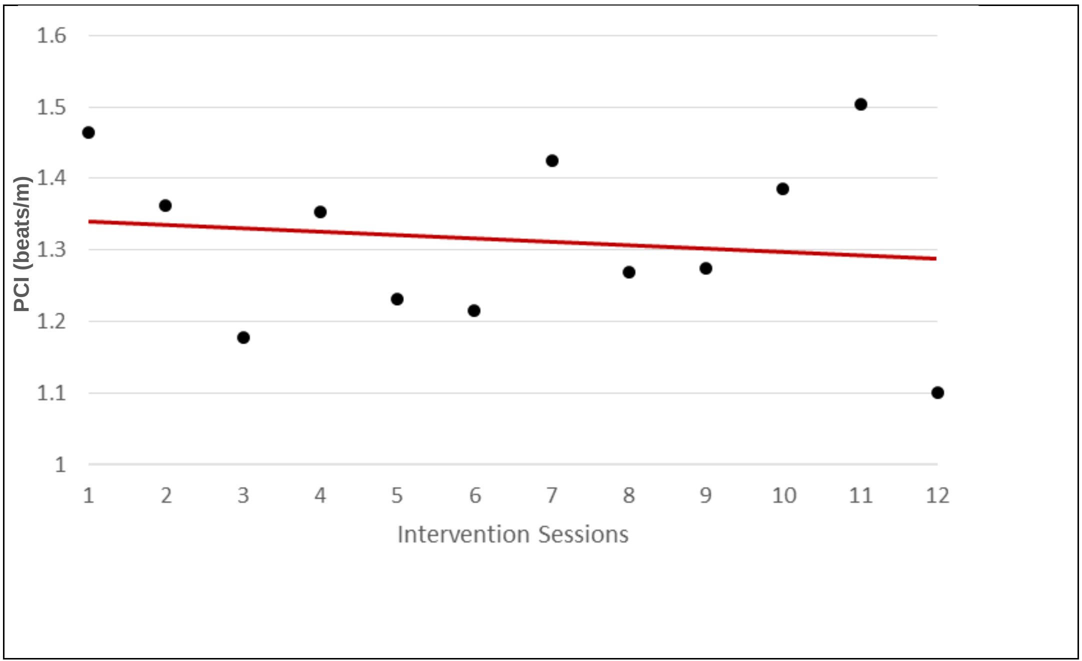


Figure VI: PCI (beats/m) per intervention session

The Wilcoxon Signed Rank statistical test was applied. Table 4 shows the actual P-values that were calculated for both PCI and walking speed. Even though a visual decline in PCI was noted, the Wilcoxon Signed Rank Test demonstrated a statistically insignificant difference between the average PCI in baseline and each intervention session. This finding was confirmed by the mixed-effects regression method that found no combined change in trend between the baseline phase and the intervention phase. The results of the PCI measurements during the intervention phase showed no consistency that is statistically supported, or that could be visually observed on the graphical depictions of these PCI results.

Table 4 Wilcoxon Signed Rank Test P-Values

	P-Values	
	Walking Speed	PCI
Intervention Session 1	50.00%	83.89%
Intervention Session 2	34.77%	78.42%
Intervention Session 3	21.58%	21.58%
Intervention Session 4	6.54%	93.46%
Intervention Session 5	6.54%	53.91%
Intervention Session 6	4.20%	53.91%
Intervention Session 7	2.44%	90.33%
Intervention Session 8	6.54%	65.23%
Intervention Session 9	6.54%	75.39%
Intervention Session 10	11.62%	95.80%
Intervention Session 11	11.62%	65.23%
Intervention Session 12	1.86%	16.11%
Post-intervention Session	2.44%	50.00%

No statistical analysis was done on the PCI data taken directly after each HT session, but it was noted that in 70 out of the 120 intervention sessions, PCI values were lower directly after an HT session, indicating a positive effect of HT on PCI within these 70 HT sessions. This observation, that a difference was made within 70 sessions will be analysed in Chapter 6.

The researcher visually observed more change in the movement patterns of the participants that made use of assistive devices than in participants that ambulated independently. These observations were made when video recordings that were made before the study (to pair the horse with the participants) were compared to video recordings taken at the last interview session.

It was further observed that eight of the 10 participants showed a higher PCI value directly before the first HT session than during most of their baseline measurements. This might be due to excitement and stress before their first HT sessions. These PCI values declined significantly within the first two interventions sessions for all eight of these participants. These observations will further be analysed in Chapter 6.

When the average walking speed was calculated for the baseline phase of each participant and then compared with the post-intervention measurement, significant increase in walking speed was visually noted. This is illustrated in Figure VII.

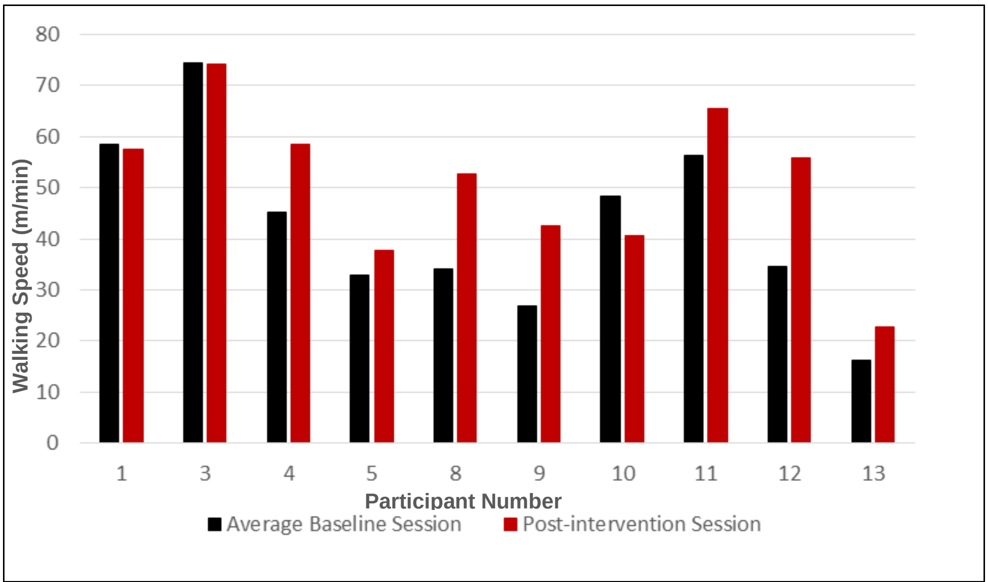


Figure VII: Walking Speed (m/min) Response per participant

The average baseline and post-intervention walking speeds of seven participants (i.e. Participant 4, 5, 8, 9, 11, 12 and 13) indicated an increase in walking speed. Participant 1 and Participant 3 were essentially unaffected and Participant 10 showed a decrease in walking speed.

Figure VIII represents the average response to the intervention sessions across all participants. From the trend line there seems to be an increase in the walking speed with the increasing number of intervention sessions across all participants.

The analysis with the Wilcoxon Signed Rank Test demonstrated an overall positive effect (based on the post-intervention session) of HT on walking speed. Table 4 above shows the P-Values calculated for walking speed, and it can be seen that HT influenced walking speed significantly from the 6th intervention session (i.e. Intervention Session 6, 7, 12 and the post-intervention session). The effect of the therapy based on walking speed indicated an overall positive effect based on the post-intervention session.

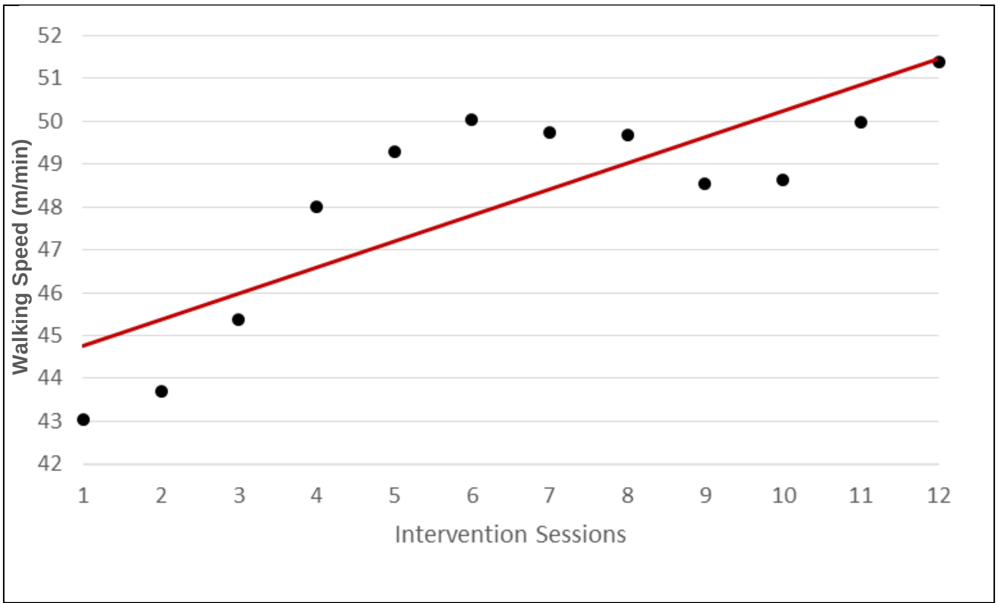


Figure VIII: Walking speed (m/min) per intervention session

When the 120 intervention sessions were analysed, 69 sessions showed a higher walking speed directly after the HT than directly before the HT, indicating a positive effect within a session. According to Chui K, Hood E and Kilma D (2012), meaningful change in walking speed is 3 m/min which was accomplished in 43 HT sessions. A significant change in walking speed is 6 m/minute (Chui et al. 2012) and 14 sessions had a walking speed increase above 6 m/min. No statistical analysis was done on the walking speed data taken directly after each HT-session.

4.4.3. Results of single participants

To avoid lengthy discussions, the results of each participant are summarised in Table 5. The PCI values in the graphs were calculated during the baseline phase and directly before each HT session. This was done in fulfilment of the first part of the aim of this research namely, to determine the effect of 12 HT sessions on PCI during ambulation, on a level surface, over a 60m distance.

The aim: to determine whether hippotherapy improves walking speed over a distance of 60 m was addressed by the measurement of walking speed as depicted in graphs and descriptions within Table 5. When walking speed improved with more than 3 m/min it was described as a small meaningful increase in walking speed (Chui et al. 2012). When the increase was more than 6 m/min, it was described as a significant increase in walking speed (Chui et al. 2012). Measurements were taken directly before an HT-session and repeated directly after the HT-session again.

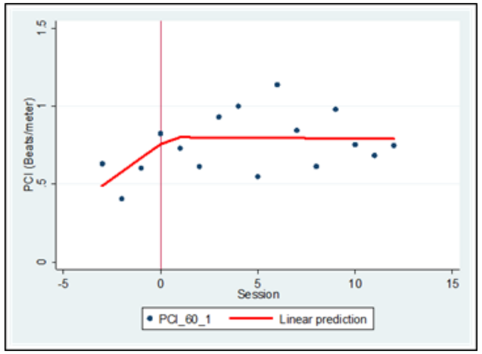
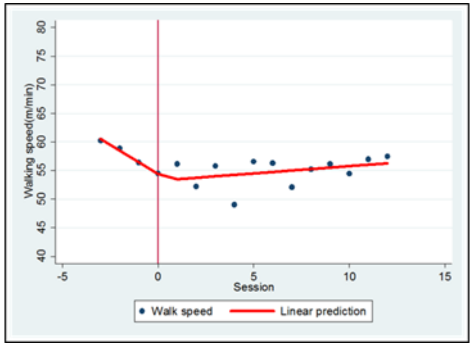
Carry-over was seen when the PCI at the beginning of one session was the same or lower than the PCI that was measured at the end of the previous session. These observations were made in accordance to the objective of the study: to determine the carry-over of the PCI at the end of one session to the start of the next session.

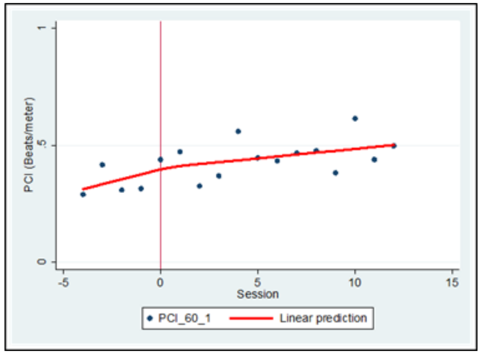
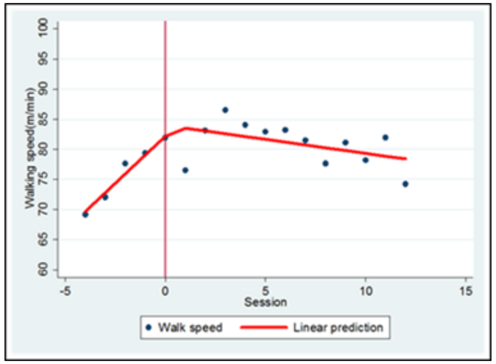
The objective: to describe the trend and level changes observed in the data patterns of PCI over the course of the study was also noted within Table 5.

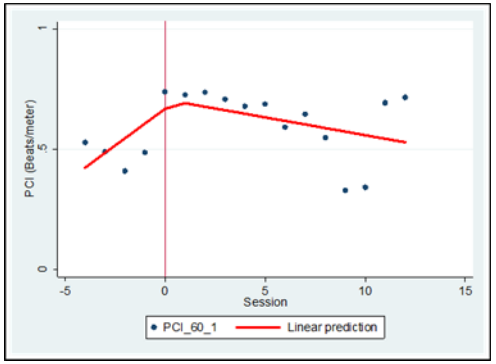
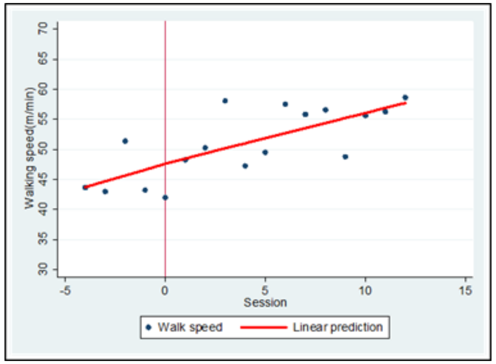
As each participant received individualised hippotherapy, it is of interest to describe Participant 10 separately. Participant 10 made use of momentum during ambulation with exaggerated upper body movement that led to frequent falling. One of the treatment goals for this participant, was to establish more control during ambulation. As more control was gained, less momentum was needed to ambulate and the walking speed visually slowed down during the intervention phase. The decrease in walking speed was not statistically significant. The walking speed was lower after the intervention in nine out of the 12 sessions. In two sessions, the change was meaningful with over four m/min decrease and in three sessions it was substantially meaningful with a measurement in this participant of over seven m/min in one session and over nine m/min in two other sessions (Chui et al. 2012).

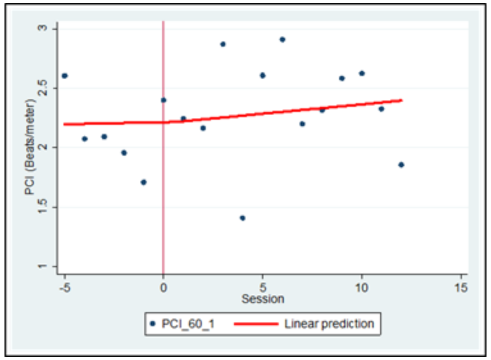
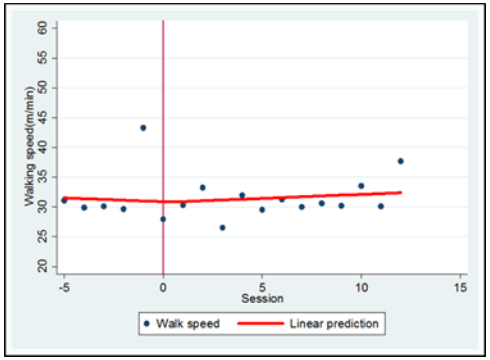
The summarised results of the participants will now be given in Table 5.

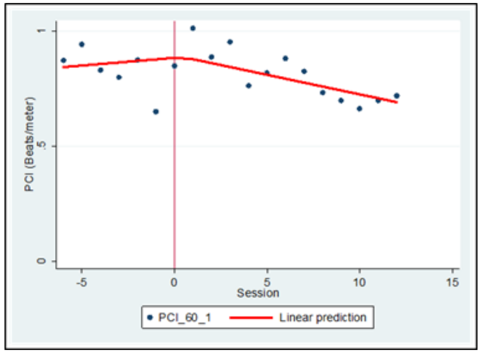
Table 5: Results of individual participants

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 1	 Baseline: Small variations were noted. Intervention: large variations were noted. Lowes PCI: 0.41 b/m during second baseline. Highest PCI: was 1.137 b/m before first HT-session.	 Baseline: steady decline (no reason known). Intervention: slight increase. Directly after each HT: Meaningful increase 3 out of 12 HT sessions. Significant increase of 11.84 m/min in 1 out of 12 HT sessions.	PCI: Five out of 12.	No trend change. Fluctuating data points	No level change	Intervention session four was postponed for two weeks due to heavy rains. Intervention session eight was postponed for one week due to rain. Intervention session nine was postponed for one week due to a public holiday.

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 3	 Baseline: A stable baseline was slightly pulled up by a higher PCI directly before the first HT session. Intervention: Stable PCI during the intervention phase. Lowes PCI: 0.29 b/m during first baseline session. Highest PCI: 0.50 b/m one-week post-intervention. Directly after each HT session, PCI was lower in seven of the 12 sessions.	 Baseline: statistically significant increase (no HT yet). Might be due to athletic training that took place during this time. Intervention: Slight decrease. Directly after each HT: A meaningful increase in one of 12.	PCI: Four out of 12	Visually upward trend in PCI during intervention-phase.	No level change.	Intervention three postponed for two weeks due to heavy rain. Intervention five postponed for one week due to participation in the South African athletics championships. The last intervention session postponed for one week due to transport problems.

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 4	 Baseline: Small variations were seen during the baseline phase but was pulled up by a higher PCI directly before the first HT session. Lowes PCI: 0.33 b/m before HT session 10. Highest PCI: 0.74 b/m directly before the first HT session. Directly after each HT, PCI was lower in six of the12 sessions.	 Baseline: Higher walking speed in session three, whereas the rest of the baseline phase showed little variation. Intervention: Statistically significant increase. Directly after each HT: A total of nine out 12 sessions showed an increase in walking speed. In two out of 12 it was a meaningful increase. In two out of 12 it was a significant increase.	PCI: Five out of 12:	Steady downward trend during intervention. Statistically insignificant.	Level change was noted with lower baseline values and higher interventi on-values.	Intervention three postponed for two weeks due to heavy rain. Intervention seven postponed for two weeks due to transport difficulties.

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 5	 Baseline: The first baseline PCI (2.61 b/m) were the highest. The following four PCI values were lower and the PCI (2.73 b/m) directly before the first HT session went up again. Intervention: High variation was noted. Lowes PCI: 1.41 b/m before HT session five. Highest PCI: 2.91 b/m before HT session seven. On overall decrease in PCI was noted when average of baseline is compared to post-test. Directly after each HT, PCI was lower in eight of the 12 sessions.	 Baseline: Stable baseline, except for baseline five. Intervention: A very stable walking speed was maintained. Directly after each HT: An increase in eight of the 12 sessions. It was meaningful in five of the 12 sessions.	PCI: Four out of 12:	Very slight upward trend during intervention.	No level change.	Intervention two postponed for two weeks due to heavy rain. These two weeks of rain were followed with transport problems. The next intervention session was thus one month after the first one and it was decided to repeat intervention session one. Intervention six was conducted at the end of the same week as intervention five to compensate for the upcoming week-long school holiday. Intervention sessions seven and eight were again conducted during the beginning and end of the same week so that this participant could finish in time before the exams started, as requested by the mother.

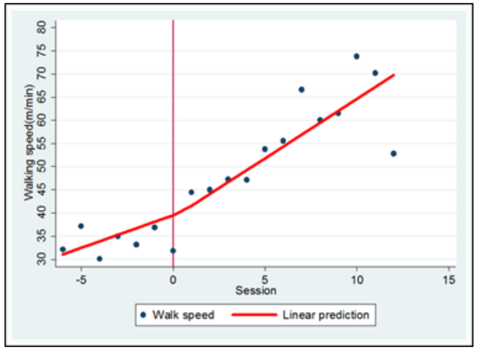
<table>
<tr><th></th><th>PCI (beats/m)</th><th>Walking speed (m/min)</th><th>Carry over</th><th>Trend change</th><th>Level change</th><th>Extraneous variable</th></tr>
<tr>
<td>Participant 8</td>
<td>

Baseline: showed a slight decline but was slightly pulled up by a higher PCI directly before the first HT session.

Intervention: Steady, statistical significant decline was identified.

Lowes PCI: 0.65b/m in the last baseline testing.

Highest PCI: 1.01 b/m before the second HT session.

Directly after each HT, PCI was lower in three out of the 12 sessions</td>
<td>

Baseline: Stable baseline

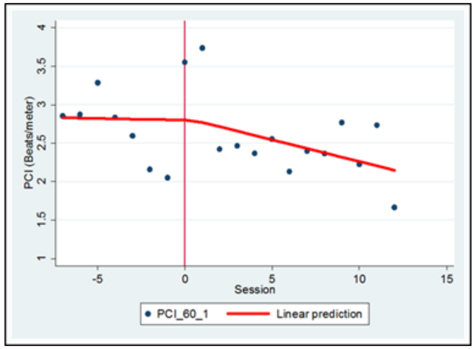
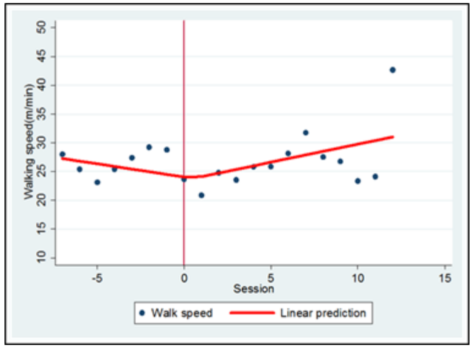
Intervention: A statistically significant increase in walking speed was noted.

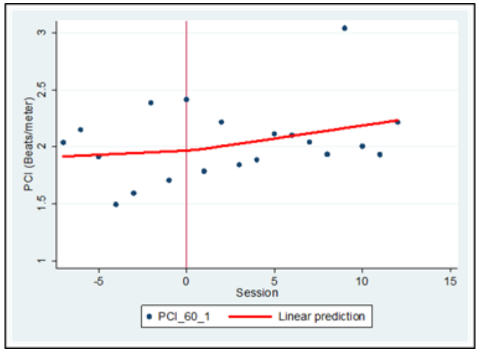
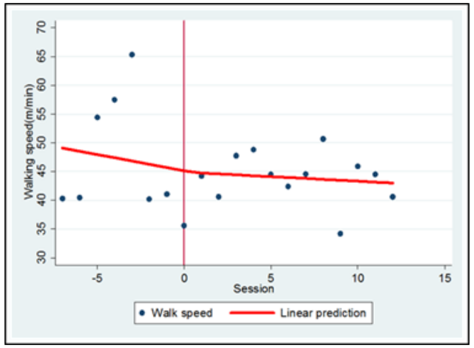
Directly after each HT: 5 out of 12 sessions demonstrated a higher walking speed.

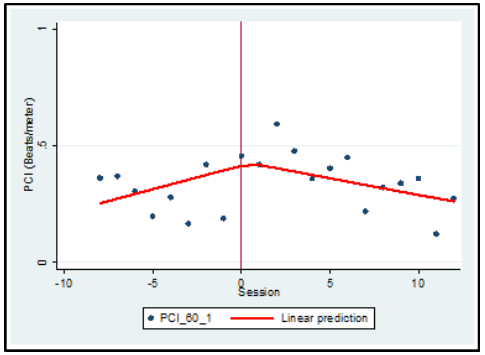
One demonstrated a meaningful increase and two demonstrated significant increase in walking speed.</td>
<td>PCI: Eight of 12</td>
<td>A statistically significant downward trend in PCI.</td>
<td>No level change</td>
<td>Baseline phase and intervention phase was separated by one week due to heavy rains.

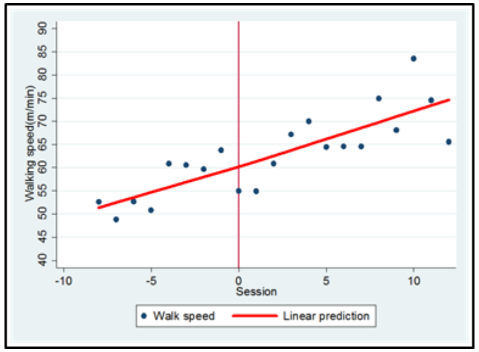
Intervention session one and two were conducted during the beginning and end of the same week due to a misunderstanding between the participant and taxi driver that caused the participant to turn up twice within one week.

Intervention 10 was postponed for one week because the researcher fell ill.</td>
</tr>
</table>

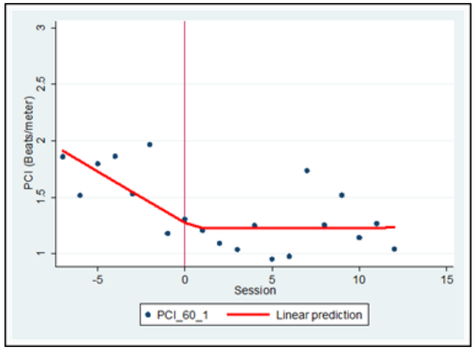
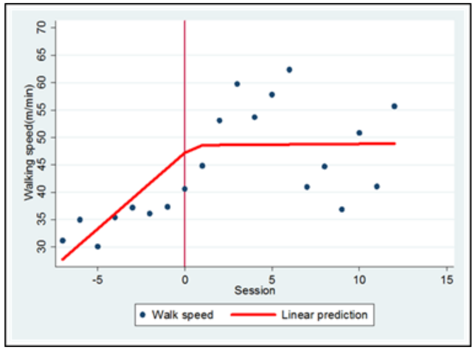
	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 9	 Baseline: First four baseline values were higher than the following three. Large variations were noted. The PCI directly before the first HT-session was higher than the other baseline measurements. Intervention: A gradual decline was noted, but was statistical insignificant. Lowes PCI: 1.66 b/m in the post-test. Highest PCI: 3.74 b/m before the second HT session. Directly after each HT, PCI was lower in nine out of the 12 sessions.	 Baseline: Stable baseline Intervention: A statistically significant increase in walking speed was noted. Directly after each HT: 5 out of 12 sessions demonstrated a higher walking speed. One demonstrated a meaningful increase and two demonstrated significant increase in walking speed.	PCI: Five out of 12.	A downward trend was noted during the intervention phase.	No level changes	Participant 9 conclude seven baseline sessions and then had to wait one week before intervention could commence due to rain. Intervention session seven was postponed for two weeks due to a family holiday.

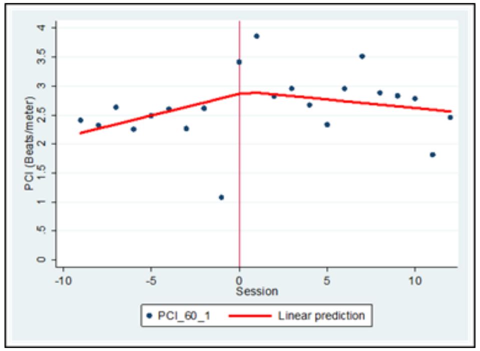
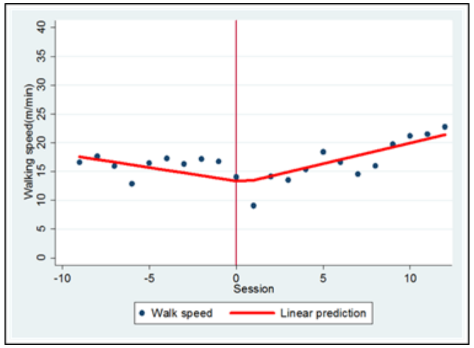
	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 10	 Baseline: Fluctuating PCI during baseline. Intervention: Higher PCI directly before the first HT. Less fluctuations in PCIs during the intervention phase than during baseline phase. Lowes PCI: 1.50 b/m during the fourth baseline session. Highest PCI: 3.04 b/m directly before 10'th HT-session. Directly after each HT, PCI was lower in five out of the 12 sessions.	 Baseline: Large variation in walking speed. Intervention: Less variation The individual goal was to gain more stability and the use of less momentum during walking. Thus a decrease in nine out of 12 sessions was indicative of the personal goal that was met. In two sessions the decrease was meaningful and in three sessions it was substantially meaningful.	PCI: Eight out of 12:	No significant trend change, but less variability.	No level change.	The school year (and therefore the baseline phase) was started one week later than the other participants due to cultural obligations. Interventions session two and three were conducted within the same week to accommodate upcoming week long school holiday. Intervention session five was postponed for one week due to rain. Intervention six was postponed for three weeks due to public holidays in combination with transportation difficulties, the election week (accompanied by a closed residence at School Two) and the fact that Participant Ten then did not return to school the next week. Intervention session eight and nine were conducted within the same week. This schedule was repeated for intervention session 10 and 11 to enable the participant to finish the intervention phase before the

<table>
<tr><th></th><th>PCI (beats/m)</th><th>Walking speed (m/min)</th><th>Carry over</th><th>Trend change</th><th>Level change</th><th>Extraneous variable</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>school exams started.</td></tr>
<tr><td>Participant 11</td><td>

Baseline: Fluctuating baseline measurements.
Higher PCI directly before the first HT.
Intervention: Decline during intervention phase was not statistical significant.
Lowes PCI: 0.12 b/m directly before the last HT-session.
Highest PCI: 0.59 b/m directly before third HT-session.
Average baseline compared to post-test was unaffected.
Directly after each HT, PCI lower in six out of the 12 sessions. </td><td>

Baseline: Walking speed showed an increase.
Intervention: Walking speed demonstrated a further increase that was statistical significant.
Directly after each HT session walking speed was higher in eight of the 12 sessions. In two sessions this change was meaningful and in four sessions the increase was significant. </td><td>PCI: Eight out of 12:</td><td>Downward trend was noted during intervention phase.</td><td>No level change.</td><td> Started baseline phase during week three of the study due to transportation difficulties experienced by the parents to attend their information session.
Intervention seven was postponed for two weeks due to the election and the researcher who fell ill the week there after.
Intervention 10 and 11 were conducted within the same week to allow for the upcoming exams. </td></tr>
</table>

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 12	 Baseline: Statistical decline (before HT) Intervention: Stabilised throughout intervention. Post-test PCI was lower than average PCI during baseline. Not higher PCI before first HT. Lowes PCI: 0.95 b/m before HT-session six. Highest PCI: 1.97 b/m during baseline six. Directly after each HT, PCI was lower in nine out of 12 sessions.	 Baseline: Sharp increase in walking speed. Statistical significant (before HT). No apparent reason. Intervention: Large variations. Directly after each HT: Six out of 12 demonstrated an increase in walking speed. Three were meaningful and three demonstrated a significant increase in walking speed.	PCI: Six out of 12.	A significant change in trend was noted between the baseline phase and intervention phase, but was not due to HT.	No level change	Baseline phase had an interruption between session six and seven due to illness of the participant. Intervention six was postponed for one week due to transport difficulties. This participant did not turn up for the final intervention session due to a misunderstanding and only turned up the week thereafter

	PCI (beats/m)	Walking speed (m/min)	Carry over	Trend change	Level change	Extraneous variable
Participant 13	 Baseline: Little fluctuation (between 2.25 b/min and 2.64 b/min) was seen during the nine baseline measurements. The PCI before the first HT pulled the regression line upwards. Intervention: A slight downward trend was noted as well as larger variation between data points than during baseline. Lowes PCI: 1.08 b/m during the last baseline. Highest PCI: 3.86 b/m before the second HT-session. Directly after each HT, nine of the 12 PCI values were lower.	 Baseline: Fairly stable baseline. Intervention: Statistical significant increase in walking speed. Directly after each HT: In 10 out of 12 sessions an increase in walking speed was noted. Six of these were a meaningful increase and one showed a significant increase in walking speed.	PCI: three out of 12:	Slight downwards trend. Not statistically significant.	No level change.	Entered the baseline phase in week two of study due to late return of the informed consent form. A week-long school holiday separated the baseline phase from the intervention phase. Intervention two was postponed for one week due to public holidays. Intervention three was postponed for two weeks due to public holidays and the election (closure of the residence during the week of the election). Intervention four was postponed due to a doctor's appointment. The last nine interventions sessions were uninterrupted but in three of those weeks two sessions were conducted per week to allow the participant to finish the intervention sessions before the July holidays commenced.

4.5. Conclusion

With regards to PCI, four of the participants demonstrated a decrease, half of the participants demonstrated an increase in PCI and one was unaffected. No definite conclusion could thus be made on the combined effect of HT on PCI. This was true when the average baseline was calculated and compared to the post-test as well as when the PCI data from session (taken directly before each HT-session) to session was taken into account.

Statistically significant trend changes in PCI were only demonstrated in Participant 8, suggesting that HT might have a positive influence on the PCI of some clients.

In eight of the 10 participants, the PCI value directly before the first intervention session was higher than during the baseline phase. This higher PCI might be due to the excitement directly before the first horse riding session and will be discussed further in Chapter 6.

When walking speed was analysed the average response across all participants demonstrated an increase in the walking speed. It should be noted that a statistically significant increase in walking speed was achieved from the 6th HT intervention session onwards, suggesting an overall positive effect (based on the post-intervention session) of HT on walking speed.

Carry-over for PCI from one session to the next occurred in 56 out of the 120 sessions.

An immediate positive effect on PCI within sessions was detected in 74 out of the 120 sessions when the results of all the interventions sessions throughout the study were combined. This was seen in a lower PCI directly after a session than directly before a session.

4.6. Summary

After background information, such as the sample characteristics and compositions as well as extraneous variables, was given, this chapter focused on the results of the first part of the research aim, namely: To determine the effect of 12 sessions of HT on the PCI during ambulation, on a level surface, over a 60 m distance.

Thereafter, the results of the following objectives were given:

- To determine whether hippotherapy improves walking speed over a distance of 60 m.
- To determine the carry-over of the PCI at the end of one session to the start of the next session.
- To describe the trend and level changes observed in the data patterns of PCI over the course of the study.

The statistically insignificant change in trend for PCI across subjects was described and the only statistical significant change in one participant (Participant 8) was noted in Table 5: Results of individual participants. A significant increase in walking speed occurred over the combined results and walking speed was also summarised for each participant in Table 5.

Chapter 5 will deal with the results in the qualitative part of the study, describing the themes that were established though the semi-structured interviews as well as providing literature control on these themes.

In Chapter 6, the results of Chapter 4 and Chapter 5 will be analysed and interpreted and compared in relation to the triangulation mixed method design that was used.

"Horses change lives. They give our young people confidence and self-esteem. They provide peace and tranquillity to troubled souls, they give us hope."

~Toni Robinson

CHAPTER 5

RESEARCH RESULTS FOR QUALITATIVE PART OF STUDY

5.1. Introduction

Five interviews were conducted with each of the participants over time. To meet the aim of the study, the researcher will give feedback on the effect of HT on school activities and to fulfil the second objective, each participant's own perspective on the effect of HT on their participation in school activities will be included.

The demographic profile of the participants that was needed for the qualitative part of the study will be given first. Secondly, the timing of the five semi-structured interviews within the broader study will be given. Thirdly, the extraneous variables that influenced the qualitative part of the study will be described. Fourthly, the questions that were included in the interviews to gain trust and openness will be discussed. Fifthly themes that emerged from the interviews will be described together with the categories within each theme and lastly, the literature on these themes will be described.

5.2. Demographic profile

In Chapter 4, the sample characteristics of each individual participant was given as the results of each participant were described separately in accordance to the single-system design that was used for the quantitative part of the study.

In this chapter, the demographic profile is presented in Table 6.

Table 6 Demographic profile

Demographics		Frequency in School 1	Frequency in School 2	Total
Gender	Female	1	2	3
	Male	3	4	7
Langue of interview	Afrikaans (home language)	4	1	5
	English (second language)	0	5.	5
Age	12 years of age	1	0	1
	13 years of age	2	5	7

Demographics		Frequency in School 1	Frequency in School 2	Total
	14 years of age	0	0	0
	15 years of age	0	1	1
	16 years of age	1	0	1
Ambulation	Wheelchair user at school	2	3	5
	Reversed Kay-walker when not in wheelchair	2	1	3
	No assistive device	2	3	5

5.3. Timing of interviews during study

The time schedule of the semi-structured interviews is shown in Table 7. For all the participants, the first interview was conducted on the same day as the first baseline testing for the quantitative part of the study. The second interview was conducted on the same day that the last baseline measurements were taken, thus on a different time in the study depending on each participant's prolonged baseline phase. The third interview was conducted in conjunction with the fifth HT session, and interview four with the ninth HT session. The final interview was conducted one week after the last HT session.

Table 7: Timetable for interviews

Week:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Participant 1	1		2					3				4				5						
Participant 3	1			2					3				4				5					
Participant 4	1			2					3				4				5					
Participant 5	1			→	2					3				4				5				
Participant 8	1			→	→	2					3				4				5			
Participant 9	1			→	→	→	2					3				4				5		
Participant 10	1			→	→	→	2					3				4				5		
Participant 11	1			→	→	→	→	2					3				4				5	
Participant 12	1			→	→	→	→	2					3				4				5	
Participant 13	1			→	→	→	→	→	2					3				4				5
		→	Prolonged Baseline							Intervention						Interviews						

5.4. Extraneous variables

English as second language could have contributed to limited understanding and less detailed responses. This seemed to be more applicable to participant four, who mostly responded: "*Fine, mam,"* to most of the questions. Because the researcher strived to know how school activities were influenced, she often restructured questions to this participant, but participant four usually still gave the same answer. As these answers did not influence the findings (direct facts that were collected or emerging of themes) negatively or positively, it was only noted and reported.

Extraneous variables such as rain did not affect the qualitative part of the study directly, as the interviews were not dependent on the weather. Nevertheless, the timing of interviews was linked to intervention session five and intervention session nine, and in that regard the rain did influence the study. For example, when session five was postponed for one week, so was interview three.

Technical problems were experienced with the video recording of interviews two and four of Participant 5. Therefore, the answers for interviews two and four were only recorded for nine participants. Technical problems were also experienced with the video recording of the first interview of Participant 11 and therefore only one baseline interview was available to use for Participant 11.

Some of the interviews were conducted at the stables where horses and other animals walking around distracted the attention of some of the participants, which could have influenced the answers given.

Some participants had difficulty staying focused during the interviews and the researcher at times had to redirect their attention.

5.5. Gaining trust

Trust is needed to set the stage for honest sharing. The researcher therefore explained to the participants that all answers will be acceptable and that they must feel free to give their own perspective. The words used by the researcher were: "tell your own story" with regards to the questions. The purpose of the first two questions, was to encourage open conversation. Question one was about feelings towards school and provided information to the researcher regarding the emotional status of the participant during each interview. This question developed an openness and trust between the researcher and participants. Question two delved into the experiences at school during the week that preceded the interview. From the answers that were given to these two questions it was clear that the participants intended to be honest as they shared deep emotional feelings regarding their schools with the researcher, yet most of the participants presented it on a very concreate level.

Due to the HT and the therapeutic relationship that developed within the therapy sessions, participants were not hesitant to give their true opinion on questions asked.

5.6. Concreate direct answers

Ten questions were asked to each participant in each of the five interviews that were conducted in accordance with Annexure F.

The direct responses obtained were summarised with short phrases (as coding) and indicated different changes in their experience of school activities by the different participants. Answers to some of these questions indicated a gradual change in school activities by some of the participants. For instance, Participant 1's answers to the question: "How often did you feel tired during the past week?" indicated change from one interview to the other, but not much change was indicated to the question in relation to movement around class. Participant 12 on the other hand reported definite change with regards to movement in class as the study progressed. It was only during further analysis of the actual wording with which participants described the school activities that similar themes emerged. These themes will be discussed in section 5.7.

Interestingly, most of the participant's first response to the question: "*Did anything change since you started horse riding?"* was that nothing had changed. When the question was asked in a different way i.e. not overtly about changes since horse riding had started, then only did the participants give information leading to the themes as discussed later. Questions like: *"Tell me more about the horses,"* solicited responses that provided such information.

To provide participants with an opportunity to report on aspects that did not change or were experienced as a negative change, question 10 was included in the study. The question was: "*What made school more difficult during the past week?"* No theme emerged out of question 10 in relation to HT, but this question did trigger personalised answers that ranged from no difficulties, uncertainties whether there were difficulties and the mentioning of definite difficulties. Difficulties that were mentioned was being in trouble, too much work, a heavy book case, exams, difficulties to concentrate, homework and social difficulties with friends. Mathematics was regularly mentioned as being a difficult subject. Again the answers were concrete in nature.

Difficulties at school differed from one week to the next and no pattern of change was noted in any of the participants that indicated changes due to HT in this regard.

Within the semi-structured interviews, the researcher also asked some participants if anything became more difficult since the participant started horse riding; some of the answers were:

"Nothing." (Participant 11 in interview five)

"Nothing came difficult everything is easier. I just need to focus and stop talking too much." (Participant 10 in interview five)

Participant 12, who reported in most interviews to feel positive about the HT, reported in interview three (during the school holiday) that HT was: *"Wasting my time…"*

Researcher: "Why do you say that?"

Participant: "Holiday, holiday …"

When asked about the horses, each and every participant had a positive response and reported that they liked the horses, wanted to ride again and enjoyed the activity. They did not seem to link horse riding with therapy at all, yet nine out of the 10 participants reported changes in some form of movement since they started HT.

A summary of the research results of each participant is given in 1.1.1.1i.Annexure P.

5.7. Themes that emerged

Changes in school activities that emerged during the analysis process were categorised in three main themes (Bradley, Curry and Devers 2007; Braun and

Clarke 2006) as summarised in Table 8. Two of these themes were anticipated prior to the study, but the theme of rest and sleep was a new theme that emerged.

During the intervention phase the question: “Did any of the things we spoke about change since you started horse riding?” were added to the interviews (from interview three onwards) in accordance with Annexure F. The same three themes emerged from the answers given to this question, consequently confirming the themes within other answers.

Table 8 Themes and categories

Theme	Category
1. Sleep and rest	Reduced fatigue
	Sleeping longer periods
2. Increase in functional ambulation	More frequent walking
	Less effort in walking
	Participation in sport and play
3. Improved neuro-musculoskeletal and muscle functioning	Sitting posture
	Joint mobility
	Balance

5.7.1. Theme one: Rest and sleep

The strongest unanticipated theme that emerged was rest and sleep. Rest is an occupation that includes relaxation and lesser participation in extraneous activities in order to regain energy and allow for renewed engagement in other occupations (American Occupational Therapy Association 2014). For sleep to effectively restore and support healthy partaking in other occupations, it has to be uninterrupted (American Occupational Therapy Association 2014; Newman, O'Regan and Hensey 2006).

Adolescents with diplegia often experience interrupted sleep (Hemmingsson, Stenhammar and Paulsson 2009; Hsiao and Nixon 2008; Newman et al. 2006) and feelings of tiredness which affect their participation in school activities negatively (Hemmingsson et al. 2009). Interrupted sleep is often caused or associated with related medical conditions, such as cramps, breathing difficulties, pain, incontinence, difficulties in rolling over in bed and epilepsy (Hemmingsson et al. 2009).

During the baseline phase of this study, feelings of tiredness were confirmed by participants in statements such as:

"*Sometimes I feel like closing my eyes and just sleep."* This answer was given by Participant 10 in interview two in relation to listening in class.

Participant 13 said: "*… I didn't have enough time to rest,"* in answer to a question about the experience at school during the past week.

"*…when the school day drags on, I become tired and exhausted and yesterday I became lightheaded and had to lie down on my arms."* (Participant 1, interview two)

The question: "How often did you feel tired during the past week?" was included into the interview guide with the objective to establish fatigue during ambulation. But fatigue was mentioned by participants in answers to several other questions as well. During a discussion on sleep (as the theme started to emerge in interviews) in interview four with Participant 3, the researcher asked: "*Did you often wake during the night?"* and the response was: "*Yes."*

a. Different Categories within theme one

Category 1 Reduced fatigue

During the intervention phase, reduced fatigue (as a result of HT) was reported by participants both in answer to the direct question about fatigue and as an aspect that changed since HT started. The questions were: "*How often did you feel tired during the past week?"*

Reactions of Participant 1 were:

Interview one: "*Many times."*

Interview two: "*Many times."*

Interview three: *"Quite often, but less than in the beginning of the year."*

Interview four: "*I did not feel tired often."*

Interview five: *"I actually never felt tired."*

Experienced as a result of HT:

"I am more relaxed, I am smiling a lot" (Participant 10, interview three)

"Not so tired." (Participant 13, interview five)

Category 2 Sleeping longer periods

Prolonged, uninterrupted sleep was reported by two participants as a direct outcome of HT and can be seen in the following quotes:

"*I sleep for longer periods of time…"* (Participant 1, interview three)

"*I sleep more. And I wake less often."* (Participant 3, interview four)

b. Literature control on theme one

In this study, participants indicated that HT had an effect on their rest and sleep, something that was also mentioned in other HT articles (Exner, Engelmann, Lange and Wenck 1994; Hiemenz 2015), but that was not researched as such. These findings are significant because rest and sleep affect everyday lives of adolescents with diplegia, including school activities (Dewald, Meijer, Oort, Kerkhof and Bogels 2010; Hemmingsson et al. 2009; Hsiao et al. 2008; Newman et al. 2006). A direct link (in 216 children with CP) between sleep related problems and performance in daytime activities was found (Hemmingsson et al. 2009; Newman et al. 2006) as well as a correlation between increased quality of life (along with daytime functioning) and reduced sleeping problems when obstructive sleep apnoea was addressed (Hsiao et al. 2008).

This study thus indicated that HT may indirectly influence school activities by affecting sleep and rest.

5.7.2. Theme two: increase in functional ambulation

Within the occupation of activities of daily living, functional ambulation is seen as the movement from one place to the other in order to perform other occupations (American Occupational Therapy Association 2014). During school activities functional ambulation is needed by the participants to reach their classes on time, to function within the class setting as well as to take part in occupations during break time and sport related activities.

a. Different Categories within theme two

Category 3 More frequent walking

Five out of the ten participants indicated that more frequent walking was the result of HT. Quotes from the interviews was:

"*In the evenings, I park my wheelchair outside and walk around inside the house."* (Participant 9, interview 5)

In relation to ambulation in the classroom, Participant 10 said in interview two: *"My movement in the class, eish, it is not okay, because I get tired very easily."* Then in the final interview, the participant reported: "*Nowadays it's easy… After the horse riding I can pick up things on my own, I can walk around if I want to."* The researcher replied: "*And you didn't do that before?"* to which the participant's final response was: "*No, I didn't"*

Also in relation to ambulation in class, Participant 12 reported in the second interview: "*I do not actually move a lot."* During the final interview the same participant reported: "*It is easier for me to walk than to roll."* The word "*roll"* referred to ambulation within the wheelchair.

In interview two, in relation to ambulation on the playground, Participant 10 reported: "*No, I never walk."* The answers to this question gradually changed and in interview five, Participant 10 reported on the same question: "*… I don't actually sit on my wheelchair, …"*

Category 4 Less effort in walking

Participants made comments that indicated reduced effort during the action of walking as result of the HT. This can also be linked to the improved neuro-musculoskeletal functions that were reported.

"I walk easier" (Participant 1, interview five)

"Yes, I walk easier in class and in the corridor. I think the horse riding helped." (Participant 5, interview five)

"Many things changed, I always walked like this…" Participant 9 indicated a crouch walking pattern during interview five and then said: "…*with bended legs, but now I walk straight."*

"I do move easier." (Participant 13, interview 5)

"I move much easier. Everything moves easier: my legs, my upper body and my arms." (Participant 12, interview five)

Category 5 Participation in sport and play

Taking part in sport related activities at school played an important role in the lives of some participants as seen in the following quotes:

"*We play tackle during each break time…" "We played with the ball."* (Participant 1, interview one)

"It was okay because I could practice some soccer and we did some athletic stuff." (Participant 11, interview one)

"The thing that I was angry of; there was no sports…" This remark was made during interview three after the sport period at the school was cancelled and re-enforces the notion that sport is important to Participant 11.

Two participants directly linked improvement in participation in sport and play to HT by saying:

"*My chase-runs improved and I tackle better."* (Participant 1, interview

"My discus improved, as my hips are better." *(*Participant 3, interview

b. Literature control on theme two

Just as enhanced functional ambulation impacted by HT emerged as a theme in this study, it emerged in the qualitative study of Debuse et al (2009) on HT as one aspect within the theme of physical improvement. These findings are strengthened by overall improvement in gross motor functioning in quantitative studies on the effect of HT (McGibbon et al. 1998; Sterba 2007; Sterba et al. 2002). Enhanced functional ambulation encourages enhanced participation in all school activities, including sport related activities which leads to an improvement in quality of life (Simeonsson et al. 2001).

Improvement in functional ambulation within the classroom setting had an influence on the independent participation in class which in itself has value to the participants (Simeonsson et al. 2001).

It was apparent in this study that more improvement in functional ambulation at school was reported in relation to indoor ambulation than to outdoor ambulation. This correlates with the study of Schenker et al. (2005) that found lower scores for outdoor-participation than for indoor participation, possibly due to more physical demands of the environment on the playground. As participation in the outdoor environment tends to be more affected, the improvement that did occur seems to be significant to participants.

5.7.3. Theme three: Improved neuro-musculoskeletal functioning

Neuro-musculoskeletal functions forms part of body functions that are affected by diplegia (American Occupational Therapy Association 2014).

c. Different Categories within theme three

Category 6 Sitting posture

Sustaining muscle contraction within sitting is due to muscle endurance (American Occupational Therapy Association 2014). According to five of the participants these aspects improved due to HT. They made comments such as:

Participant 8 in interview two: "*Since I can remember, it was difficult for me to sit upright. I am used to lying backwards since grade one."* The same participant in interview five: "*Nowadays I can sit up straight for longer periods…"*

"The sitting is getting easy because now I am not sitting as the way I was sitting …" the participant gestured sacral sitting and then continued: *"…now it is easy*." And then demonstrated sitting up straight.

"I sit more up right on the chair, because I always lay back, now I sit up straight."

The researcher asked another participant: "*You said that you sit more upright. Do you think it is due to the horse riding or did you do some other exercises?"* Then the participant linked the HT to the class situation by saying: "*Aaaa, it's during the horse riding, when you say do this and then I do it, so when I'm in class then I feel like I am* *tired, then I just remember the exercises and then I try them and then it is very easy then I feel comfortable and then I don't get lazy."* Even though this comment can be linked to the theme of rest and sleep, it was said in the context of improved sitting posture.

"Maybe it is changing like the way I am sitting." This comment was made after careful consideration about the effect of HT.

Category 7 Joint mobility

Joint mobility is seen in the range of motion that is present in a joint and is influenced by muscle tone, muscle power and muscle endurance (American Occupational Therapy Association 2014). Quotes from participants that indicate their perception on the effect of HT on joint mobility were:

"I became a little bit stronger." (Participant 9, interview five)

"I can now open my legs wider." (Participant 9, interview 3)

With a big smile "…*I must admit, I am less stiff in my hips when taking part in sport and so."* (Participant 3, interview four)

"There were drastic changes, my hips became looser, … it was definitely the horses." (Participant 3, interview four)

*"Much easier to stand up…" P*articipant 9 then described more independence in toileting at school during interview four.

"… it is starting to change my tummy muscles…" (Participant 11, interviews three, four and five)

"My legs are looser" (Participant 13, interview three) and *"The legs, they can now straighten"* (Participant 13, interview five)

Category 8 Balance

"*My balance started improving."* (Participant 1, interview three)

Participant 9 responded in interview four to the question (did anything change since you started horse riding) by saying: *"look…"* then demonstrated better balance by showing the researcher how the warm-up exercises (used during the HT) were done when sitting on a chair without back and arm support.

During an HT session Participant 3 reported that balance improved to such an extent that the participant was now able to throw a javelin without being fastened in the chair.

d. Literature control on theme three

Comments with regards to neuro-musculoskeletal functioning made within the study of Debuse et al. (2009) supports the comments made within this study. Debuse et al. (2009) reported among other physical effects, improved sitting posture, improved balance and improved range of motion as seen from the participant's perspective. The effect of HT in this regard is further strengthened by quantitative studies on posture and balance (Bertoti 1988; Sterba 2007; Sterba et al. 2002; Zadnikar et al. 2011). Bertoti (1988) conducted the first known study on the effect of HT on posture and found statistically significant improvement in posture in the 11 participants. The study of Bertoti (1988) was included in Zadnikar's (2011) meta-analysis of eight studies on posture. Due to the small sample size in all the studies, Zadnikar (2011) concluded that HT seemingly had a positive effect on posture but that the findings in the eight studies could not be generalised to the broader CP population. This study again, within a small population, confirms that HT seemingly has a positive effect on neuro-musculoskeletal functioning.

5.8. Discussion

During the semi-structured interviews, it became apparent that most of the participants used more concreate reasoning than was anticipated by the researcher. This concrete answering was demonstrated by Participant 1 in interview one to the question: "*How do you feel about school?"* Participant 1 one answered: "*Nice, some days it is less nice because we have too much work, some days are very-very nice*."

The themes that were discussed above were all in relation to positive changes experienced by participants. Participants reported no negative changes in relation to HT, but participants did report personal experiences that were difficult for them such as exams, being in trouble at school, homework, a heavy book case and social problems.

From the different answers to the different questions, it was clear that each participant experienced the effect of HT in a unique way even though there were similar themes. In fact, some participants did not even think that HT had any influence on their school activities, even though their consecutive answers to some questions suggested differently. The lack to link HT to functional outcomes might be explained with the findings of Debuse et al (2009) that participants do not think of HT as therapy but rather as horse riding. In this study, the participants that were attending skills classes at school displayed more concrete reasoning than the participants who attended the academic programme. The participants in the skills classes also tended to give answers related to the specific day that the interview was conducted and at times seem unaware of the concept of time.

The three main themes that emerged from the semi-structured interviews indicate some change, but due to the small sample size and different aspects that were mentioned, these themes cannot be generalised to the greater population of adolescents with diplegia, but can assist in themes to be studied in future, as will be described in Chapter 6.

5.9. Summary

In this chapter, the results of the qualitative part of the research were given by describing each of the themes that was identified through the semi-structured interviews. Explanations on the background of some answers as well as a literature control were given in order for the reader to understand the context.

The results were interpreted, for both the quantitative and qualitative parts of the study, in Chapter 6.

A man on a horse is spiritually as well as physically bigger than a man on foot. ~John Steinbeck

CHAPTER 6

ANALYSIS AND CONCLUSION OF RESEARCH FINDINGS

6.1. Introduction

In the previous two chapters, the results of this research were given at length. In this chapter, the researcher will discuss the results of the research in terms of the research aim. To understand the influence of HT on PCI and school activities a short description of the progression of the study will firstly be given. Secondly, the influence of the extraneous variables mentioned in Chapter 4 will be discussed. Thirdly, the results in relation to each objective in the quantitative part of the study will be given, followed by a discussion on the results in relation to the qualitative objective. Fourthly the influence of HT on PCI will be discussed as this was the first part of the aim of the study.

After the analysis of the results, a description of the shortcomings of the study will be given, followed by opportunities for further research.

6.2. Progression of the study

Most of the parents, guardians and adolescents that were contacted prior to the study were excited to take part in the study. Throughout the study, some of the parents offered information on the progress of the participants without any formal interviews. This information confirmed some of the answers given by participants during the formal interviews. Interviewing parents as well as the participants might be a valuable consideration during further research. This aspect will be discussed further in the recommendation section of the study.

When the study was planned, the researcher realised that there would be challenges involved in the measurement of ambulatory function and therefore selected the measurement tool that (according to the available literature) was most likely to indicate changes in the ambulation of participants (Bratteby Tollerz et al. 2011; Plasschaert et al. 2011; Raja et al. 2007). The researcher decided to include quantitative measurements of PCI as well as qualitative semi-structured interviews with participants on their school activities to diversify the study methodology. This semi-structured interviews were in accordance with recommendations made by MacKinnon (1995b) and had a baseline phase and an intervention phase. This made comparisons between the quantitative part of the study (also with a baseline phase and an intervention phase) easier.

During a six-month period the participants took part in both the baseline phase as well as the intervention phase. The intervention, namely HT was executed at a stable yard close to Pretoria. Each participant received intensive, individualised HT for 12 sessions that was followed by one last calculation of PCI and semi-structured interview one week after the last HT.

6.3. Extraneous variables

Several extraneous variables occurred during the six-month duration of the study. Extraneous variables, as explained in section 4.3, influenced and sometimes interrupted the HT sessions. To examine the possible influence of the extraneous variables, the researcher systematically compared PCI results as well walking speed in the first session after an interruption to other sessions and no direct influence were observed. Although these extraneous variables were not ideal, one can reason that it led to a more representative study (experience in real life) as contingencies such as rain and illness do affect HT in reality.

6.4. Objective i: The effect of HT on walking speed

The first objective of the study was to determine whether hippotherapy improves walking speed over a distance of 60m. This formed part of the quantitative part of the study.

The walking speed in this study showed a statistically significant increase as demonstrated by the Wilcoxon Signed Rank statistical test. This study also confirms findings in younger children (ages four to twelve) with CP (Haehl et al. 1999; McGibbon et al. 1998; Sterba 2007) that indicated positive effect of HT on gross motor functioning and mobility. This study indicates a positive effect of HT on walking speed of adolescents with diplegia, even though the sample group was too small for definite generalizations.

These results bring hope to children and adolescents with diplegia as bones, joints and muscles of the lower limbs (including the pelvis) are affected in diplegia (Perry et al. 2010), causing a decrease in walking speed (Bogey 2012; Rodda et al. 2001; Thomas et al. 1996). Walking speed of people with diplegia also tends to further decrease as they grow older (Gannotti et al. 2008; Johnston et al. 2004; Suzuki et al. 2001). HT thus counters this occurrence in diplegia and this study is in agreement with other studies (Fízková et al. 2013; Rigby 2009) that indicated changes in the pelvis, ankle, knee and hips through HT (as these changes influence ambulation) even though these changes in these studies were found to be low in statistical significance. The functional mobility in two children with CP (Haehl et al. 1999) and gross motor function (Casady et al. 2004) were also found to improve through HT and these findings were again supported by the findings of this study.

The qualitative results in this study further confirmed the increase in walking speed as participants reported more frequent ambulation as well as easier ambulation. The cumulative results in different studies all indicate that HT have a positive effect on ambulation and significantly increase walking speed in children and adolescents with diplegia.

As the third and fourth objective of the study also relate to the quantitative part of the study, they will be described next. The second objective formed part of the qualitative part of the study it is described under 6.7.

6.5. Objective iii: Carry-over of PCI from one session to the other

The third objective of the study was to determine the carry-over of the PCI at the end of one session to the start of the next session.

Carry-over of PCI from the end of one session to the beginning of the next session occurred in 56 out of the 120 sessions. This indicates that even though no significant change in PCI was demonstrated by the study, there was a carry-over effect of 46,66%. Carry-over in various other aspects of HT still remains a topic to be studied in future. The researcher could not find any literature on the carry-over of the results of HT from one session to the other and yet it is a question that occupational therapists frequently ask the researcher.

The changes that were reported in relation to school activities indicated that carry-over took place. In this context, carry-over is seen as the effect form the HT into every day occupations.

6.6. Objective iv: Trend and level changes of PCI

The fourth objective was to describe the trend and level changes observed in the data patterns of PCI over the course of the study.

There was a downward trend in PCI levels during the intervention phase in five of the 10 participants (see Chapter4), but only one was statistical significant, indicating a decrease in PCI values during the intervention phase in Participant 8. Only one level change was observed in Participant 4 who had lower baseline values and higher intervention values. Trend and level changes were specific to each participant and generalisation across participants in this study is difficult in this regard.

Interesting trend changes were also noted in walking speed and therefore the researcher discussed the observations in each individual participant and possible reasons for each of these observations in Annexure P.

6.7. Objective ii: The effect of HT on school activities

The second objective was to determine and describe the effect of hippotherapy on school activities from the adolescent's own perspective.

This objective formed part of the qualitative part of the study. As there was no study found by the researcher that investigated the effect of HT on school activities and very few studies on school activities themselves, this study aimed to fill this void.

This study produced concrete answers to the questions asked in relation to school activities that proved to be valuable with regards to the understanding of the effect of HT on each participant. These aspects are therefore mentioned in the combined results of each participant in Annexure P. This study further produced general themes that indicated an effect of HT on school activities. These themes were: improved rest and sleep, improved functional ambulation, and improved neuro-musculoskeletal functioning. These themes were developed from the answers given by the participants themselves in relation to concrete questioning about school activities and therefore provided the answers to the objective of determining and describing the effect of hippotherapy on school activities, from the adolescent's own perspective.

As stated in Chapter 5, these themes and the effect thereof on participation in school activities were weakly supported in literature. The theme of rest and sleep was not previously studied in relation to HT, but it was mentioned as an associated effect within a study on the effect of HT on paraplegic patients (Exner et al. 1994). Through clinical reasoning the researcher states that the occupation of rest and sleep influences the occupation of education (American Occupational Therapy Association 2014) and therefore school activities. Assumptions with regard to school activities were made from studies (Hemmingsson et al. 2009; Newman et al. 2006) that linked difficulty in relation to sleep and rest to problematic daytime performance.

The theme of improved functional ambulation was better anticipated as it could be linked to school activities such as ambulation in class and on the playground. The relations between HT and ambulation were addressed within the literature review of this study and in the quantitative part of the study. This theme supported the findings in the quantitative part with regards to improved walking speed, but it did more than that by stating that the participants themselves experienced more frequent walking with less effort as a result of HT. Participation in sport and play was a logical result of better ambulation and an indication that better functioning in one area carried over to another area of school activities.

The last theme of improved neuro-musculoskeletal functioning was anticipated, as other studies (Bertoti 1988; Sterba 2007; Zadnikar et al. 2011) already demonstrated an improvement in these client factors (American Occupational Therapy Association 2014) in younger participants through HT. This study now confirms that this small group of adolescent participants also noted a positive change in this regard.

Apart from addressing the aim and objectives of this study, the themes that emerged from of the qualitative part of the study provide valuable topics for future research on the effect of HT, both quantitatively and qualitatively.

6.8. Aim of the study: The effect of HT on PCI

The first part of the aim of the study was to determine the effect of 12 sessions of HT on PCI. This aim was met within the quantitative part of the study that was divided into a baseline phase and an intervention phase. Some participants had three or four baseline measurements and other participants had more (up to nine) as dictated by the single-system design with multiple baselines across subjects (Backman et al. 1997; Graham et al. 2005). A minimum of three baseline measurements was suggested in literature as an adequate number of baseline measurements (Backman et al. 1997) but for this study it proved to be too few to allow the use of statistical methods such as Rn statistics (Wolery et al. 1982) or the split-middle method (Backman et al. 1997; Wolery et al. 1982). Therefore, piecewise linear regression (2007) was used to render regression lines (visually displaying the trends) for all the participants for statistical analysis of all data. The Wilcoxon Signed Rank Test was then incorporated as a non-parametric test to compare average baseline measurements to the post-test measurement (Stats to do 2015).

PCI (as indication of change in ambulatory performance) showed no statistically significant change in the combined PCI measurements for all the participants over the course of the study. This study's results on the effect of HT on the PCI of adolescents with diplegia are therefore in conflict with the results of the study of McGibbon (1998) on younger children with CP. This might be due to the age difference of participants and therefore indicates the need for further research on the influence of HT on different age groups.

Different factors might have had an influence on the PCI values of participants, such as the differences in the participant's GMFCS. Most children with CP that participated in previous studies on PCI were classified as Level I and Level II within the GMFCS (Bratteby Tollerz et al. 2011; Raja et al. 2007; Rose et al. 1989), but in this study, five participants were more affected and classified as Level III on the GMFCS. Being more affected might have an unknown influence on PCI-values and needs further investigation through future research.

Being physically more affected might also have a direct effect on resting heart rate (Bratteby Tollerz et al. 2011; Rose et al. 1989), causing participants not to reach a steady state during resting heart rate. This might also be true for walking heart rate as was suggested by Boyd et al. (1999) and Bratteby Tollerz et al. (Bratteby Tollerz et al. 2011). As no research could be found by the researcher on resting heart rate and walking heart rate in adolescents with diplegia within the different GMFCS-levels, more detailed analysis on the influence of heart rate in this particular study was not possible. Walking heart rate should ideally reach steady state conditions for the calculation of PCI (Boyd et al. 1999), and consequently it is assumed that steady state heart rate was not reached during this study, which led to the inconclusive results of this study regarding the effect of HT on PCI.

6.9. Combined effect of HT on PCI and school activities

When both the quantitative and qualitative results of this study are considered it is clear that each participant is an individual person and that HT as individual treatment strategy has an individualised effect, confirming that the choice of a single-system design was appropriate. Within individual participants the results of the quantitative part of the study and concrete answers to questions within the qualitative part of the study only confirmed one another explicitly in Participant 9. The link between the two parts of the study was more subtle in the other participants.

Participant 8 who had a statistical significant downward trend in PCI as well as a statistical significant increase in walking speed only reported an improved sitting posture in class. When each participant's individual situation is taken into account the data became clearer and the researcher therefore gave a short discussion on each participant within Annexure P.

The combined results within the quantitative part of the study were however that walking speed increased and a combined theme in the qualitative part of the study was improvement in functional ambulation as described in section 6.4. In this regard the two parts of the study did indeed complement each other.

6.10. Shortcomings in the research

As there are no quantitative measurement tools (to the researcher's knowledge) that are specifically developed to measure functional improvement due to HT, indirect measures of function were used. PCI was selected to be used in this study and within this, also the measurement of walking speed, resting heart rate and walking heart rate. For the qualitative part of the study, the semi-structured interview was applied to assess the functioning of participants in school activities.

As the results of the PCI measurements showed no consistency that is statistically supported, it has been shown not to be a suitable measurement tool to meet the aim of this study. Thus, the absence of specific, specialised measurement instruments to measure the effect of HT was a short-coming in this study.

Even though the single-system design with a prolonged baseline across subjects allowed for longer baseline measurements, the baseline phase for the first participants was too short to allow for more comprehensive statistical analysis. The decision on the length of the baseline was partly made in accordance with literature that suggested a minimum of three weeks (Backman et al. 1997) and partly decided to meet the time frame in which the research had to be conducted (due to practical limitations). The researcher recommends a minimum baseline phase of at least five measurements in future research.

Many contingencies occurred that were not foreseen by the researcher. Though no direct effect was noted, these events are not ideal within a research setting and introduced – often unknown – confounders that could have influenced the research.

6.11. Opportunities for further research

It is recommended that a measurement tool be researched to measure the effect of HT. Few standardised tests on people with diplegia and even fewer measurement instruments are available to measure the effect of HT. In this study different clinical changes were noted in each and every participant, but until more responsive measuring instruments for HT are available, assessing the clinical effects of HT will remain challenging. Such an evaluation tool needs to be sensitive to small changes and needs to be easy to administer frequently to enable daily evaluations within the HT setting. Easy measuring will encourage occupational therapists to incorporate research into everyday practice and thus provide evidence-based therapy.

The findings on individual participants in the study suggest ample topics for further research on the effect of HT within the diplegic population and might even be expanded to other populations. Such topics are: sleep and rest, functional ambulation, posture of adolescents, sport participation, joint mobility, balance, activities of daily living, the perception of parents and care givers and the psychological effect of HT on both the participants and their care-givers. Improvement in working speed in class and ADL-functioning were also mentioned by Participant 9 as aspects that changed through the intervention sessions, and that might be studied in future.

The effect of HT in relation to the age of participants needs to be investigated further as the results in relation to PCI within this study on adolescents and the results on PCI in younger children in McGibbon's (1998) study, differed.

This study also led to questions in relation to the effect of steady state heart rate in the diplegic and broader CP-population, both when resting and walking heart rates are measured. Literature on when steady state heart rate is reached as well as under what conditions it is reached is vague. Not reaching a steady state hart rate during walking might have had an influence on the results of this study.

The downward trend in PCI during the baseline phase that was seen in participants five and 12 (who mainly made use of wheelchair ambulation) might indicate a positive effect of regular walking, and the researcher suggests further research with relation to more frequent walking of adolescents with diplegia, even if walking is not their main means of ambulation.

Comments from the parents did not officially form part of the qualitative part of the study, but did suggest some change. The opinion of care-workers and parents might be further explored in future studies, but should not exclude the opinions of the participants themselves.

6.12. Communicating the results

The results of this study will be communicated to the parents and participants and the broader occupational therapy community by presenting the results at the Occupational Therapy Association of South Africa's (OTASA) congress. The researcher is planning to submit an article to the South African Journal of Occupational Therapy. The researcher will also apply to international occupational therapy journals to publish the findings of this study.

According to the rules of the Gauteng Department of Education, the dissertation will be sent to them. It will be stored in the library of the University of Pretoria and the results will be published on EATASA's website.

6.13. Conclusion

The research question was: Will HT on adolescents with diplegia affect their PCI during ambulation over a distance of 60 m and will HT affect their school activities?

The short answer to the research question is: Yes, there was an effect. The explanatory answer is: Even though the effects of HT on PCI were inconclusive, the walking speed of participants improved statistical significantly. Better movement patterns were clinically noticed after the study than before the study, especially in the participants that made use of assistive devices, but this was not reflected in an improvement in PCI as one would have suspected. Evaluation check lists and a panel of experts evaluating different aspects of ambulation might provide a more objective view on the effect of HT on ambulation of adolescents with diplegia in future.

The qualitative part of the study explored the effects of HT on school activities from the perspectives of the participants and provided insight into different aspects of school functioning. The participants had different opinions on the effect of HT, although all agreed that they would take part in HT again should the opportunity arise. They did not necessarily link changes in school activities to HT or at times were not even aware of changes in school activities, even though their own answers suggested change from one interview to another.

This study again emphasises the fact that occupational therapists work with individuals that react individually to treatment, making quantitative research difficult with regards to sample size as well as measurement tools.

Further research that explores the findings of this study might shed light on the complexities surrounding both the physical and psychological effects of HT on participants with diplegia.

6.14. Summary

The use of HT by occupational therapists as treatment strategy is still a young concept in South Africa; EATASA was only founded in 2010. As there is a need to provide evidence-based practice this study attempted the first research on HT in South Africa and as such laid the groundwork for future research. This study not only explored the direct effect of HT on PCI (including walking speed) and school activities in this particular sample population but also revealed other underlying fields for potential research.

Within the six chapters of this dissertation, the research orientation, literature review, the research design, methods, the results and analysis thereof were provided. The research population comprised adolescents with diplegia. In literature, the researcher could not find studies on HT with an exclusive adolescent population. In this regard, this study not only pioneered the field of HT in South Africa, but also worldwide.

The study obtained meaningful quantitative and qualitative results that concluded a positive impact of HT on adolescents with diplegia, as well as identified several further opportunities for research in the field.

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