The Effect of Therapeutic Horseback Riding on Heart Rate Variability of Children with Disabilities

By

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Declaration

I, Zingisa Zine Nqwena declare that:

1. The work presented in this dissertation is my own original research, except where otherwise indicated.

2. This study has not previously been submitted to UKZN or another tertiary institution for purposes of obtaining a degree or any other academic qualification.

3. Information obtained from other researchers has been acknowledged and referenced accordingly.

4. This dissertation does not contain text, graphics or any tables copied from the internet unless referenced.

Signature: ______________________ Date:____________________

Dedication

I dedicate this dissertation to both my parents – You have been my inspiration and have always encouraged and supported me in my studies and everything. You will always be in my heart.

Acknowledgements

I would like to acknowledge and appreciate the following:

1. My supervisor – for the guidance throughout the study and for always keeping me motivated.

2. Participants' parents and their children – for making it possible for me to conduct this research through participation, engagement and commitment.

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ABSTRACT

Introduction: Heart rate variability (HRV) is the oscillation in the interval between consecutive heart beats, resulting from dynamic interplay between multiple physiologic mechanisms that regulate instantaneous heart rate. Short-term heart rate regulation is governed by sympathetic and parasympathetic neural activity and therefore HRV examination can be used as a non-invasive estimate of the functioning of the autonomic nervous system (ANS).

Aim: To determine the effects of therapeutic horseback riding (THR) intervention on the HRV of children with disabilities including autism spectrum disorder, cerebral palsy, pervasive developmental disorder, sensory problems, and Down syndrome. The objective was to examine if THR intervention improves the HRV of children, hence improving the parasympathetic activity that is associated with a calm and relaxed state.

Methods: This is a quasi-experimental design. Heart rate variability components (time and frequency domain) were measured over six intervention group sessions of THR which were conducted once a week for six weeks. The duration of the THR sessions was 20-25 minutes for each group. The THR sessions included riding, mounting and dismounting, trotting, as well as performing activities such as extending arms and throwing a ball while on a horse. Heart rate variability measures were recorded from 29 participants presenting with various disabilities, and was assessed in both time and frequency domains.

Results: Over the six THR sessions, the time domain component (RR interval) showed a significant increase in HRV for pre-THR from session one to session six ($p=0.011$), indicating improved vagal activation. However, frequency domain showed both increased sympathetic activity from session one to session six ($p=0.022$) reflected by component coefficient of variance for low frequency (CCV LF) and increased parasympathetic activation during THR from session four to session six ($p=0.045$), reflected by total power (TP).

Conclusion: Therapeutic horseback riding intervention of six sessions demonstrated a change in HRV of children with disabilities. However, the changes obtained were not significant to make conclusive measures as to whether sympathetic or parasympathetic activity is predominantly increased after the six sessions. Further research involving a larger sample with a single type of a disability would be recommended to improve the reliability and

validity of the study. Furthermore, having a control group would improve the reliability of the study.

Contents

Abbreviations

ANOVA	Analysis of variance
ANS	Autonomic nervous system
ASD	Autism spectrum disorder
BBS	Berg balance scale
CCV	Component co-efficient of variation
CP	Cerebral palsy
DAN	Diabetic autonomic neuropathy
DS	Down syndrome
ECG	Electro-cardiogram
HR	Heart rate
HRV	Heart rate variability
HF	High frequency
IBI	Inter-beat interval
IDDM	Insulin-dependent diabetes mellitus
LF	Low frequency
MI	Myocardial infarction
MSSD	Mean squared successive differences
NDT	Neuro-developmental treatment
OPQ	Occupational performance questionnaire
PDD-NOS	Pervasive developmental disorder- not otherwise specified
RMSSD	Root mean square of successive differences
RR interval	Distance between successive heartbeats

SA	Spectral analysis
SAHRV	Spectral analysis of heart rate variability
SPSS	Statistical package for social sciences
THR	Therapeutic horseback riding
TP	Total power
TUG	Timed up and go

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CHAPTER ONE – INTRODUCTION

1.1 Background

For many years, people with disabilities used horses for transport and enjoyment (Bowes & Cook, 2007a), until it was discovered that horse riding could be used to treat physical and mental disabilities. Horse riding benefits were first discovered by Dames Agnes Hunt a founder of the first orthopaedic hospital in Oswestry in 1901 and Olive Sands, a physiotherapist who used horses for rehabilitation of soldiers during the First World War (Bowes & Cook, 2007a). Horse riding is now being used as a therapy to rehabilitate and manage several types of disabilities including cerebral palsy, learning disabilities, amputations, autism, spinal cord injuries, neurological disorders and emotional problems (Lessick,Shinaver,Post,Rivera, & Lemon, 2004).

Therapeutic horseback riding (THR) is a method of treatment involving riding a horse and performing certain activities on a horse to accomplish physical, emotional, social, cognitive, behavioural and educational goals (Lessick et al., 2004). Therapeutic horseback riding is similar to Hippotherapy, however, THR is performed by a trained instructor teaching the rider to improve basic riding skills, while hippotherapy is performed by a physical therapist or occupational therapist using equine movements to improve posture, balance and fine motor skills (Snider,Korner-Bitensky,Kammann,Warner, & Saleh, 2007).

The movement of the horse's pelvis moves the rider with the same three dimensional movements which occurs during human walking, providing motor and sensory inputs similar to those received during walking, hence providing neuromuscular stimulation (Bowes & Cook, 2007b). The benefits of THR include stimulation of respiration and circulation, improved range of motion, and relaxation of tight muscle for conditions such as muscular dystrophy, poliomyelitis, amputation and multiple sclerosis (Riding for the Disabled Association, 1987). Studies have shown improvements in balance (Homnick,Henning,Swain, & Homnick, 2015; Kang, 2015; Miller & Alstan, 2004), motor and sensory efficiency (Wuang,Wang,Huang, & Su, 2010) and social motivation (Bass,Duchowny, & Llabre, 2009).

Table 1.1: Percentage improvement for balance and social motivation from different studies

Reference	n	Mean age (years)	Balance improvement (%)			Social motivation(%)
			TUG	BBS	FABS	
Kang (2015)	10	70.1	25.9	12.7	-	-
Homnick et al. (2015)	9	65	-	1.1	5	-
Bass et al. (2009)	19	6.9	-	-	-	27.7

TUG = Timed up and go; BBS = Berg balance scale, FABS = Fullerton advanced balance scale

Numerous benefits of THR have been proven through various methods (Homnick et al., 2015; Kang, 2015; Miller & Alstan, 2004), however the use of heart rate variability (HRV) as a method to measure stress or relaxation status is limited. Heart rate variability can be used to assess if an individual is stressed or is in a more relaxed state (Michels et al., 2013).

Heart rate variability is the oscillation in the interval between consecutive heart beats (Schroeder et al., 2004). Heart rate (HR) varies from beat to beat during normal sinus rhythm (Bilchick & Berger, 2006). Heart rate variability can simply be defined as a time gap between the heartbeats (Figure 1.1), which normally varies as you breath in and out. Low HRV is defined as a low variability in the distance between consecutive heat beats, while high HRV is high variability of the distance between consecutive R peaks of the heart beat signal (Michels et al., 2013). In healthy individuals, HRV is normally higher, while lower HRV is associated risks of cardiovascular diseases (Colhoun,Underwood,Fuller, & Rubens, 2001).

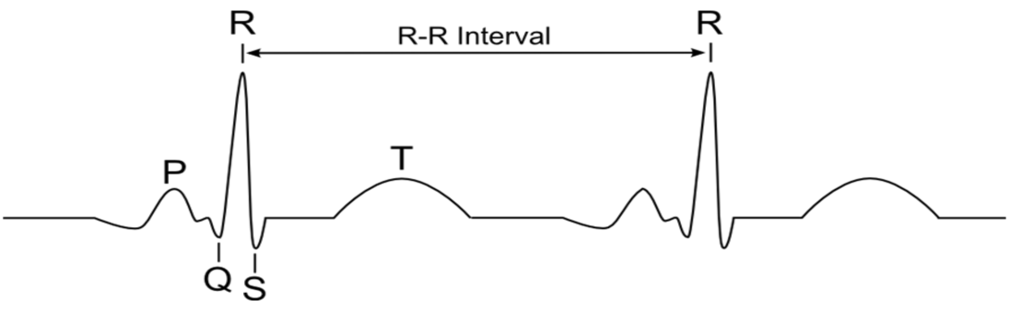

Figure 1.1: An example of an RR interval

(Paramedicine, 2010)

Heart rate variability results from the dynamic interplay between multiple physiologic mechanisms that regulate instantaneous HR (Bilchick & Berger, 2006). Short term HR regulation is governed by sympathetic (fight or flight) and parasympathetic (relaxation state) neural activity (Bilchick & Berger, 2006) and therefore, HRV examination can be used as a non-invasive estimate of the functioning of the autonomic nervous system (ANS). Low parasympathetic activity is linked to poor emotion regulation (Porges,Doussard-Roosevelt, & Maiti, 1994) and high stress levels (Porges, 1995). Furthermore, HRV can also be used to determine regulation of the peripheral viscera and the heart by the ANS (Xie et al., 2005)

1.2 Problem Statement

There is limited research on therapeutic horseback riding effects on heart rate variability of children, particularly those with disabilities.

1.3 Study aim

The aim of the study was to examine the effects of THR on heart rate variability in children with disabilities, including neurodevelopmental disorders, sensory disorders and physical disabilities.

1.4 Study Objectives

- To examine the effects of THR on the activity of the parasympathetic nervous system over a period of time in children with disabilities, via HRV testing pre- and post-intervention.
- To determine the effects of THR on the occupational performance in children with disabilities pre- and post-intervention.

1.5 Hypotheses

1.5.1 Hypothesis

Therapeutic horse riding over a six-week period will increase the overall HRV of children with neurodevelopmental disorders, sensory disorders and physical disabilities.

1.5.2 Null hypothesis

Therapeutic horse riding over a six week period will not have an effect on HRV in children with neurodevelopmental disorders, sensory disorders and physical disabilities.

1.6 Significance of the study

The findings of this study could potentially provide a basis for future studies to build upon as it could provide some indication as to the change, if any, in stress levels of the children with disabilities. This could be of significance for the future treatment of children, specifically, children with varying physical or mental limitations.

Although the dissertation is presented in the traditional format, a manuscript has been submitted to the African Journal of Disability (ISSN: 2223-9170 (print) | ISSN: 2226-7220 (online)) for publication (Appendix V). The manuscript is currently been reviewed.

CHAPTER TWO – LITERATURE REVIEW

This chapter reviews therapeutic horseback riding (THR), describing the theory of THR, psychological and physical effects of THR. An overview on disabilities managed by THR will be presented, including autism, cerebral palsy, Down syndrome and other intellectual impairments. Heart rate variability (HRV) is also used in the prediction of cardiac heart failure in patients, diabetic autonomic neuropathy and the assessment of HRV in healthy individuals comparing different ages and gender. Heart rate variability has also been found to be useful in sports and children with disabilities.

2.1 Therapeutic horseback riding

Therapeutic horseback riding involves the use of different movements and exercises on a horse for physical, behavioural and mental benefits (Lessick et al., 2004). Examples of therapeutic riding exercises include but not limited to riding forward, sitting on a horse using proper posture, extending arms, reaching to touch the horse’s ears or tail and trotting (Lessick et al., 2004). Therapeutic horseback riding is similar to hippotherapy but differs mainly by cost and practise. Hippotherapy is performed by a licensed physical or occupational therapist and has very specific physical tasks and goals, including improvement in balance, posture, function and mobility (Zadnikav & Kastrin, 2011). It is costly compared to THR, like any therapy, and is sometimes covered by medical insurance. Therapeutic horseback riding is performed by specially trained riding instructors and assistants usually not medical professionals (Ward,Whalon,Rusnak,Wendell, & Paschall, 2013; Zadnikav & Kastrin, 2011).

Therapeutic horseback riding lessons are more for physically and mentally disabled as well as children and adults with behavioural or emotional issues, with goals also to improve balance and posture, as well as sensory-motor and perceptual motor skills (Zadnikav & Kastrin, 2011). Equine-assisted activities are taught by riding instructors sometimes assisted by volunteers who lead the horses and sidewalk next to the riders to ensure their safety (Zadnikav & Kastrin, 2011).

2.2 The therapeutic horseback riding rationale

The benefits of THR are attributed to the reason that the movement of the horse’s pelvis moves the rider with the same three dimensional movements which occurs during human walking, providing motor and sensory inputs similar to those received during walking, hence providing neuromuscular stimulation (Bowes & Cook, 2007b). The rider sits on the horse’s back near the pelvis, which is largely driven by movement of the horse's hind limbs when walking (Garner & Rigby, 2015). When subjectively observing a person walking and a person riding a horse, both show translation and rotations about the three axes (Garner & Rigby, 2015).

Garner and Rigby (2015) measured and compared human body motions when walking to those when riding a horse. Three dimensional pelvic motions of able-bodied children were measured during walking as well as during horse riding in the arena. A total of six participants aged 8-12 years were recruited. Participants were healthy with no disabilities and inexperienced with horse riding. Four horses of different sizes and gait patterns were used in the study. The horses were trained for and familiar with equine assisted therapy practice. There were two different sessions on separate days each involving three participants. Despite variations across walkers, horses and riders, results demonstrated strong similarities between human pelvis motions when walking and when riding on a horse. Riding reproduces natural human movement patterns. Therefore, THR could provide therapeutic benefits to individuals with disabilities who cannot move naturally on their own (Garner & Rigby, 2015).

2.3 The psychological effects of therapeutic horseback riding on children without disabilities

Therapeutic horseback riding improves behavioural patterns, self-esteem and social skills (Miller & Alstan, 2004). Socialisation is aided through THR which reduces negative social skills. Negative social skills increase the difficulty to develop positive relationships resulting in poor self-esteem and negative behaviour. Teachers reported improved behaviour and attitude in class for children undergoing THR (Crawley,Cawley, & Retter, 1994). Another study by All, Loving and Crane (1999) also reported improved self-esteem and confidence, which comes from the ability to control an animal of a big weight. Therapeutic horseback riding encourages risk taking, develops patience, emotion control, self-discipline and sense of normality. Therapeutic horseback riding also has a calming effect and helps a person to relax (All et al., 1999).

Miller and Alstan (2004) conducted a study on the benefits of therapeutic riding as perceived by parents of children enrolled in a therapeutic programme. This was achieved by interviewing parents of children undergoing THR of any changes noticed in the children's' performance in school and at home. Parents reported great improvements in social and academic development as well as personal responsibility. Therapeutic horseback riding was therefore perceived as an educational benefit for children who are mentally and physically challenged.

2.4 The physical effects of therapeutic horseback riding on children without disabilities

There have been improvements in balance aided by THR. During riding, the rider needs to balance by recruiting selected muscles to avoid falling and being thrown off balance. Proprioceptors are also activated during THR which improved proprioception. Muscles are also being stretched during THR, which is of benefit for tight or spastic muscles. Sitting on a horse requires inner thigh muscles (adductors) to be stretched, which improves flexibility. A rhythmic motion of the horse and its warmth reduces spasticity and aids in relaxation of muscles (Miller & Alstan, 2004).

Table 2.1: Summary of Therapeutic horseback riding effects

Psychological effects of THR on children without disabilities: Improved	**Physical effects of THR on children without disabilities**	**Physical effects of THR on the elderly**
Improvement in:	Improvement in:	Improvement in:
Behavioural patterns	Balance	Balance
Self-esteem	Proprioception	Stability
Social skills	Flexibility	Posture
Confidence		Proprioception
Personal responsibility		

2.5 The physical effects of therapeutic horseback riding on the elderly

Horseback riding has been shown to improve balance not only of children, but for the elderly as well. A study examined the effects of mechanical horseback riding on balance of the elderly (Kang, 2015). Participants who were treated under the elderly welfare act and those hospitalised in a nursing hospital, with the mean age 70 years for experimental group and 71 for the control group, were recruited into the study. The control group was involved in single leg stand programme and the experimental group participated in mechanical horseback riding for 15 min, five times a week for a period of six weeks. Balance was tested for both group pre- and post-intervention using the Berg balance scale (BBS) and timed up and go (TUG). There were significant improvements ($p<0.05$) for the experimental group and no significant differences for the control group for both BBS and TUG. Therapeutic horseback riding improves muscle strength, vestibular and visual stimuli. Stability, balance of spine and postural adjustment is achieved through repeated stimuli of the horse's movement which recruits muscles around the pelvis, abdomen and waist to maintain posture, improving proprioception (Kang, 2015).

A limitation of the study by Kang (2015), however, is mechanical horseback riding, which is a machine with similar movements as the horse, was used instead of the actual horse. On the other hand a study that used a horse to test balance in the elderly involved nine participants with mean age 70.1 years. Participants were involved in THR once a week for a period of ten weeks, and a control group of six participants of the same age who were not involved in any balance training but continued with their daily living activities. Small but measureable improvements in balance were observed in both the control and experimental group, suggesting potential efficacy of a therapeutic riding intervention in older adults (Homnick et al., 2015).

Based on the available literature reviewed, THR elicits improvements, with no detrimental effects, which could be of benefit for children with disabilities.

2.6 Disability Overview

2.6.1 Autism

Autism is a neural developmental disorder occurring from 0-3 years of age and affects communication and social interaction with others (Brill, 2008). It is also characterised by restricted interests and repetitive behaviour (Gabriels et al., 2012). Eyal, Hart, Onculer, Oren, and Rossi (2010) state that in South Africa, the prevalence of autism is one in 86 children under the age of six years. Another study showed that 5-10 per 10 000 individuals were autistic (Bradshow, 2001).

Autism is categorised into the following five types, based on noticeable symptoms such as difficulty in coordination, degree of social interaction and the degree of poor communication skills(Willis, 2009):

- Classic autistic disorder (Kanner's syndrome) is characterised by delayed social interaction and communication, as well as repetitive behaviour.

- Asperger disorder is when children progressively learn how to socialise and communicate at school level, and can have above average intelligence. Due to underdevelopment of motor skills, there is difficulty with coordination.

- Pervasive developmental disorder-not otherwise specified (PDD-NOS), which is similar to the classic autistic disorder and can be differentiated by researchers and doctors.

- Rett's syndrome occurs almost exclusively in girls, but is very rare. This is known to worsen with time and is characterised by muscle atrophy, repetitive hand movements and decrease in head growth.

- Childhood disintegrative disorder (Heller's syndrome) involves normal growth of a child for the first few months, followed by regression and forgetting how to perform tasks. This usually occurs between the ages 3-4 years.

The classifications mentioned above are known as autism spectrum disorders.

2.6.2 Cerebral palsy

Cerebral palsy (CP) is a disorder of movement or posture acquired early in life due to abnormality in the brain (Blair & Watson, 2006). Classification is based on neurological signs and there are primarily three types of CP, being; (i) spastic, (ii) athetoid and (iii) ataxic CP (Cans,De la Cruz, & Mermet, 2008).

Classification of CP

Spastic CP

This is characterised by hypertonia which results from lesions to upper motor neurons. There is also increased tendon jerks and clonus, which is the involuntary muscular contractions and relaxations (Levitt, 2010). Spastic CP patients usually exhibit abnormal posture, with the head and trunk becoming floppy possibly due to the delayed development of the mechanisms of postural stabilisation and adjustment of head and trunk (Levitt, 2010). Some other associated impairments are epilepsy, sensory loss, poor respiration and below average intelligence (Levitt, 2010).

Athetoid CP (Dyskinetic, dystonic)

There is usually damage in pyrimidial tract and extrapyrymidial motor system. Movements are involuntary and muscles in the face and tongue may also be affected (Peacock, 2000).

The involuntary/unwanted movements interfere with all movements the child tries to make (Finnie, 2004). These involuntary actions are increased by excitement, fear and effort to make voluntary movements (Levitt, 2010). Abnormality involves leaning backwards with hip extension, lordosis and kyphosis with chin in chest (Levitt, 2010). There is also difficulty in holding onto objects due to involuntary movements. Other impairments include hearing loss and speech difficulties (Levitt, 2010).

Ataxic CP

The damage is in the cerebellum, which is responsible for balance and coordination and therefore there is usually disturbance in balance, poor stabilisation of the head, trunk, shoulder and pelvic girdle (Levitt, 2010). There is also decreased muscle tone and the patients suffer from muscle weakness. Patients are usually clumsy but can be intelligent (Levitt, 2010).

In all the three classifications, there can either be diplegia (two limbs affected), quadriplegia (all limbs affected), hemiplegia (limbs and body on one side affected). Classification can also be based on motor function and include level I to level V, of which level I involves functioning without any restrictions, except advanced motor skills. Level V involves severe motor restrictions (Levitt, 2010).

2.6.3 Down syndrome

Down syndrome or Down’s syndrome (DS) is a chromosomal disorder whereby there is a presence of a third copy of chromosome 21 (Desai & Fayetteville, 1997). This condition is characterised by slanted eyes, a flat and broad face, poor muscle tone and excessive joint laxity (Desai & Fayetteville, 1997). Down syndrome results in reduced cognitive ability and reduction in physical growth. Down syndrome cannot be cured, but can be managed and treated by preventing factors that may result in mortality. Management of DS includes assessment of heart disease and hearing loss, monitoring of thyroid function and coeliac disease, prevention of obesity and periodontal diseases and vigilance to arthritis, diabetes mellitus and leukaemia (Roizen & Patterson, 2003).

2.7 The effect of therapeutic horseback riding on children with disabilities

Therapeutic horseback riding has been shown to reduce the severity of autism (Van de Hout & Bragonje, 2010). The study involved a ten-week horse riding programme in 60 autistic children between two to 14 years old, assessing autism severity pre- and post- intervention using the childhood autism rating scale. There was significant reduction of the severity of autism, with also improvements in social functioning, communication skills and physical behaviour (Van de Hout & Bragonje, 2010).

Gabriels et al. (2012) evaluated the effect of ten 1-hour weekly lessons of THR in self-regulating behaviours, adaptive skills and motor skills in school age children and adolescents diagnosed with autistic or arsperger's disorder. The study included 42 participants between ages 6-16 years, of which 16 participated in a 10-week waitlist control condition before THR. Improvements were evident on measures of irritability, lethargy, stereotypic behaviour, hyperactivity and motor skills on participants who completed ten weeks THR.

A more recent study (Lanning,Matyastik-Baier,Ivey-Hatz,Krenek, & Tubbs, 2014) has also shown improvement in behaviour of children with autism spectrum disorder (ASD) who participated in a nine-week programme of equine assisted activities which included THR, compared to those who participated in a non-equine intervention. Similarly, a four-week THR intervention showed an improvement in social skills of children with ASD. Improvements were noted in affective understanding and perspective taking, initiating interactions and maintaining interactions (Ghorban,Sedigheh,Marzieh, & Yaghoob, 2013). Children (n=6) were involved in THR programme twice a week for four weeks, with each session being 45 minutes long.

A study conducted by Wuang, Wang, Huang, and Su (2010) also showed that occupational therapy that is followed by a 20 week simulated developmental horse riding programme was effective, with improved motor and sensory efficiency children. Similarly, results obtained by Bass, Duchowny, and Llabre (2009) showed that when comparing autistic children involved in THR and those who are not, THR resulted in less inattention and improved social motivation for horseback riding children. The THR included stretching activities while on the horse, riding skills and social communication skills while on a horse.

Ionatamishvili, Tsverava, Loriya, Sheshaberidze, and Rukhadze (2004) conducted a study comparing the effectiveness of horse riding therapy over the exercise therapy on children with cerebral palsy. Participants (n=50) in the test group, which were those receiving THR, and participants (n=50) in the control group, those receiving exercise therapy, a bobath method, were involved in the study. Bobath method is a neurodevelopmental treatment (NDT) that involves use of specialised handling techniques that improve the quality of muscle tone essential for effective movement (Barber, 2008). Use of everyday activities such as playing and dressing is applicable to promote practice (Barber, 2008). The findings were that both methods were effective, however, THR was more effective as the new motor skills were maximally close to normal, there was more reduced spastic disorder and THR ensured ultimate mobilisation of compensatory possibilities of a child's developing brain (Ionatamishvili et al., 2004).

The findings of a study by Borges, Werneck, Silva, Gandolfi, and Pratesi (2011) showed similar results to Ionatamishvili et al. (2004), comparing the bobath method and simulated horse riding therapy on 40 children with cerebral palsy, 20 for the test group and 20 for the control for 12 sessions. The results showed significant improvement in antero-posterior ($p<0.0001$) and medio-lateral ($p<0.0069$) directions for the test group, indicating improved postural control in the test group receiving THR compared to those who received conventional physical therapy.

Winchester, Kendall, Peters, Sears, and Winkley (2002) studied the effect of therapeutic horse riding on children who were developmentally delayed, which included down syndrome, autism, spina bifida and traumatic brain injury. The intervention was a seven-week programme of THR and there were improvements observed in gross motor function, which were maintained for seven weeks after the THR has ended.

Studies have shown THR to have several benefits, including physical, psychological, and social benefits. However, there is limited research with regards to physiological benefits of THR, which could be, but not limited to, the changes in heart rate variability of children during THR. This study focuses on THR effect on heart rate variability of children with disabilities including autism, cerebral palsy, Down syndrome and other intellectual impairments on children.

2.8 Heart rate variability

Heart rate variability (HRV) is becoming more recognised and more extensively applied to different fields of study ranging from assessment in healthy individuals, clinical conditions and in sports. Early studies reveal that HRV provides information for risk stratification and evaluation of autonomic tone after myocardial infarction (Lombardi & Mortara, 1998). Patients with cardiac failure have reduced HRV as a result of predominant sympathetic activity and reduced vagal activity of sinus node. The measure of time domain can also be correlated to the severity of the disease (Lombardi & Mortara, 1998). One study examined the association of reduced HRV with risk for cardiac events and revealed that all HRV measures except low frequency to high frequency (LF/HF) ratio were significantly associated with risks for cardiac events (Tsuji et al., 1996).

Abnormal HRV has correlated with increased mortality in patients with prior myocardial infarction (MI) and chronic heart failure. The study enrolled 1284 patients with a recent MI. Over a follow up of 21 months, HRV was an independent predictor of cardiac mortality (La Rovere et al., 2001). Short-term HRV has been reported to predict sudden cardiac death in chronic heart failure patients in another study (La Rovere et al., 2003).

Heart rate variability has been used in patients with diabetes mellitus. Heart rate variability was measured in eighteen males with average age 41 years and presenting with insulin-dependent diabetes mellitus (IDDM) for the duration longer than five years. Results showed that high frequency spectra might be useful in identifying early autonomic dysfunction in patients with IDDM, as results correlated significantly with another method of identifying autonomic dysfunction known as the Ewing battery, which was performed on the same 18 male participants for comparison (Takase et al., 2002).

Chessa et al. (2002) also assessed HRV in children with IDDM to predict for diabetic autonomic neuropathy (DAN). Heart rate variability was analysed in 50 asymptomatic children with IDDM and 30 healthy children with matched age and gender. Results showed alteration in autonomic function in asymptomatic children with IDDM. There was a reduction of root mean square of successive differences (RMSSD) , percentage of consecutive normal RR intervals (time between QRS complexes) differing more than 50 ms (pNN50), high frequency (HF), all of which are specific expression of vagal activity (Chessa et al., 2002). This confirmed that HRV can be used to investigate the development of pre-clinical DAN in children. This autonomic dysfunction was found in children who presented with diabetes for more than eight years. Heart rate variability analysis indicates an early impairments of parasympathetic activity with a likely predominant activity in sympathetic activity (Chessa et al., 2002).

Effect of age and gender on HRV

In healthy individuals, HRV assessment has been used to determine if there are any age and gender differences. A study by O’brien, O’hare, and Corrall (1986) reported a decline in heart rate variation with increasing age, which suggested that normal ranges for test of autonomic function should be related to the age of the individual. The difference in HRV between ages is due to changes that occur with increasing age such as increase in basal and stimulated plasma noradrenaline concentrations, altered adrenoreceptor function and diminished responsiveness to adrenergic agonist and antagonist.

Yukishita et al. (2010) also reported HRV to be reduced with age for both men and women. The study also showed that men have higher a HRV than women between the ages 20-30 years, and women presented with higher HRV parameters than men at the age 40 years and above. The significant reduction in overall autonomic function and parasympathetic activity was associated with the feeling of sudden reduction in strength in men, whereas the gradual reduction in women later in life may account for the increased longevity than men (Yukishita et al., 2010). Gender differences were also noted in a study by Saleem, Hussain, Majeed and Khan (2012), with HRV indices lower in females compared to males. The study involved 45 participants between the ages of 29-80 years of age with a mean age of 42 in Pakistan. The increased HRV parameters in females suggested sympathetic hyperactivity in females as compared to males (Saleem et al., 2012).

HRV in sports

Heart rate variability is useful in sports for programme prescription, maintaining fitness and improving performance. Heart rate variability parameters change during and after exercise and can therefore be used to analyse the stress the body experiences during exercise and to examine physiological recovery post-exercise (Makivic,Nikic, & Willis, 2013). Heart rate variability can help manage physical fatigue and exercise intensity and to individualise the exercise programme based on the HRV measurements of the individual. During exercise, the RR intervals become shorter and less varied, resulting from the increased sympathetic activity and parasympathetic withdrawal. Therefore, variation in the RR intervals can provide information regarding physiological stress and fatigue levels during and after training (Makivic et al., 2013). Daily exercise intensity can be prescribed to athletes based on the HRV of the athlete, lowering the intensity if the athlete's HRV decreases, which helps to maintain fitness (Pitchot et al., 2002).

Improvement and adjustments in an individual's abilities change with training over time; HRV analysis assists to prevent overtraining/undertraining as it reflects the major regulatory processes after exercise (Makivic et al., 2013). There is increased sympathetic activity or increased parasympathetic activity at rest in over trained state, depending on the type of overtraining. Increases in exercise volume increases sympathetic activity and increase in intensity results in increase in parasympathetic activity (Makivic et al., 2013). Regular exercise induces long term increase in HRV resulting from changes in the ANS. This is due to increased parasympathetic tone evidenced by increase in HF (Pitchot et al., 2002). The lack of an appropriate recovery period and intensive training periods can cause overtraining syndrome, which can in turn decrease performance. Therefore HRV indices can be used to monitor and prevent overtraining (Pitchot et al., 2002).

2.9 Heart rate variability associations with children with disabilities

Limited studies have assessed HRV in children with disabilities. Heart rate variability during sleep was found to be increased in children with multiple disabilities compared to healthy children between the ages 4-12 years (Bouquier,Amand, & Van Eecke, 2013). Increased HRV was associated with increased sympathetic activity in children with disabilities, due to a reduction in adaptive abilities of the children’s autonomic nervous system (Bouquier et al., 2013).

To the author’s knowledge, to date, a single study in the literature assessed the effects of THR on HRV of children with disabilities (Naidoo et al., 2014). The study examined the acute HRV responses to a THR session in children (n=5) with autism spectrum disorders. The findings were increased root mean squared successive differences (RMSSD) between inter-beat intervals post-THR and reduced low frequency to high frequency (LF/HF) ratio, which were both suggestive, although not conclusive, of increase in parasympathetic activity after THR. As such, the current study examined the effect of THR over a period of six sessions on HRV in children with various disabilities.

CHAPTER THREE - METHODOLOGY

3.1 Study design

The study used a nonrandomised pre-and post-tests quasi-experimental design to assess the effect of the therapeutic horseback riding (THR) intervention of six sessions on the heart rate variability (HRV) of children with disabilities. The number of sessions was selected for convenience, as participants were only attending THR during the school terms and not during school holidays. Therefore, six sessions were selected to ensure succession of THR. Quasi-experiments are studies that aim to evaluate interventions but that do not use randomisation. Similar to randomised trials, quasi-experiments aim to demonstrate causality between an intervention and an outcome (Harris et al., 2006). The purpose of the quasi-experimental designs is to fit the design to the real world settings while still trying to control as many of the threats to internal validity as possible (Thomas,Nelson, & Silverman, 2005). Internal validity is the extent to which the results of a study can be attributed to the intervention used in that study, which in this study is THR. The pre-test-post-test means that the measurements are taken before the intervention as well as after the intervention. The purpose of this design is to determine the amount of change produced by the intervention (Thomas et al., 2005). Pre-test-post-test was measured in this study. However, internal validity was not entirely accomplished as participants were undergoing other therapies in conjuction with THR. The dependent variable was the heart rate variability measure, whilst the independent variables were the children with disabilities.

3.2 Population and Sample

This study was conducted on children with disabilities participating in a THR programme at the Ridge Top Equine Centre, KwaZulu-Natal, South Africa. A convenient sample of 29 children with disabilities (18 boys and 11 girls) attending THR sessions was selected. The sample was selected due to the easy accessibility to the children in the THR programme by the researcher. Out of the 29 participants, twelve (9.58 ± 1.89 years) presented with autism spectrum disorder (41%), ten (7.7 ± 1.89 years) with cerebral palsy (34 %), three (9.33 ± 2.89) with pervasive developmental disorder (10%), one (7 years) with developmental learning disability (3%), one (6 years) with sensory problems (3%), one (7 years) with fanconi syndrome (3%), one (7 years) with blindness (3%) and one (11 years) with Down syndrome (3%). The diagnosis for participants was determined by their own physicians prior to the start of THR, and the file to this information was made available to the researcher.

Selection of participants was performed over a period of three months and the assessment was conducted from April to November 2015 for different groups of participants.

Participants adhered to the following inclusion and exclusion criteria:

3.2.1 Inclusion criteria

- Children between 5 and 18 years. The number of children undergoing THR was limited, therefore this age range was selected in an attempt to include the most participants possible so as to maximise the sample size.
- Presenting with a disability, as determined by the physician.
- Attending group THR sessions for longer than three months.

3.2.2 Exclusion criteria

- Children over the age of 18 years.
- Presenting with no disability.
- Attending individual THR sessions.
- Less than three months experience of THR sessions.

3.3 Testing procedures and protocol

Phase One

A letter to the owner of the riding school requesting permission was sent (Appendix Ia). Subsequent permission was granted to conduct the study (Appendix Ib). Information sheets and consent forms (Appendix II) and an occupational performance questionnaire (Appendix IV) were given to the parents of the participants to complete once ethical clearance from the University's Biomedical Research Ethics Committee was granted (Appendix III). Participation was voluntary and participants could withdraw from the study at any time without consequence. The participants' teachers were present during the study as the participants conducted their riding lesson as per normal.

Phase Two

Teachers were shown how to place the electrodes on the participants and were requested to familiarise the children during school hours. There were reports from teachers that familiarisation was performed at school. However, to ensure this, participants were familiarised with the placement of the electrodes on their chest (Figure 3.1) during THR sessions two weeks prior to the start of the THR intervention by the researcher.

Source: (Camntech, 2014)

Figure 3.1: Placement of the electrodes and actiheart on the chest

Phase Three

Testing was conducted at Ridge Top Equine Centre in Durban, KwaZulu-Natal, South Africa, after the familiarisation session at the center and from school, and once consent was granted by parents and assent granted by children. Testing was performed in the morning between 08:30 – 11:00 am as that was the scheduled time for riding lessons. Different groups were attending THR once a week on different days of the week, therefore testing was conducted Monday to Friday for different groups. However, each group was attending THR on the same day every week. Measurements were taken once a week for a period of six weeks. The Actiheart monitor was used to record data, attaching two electrodes on the chest and the Actiheart. The researcher clarified and answered questions related to the testing procedures.

3.4 Heart rate variability measurement

The Actiheart monitors (Figure 3.2) were used to measure the inter-beat intervals (IBIs) on participants using the short term HRV monitoring set-up on the Actiheart software. Two electro-cardiogram (ECG) electrodes were placed on the chest on V2 (fourth rib space on the left of the sternum) and V5 (on the 6th rib in line with the anterior axillary line) of the participant. The round bigger end of the Actiheart monitor was attached on the electrode at V2 and the smaller end attached at V5 for recording, as shown in Figure 3.1.

Source: (Salusa)

Figure 3.2: Actiheart monitor

The actiheart monitor was set up on a laptop with the actiheart software, where the participant's information including weight, height, age, gender was recorded. Actiheart was then attached to the chest and recording started. The data was transferred immediately after the session for each participant.

Measurements were recorded during three stages between 08h30 to 11h00. During the first stage, pre-THR measurements were recorded for five minutes with participants seated on chairs, five minutes before the start of THR. The second stage of measurements was recorded during the THR session for 20-25 minutes. Lastly, stage three, post-THR measurements were recorded for five minutes with participants seated on chairs, immediately after the end of THR session. All measurements including pre-, during and post-THR were performed in groups. Participants would generally arrive from the school to the riding centre and be seated around a table next to the arena. As per instruction from the riding instructor, participants had to wait for their riding turn. When finished, participants would again be seated on the chairs to wait for the group that would still be riding. Hence, this time period and setting was used for the measurements for pre- and post-THR, so as not to change the routine that the participants were already familiar with. The same device was used for each participant for pre-, during and post-THR for each session, but not necessarily the same device for the subsequent session. However, the devices were all identical with specific coding.

Heart rate variability has time and frequency domain components. Time domain includes mean R-R interval, which is the distance between successive heartbeats, expressing mainly the parasympathetic activity. The mean squared successive differences between R-R intervals (MSSD) is the estimate of the short term component of HRV and provides vagal index. An increase in this value also reflects increase in parasympathetic activity (Taskforce, 1996).

Total power (TP) is the variance of all the RR intervals, with frequency ranges approximately ≤0.4 Hz, measured in ms^2 (Taskforce, 1996). Component coefficient of variation (CCV) also represents the variation of HRV (expressed in %). Component coefficient of variation (CCV) high frequency (HF) and CCV low frequency (LF) reflect the parasympathetic and sympathetic activity, respectively (Kurosawa et al., 2007).

Frequency domain measures pertain to HRV at certain frequency ranges associated with specific physiological processes. Parameters evaluated are total power (TP) at high frequency (HF) and low frequency (LF). The TP at high frequency peak (0.15-0.4 HZ) corresponds to respiratory sinus arrhythmia and reflects the parasympathetic activity (Moodithaya & Avadhany, 2009) and the TP at LF peak (0.04-0.15 HZ) predominantly reflects sympathetic activity since it is influenced by blood pressure baroreceptor mediated regulation (Moodithaya & Avadhany, 2009). The LF/HF ratio is also used to assess the balance between sympathetic and parasympathetic activity. LF/HF ratio of one indicates the balance between the two systems. Increase in the ratio indicates an increase in sympathetic activity and decrease indicates a predominant increase in parasympathetic activity.

The variables of interest in this study were power at high frequency (HF), power at low frequency (LF), LF/HF ratio, inter-beat interval (RR), mean squared successive differences between R-R intervals (MSSD), and total power (TP). Component coefficient of variation (CCV) for HF and LF were also assessed.

3.5 Therapeutic horseback riding sessions

Participants were involved in group THR sessions in an outdoor arena conducted by a certified THR instructor. Each group consisted 4-6 riders per session. For each of the sessions, each participant had one volunteer leading the horse and two volunteers as side walkers to assist in THR activities and to ensure proper posture maintenance. The THR instructor stood in the centre of the arena and instructed the horse leaders, riders and side walker of the activities to perform during THR.

The sessions included riding, mounting and dismounting, trotting as well as performing activities such as throwing a ball, extending arms and reaching to touch the horse’s ears or tail during riding. Therapeutic horseback riding sessions were conducted by the same instructor for each group of participants, together with the same side walkers and leaders for each participant. Each participant had a THR session once a week, on the same day every week, and measurements were recorded once a week for six sessions. The same horse was assigned for each participant for all six THR sessions.

3.6 Occupational performance questionnaire

The Occupational Performance Questionnaire (OPQ) was utilised to collect pre-and post-THR programme data (Appendix IV). The questionnaire was adapted from the “Development of a questionnaire to determine change in the occupational performance of pre-schoolchildren with Autism Spectrum Disorders receiving Occupational Therapy – Sensory Integration” (Wallace, 2009). The OPQ was adapted by using similar questions to those asked in children before and after receiving occupational therapy, however using THR as an intervention in this study. The OPQ included information on sleeping patterns, toilet training, impact of the disability on social functions, impact on family members, social interaction, play-time and schooling. The questionnaire was administered to parents/guardians at the first session of THR and post-six weeks of THR. The objective of the questionnaire was to assess if the THR improved the quality of life of the children with disabilities.

3.7 Data analysis

3.7.1 Heart rate variability

The recorded data for pre-THR, during THR and post-THR session were transferred to the Actiheart software after each session and all data exported to the HRV analysis software at the end of the six sessions for all participants. R-R intervals (time between QRS complexes) were exported as a text file for time domain and spectral HRV analysis using the VarCor PF7 diagnostic device software (DIMEA Group, Olomouc, Czech Republic). The R-R intervals were examined, and all premature ventricular contractions, missing beats, and any artefacts were manually filtered. A set of 300 artefact-free subsequent R-R intervals was obtained. A spectral analysis of heart rate variability (SAHRV) was used to assess the autonomic nervous system (ANS) activity and was performed using the Fast Fourier Transformation. The spectral analysis (SA) incorporated a sliding 256 points Hanning window and a Coarse-Graining Spectral Analysis algorithm (Yamamoto & Hughson, 1991). The power spectra were quantified by integrating the area under the power spectral density curve. Two frequency bands were used: low frequency (LF) from 0.05 to 0.15 Hz and high frequency (HF) from 0.15 to 0.50 Hz. The normalised low and high frequency power (LFnu and HFnu, respectively) were calculated as follows: 100 % * LF/ (LF+HF) and 100 % * HF/ (LF+HF), respectively. Normalisation minimises the effect on the values of LF and HF components of the changes in total power (Taskforce, 1996). Repeated measures analysis of variance (ANOVA) was used and applied to each variable for pre-, riding and post- THR separately.

3.7.2 Occupational performance Questionnaire

The data were analysed using SPSS (version 21) with significance set at $p \leq 0.05$. Statistics and tests used were descriptive statistics including means and standard deviations, where applicable, with frequencies represented in tables or graphs. Binomial test was used to test whether the proportion falling in each of the two categories was equal. McNemar test was used to assess for significance of changes and used to test whether there are differences pre- to post- intervention, with binary measured variables. When the data were categorical (more than 2 categories), then the Marginal Homogeneity test was used. Chi-square (goodness-of-fit-test) was used on a categorical variable to test whether any of the response options were selected significantly more/less often that the others. Under the null hypothesis, it was assumed that all responses were equally selected.

3.8 Ethical considerations

The study was approved (BF074/14) by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, South Africa (Appendix III). Permission to conduct the study was granted by parents, participants and the owner of the riding school. Informed written consent and child assent were obtained prior to proceeding with the study. Participation in the study was voluntary and participants were informed that they could withdraw at any time without fear of victimisation or consequence. Anonymity of each participant was maintained by use of coding to protect the identity of participants and data was kept confidential for use by the researcher and supervisors only. Records of each participant will be kept at the Discipline of Biokinetics, Exercise and Leisure Sciences in a locked cabinet at the University of Kwazulu-Natal Westville Campus, South Africa, for a period of five years, after which all information will be destroyed. Computer data was secured by password-protected files.

CHAPTER FOUR- RESULTS

This chapter presents analysis of the results gathered in this study. The demographics of the sample are provided including gender, racial group, age, weight, height and the type of disability the participants presented with (Table 4.1). Measurements analysed were heart rate variability components, including time domain and frequency domain. Occupational performance of children with disabilities was also analysed based on the occupational performance questionnaire completed by parents and guardians.

4.1 Sample demographics

The demographics presented in Table 4.1 show that 18 of the participants were male (62%). and 11 were female (38%). Participants comprised of four racial groups, including White (31%), Black (28%), Coloured (24%) and Indian (17%). The mean age for all the participants was 8.69 (±2.22) years. Most of the participants involved in the study presented with autism spectrum disorder (41%), followed by cerebral palsy (34%), pervasive developmental disorder (10%), developmental learning disability (3%), sensory problems (3%), fanconi syndrome (3%), blindness (3%) and Down syndrome (3%). The mean weight and height of the participants were 30.30kg (±12.91), and 1.27m (±0.15), respectively.

Table 4.1: Sample demographics of participants (n=29)

Category	Component	n (%)
Gender	Male	18 (62)
	Female	11 (38)
Race	White	9 (31)
	Black	8 (28)
	Indian	5 (17)
	Coloured	7 (24)
Mean Age (years) (SD)	8.69 (±2.22)	
Mean Weight (Kg) (SD)	30.30 (±12.91)	
Mean Height (m) (SD)	1.27 (±0.15)	
Disability	Autism spectrum disorder	12 (41)
	Cerebral palsy	10 (34)
	Pervasive developmental disorder	3 (10)
	Developmental learning disability	1 (3)

	Sensory problems	1 (3)
	Fanconi syndrome	1 (3)
	Blindness	1 (3)
	Down syndrome	1 (3)

4.2 Heart rate variability (HRV)

Heart rate variability data comprised of results of 26 participants, as one participant was excluded in the study due to inability to complete the six sessions and data was missing for two participants. Repeated measures analysis of variance (ANOVA) was used and applied to each variable for pre-, riding and post- THR separately to determine significance for the results of 26 participants.

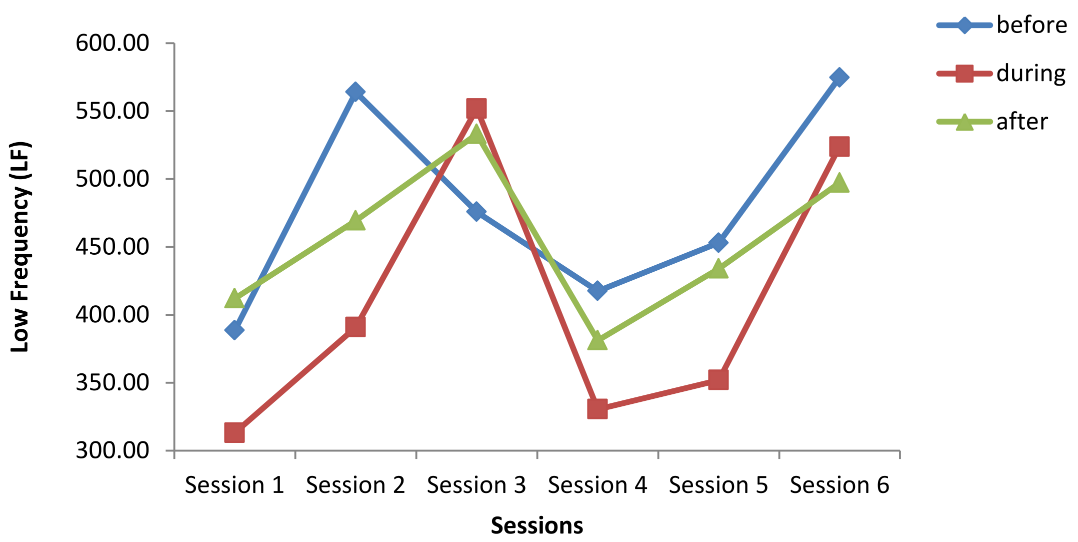

Figure 4.1: Power at low frequency before, during and after THR over six sessions

Figure 4.1 showed no significant differences in LF (sympathetic activity) from session one to session six for pre-, during and post-THR.

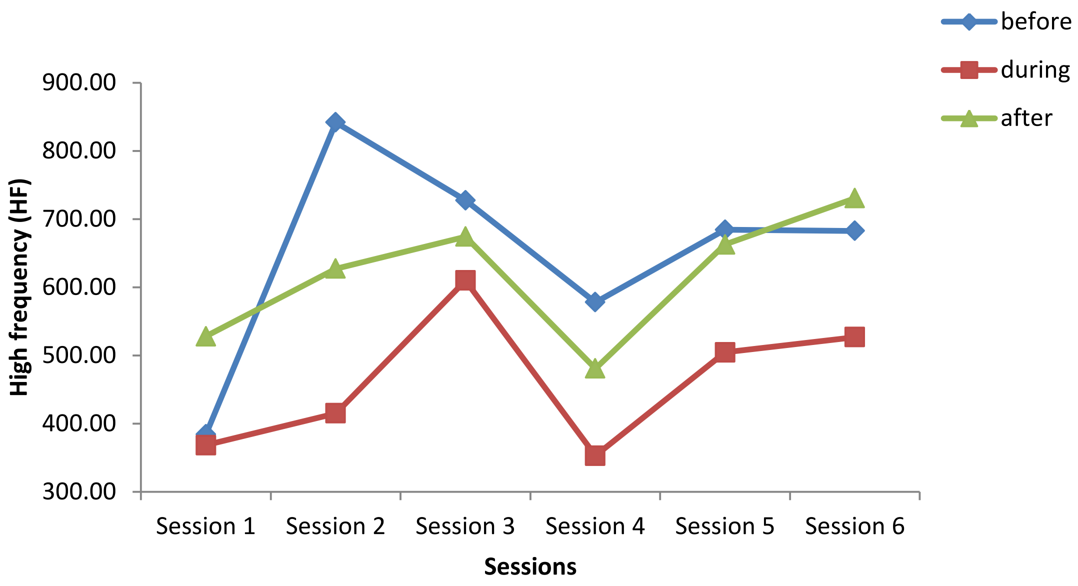

Figure 4.2: Power at high frequency before, during and after THR over six sessions

Figure 4.2 showed no significant differences in HF (parasympathetic activity) from session one to session six for pre-, during and post-THR.

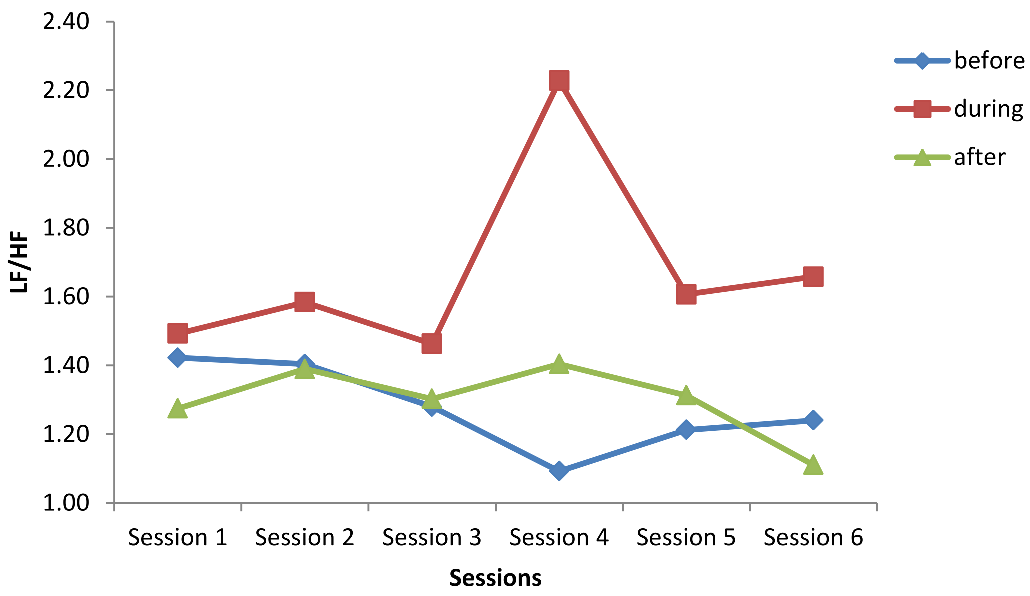

Figure 4.3: LF/HF before, during and after THR over six sessions

Figure 4.3 showed no significant differences in LF/HF from session one to session six for pre-, during and post-THR.

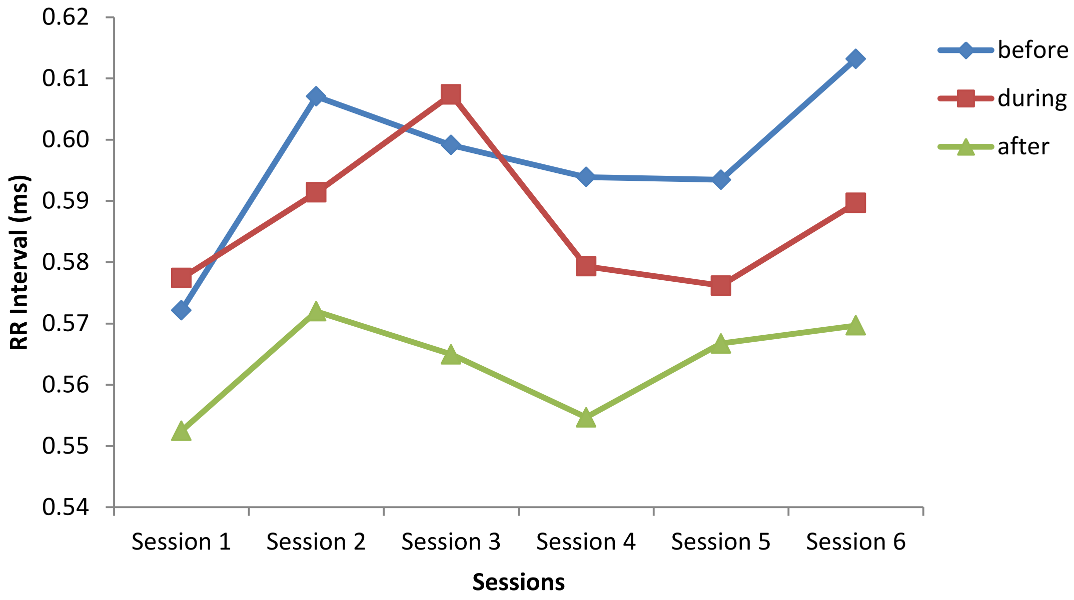

Figure 4.4: RR interval before, during and after THR over six sessions

The average RR for pre- THR scores were significantly lower at session one than at session two, (p=0.022), session three (p=0.044) and session six (p=0.011). The mean values for RR pre- THR were 0.57 (±0.06), 0.61 (±0.69), 0.60 (±0.56) and 0.61 (±0.69) for sessions one, two, three and six, respectively. Sessions four and five showed no significant differences pre- THR. There were no significant differences for during and post- THR over the six sessions.

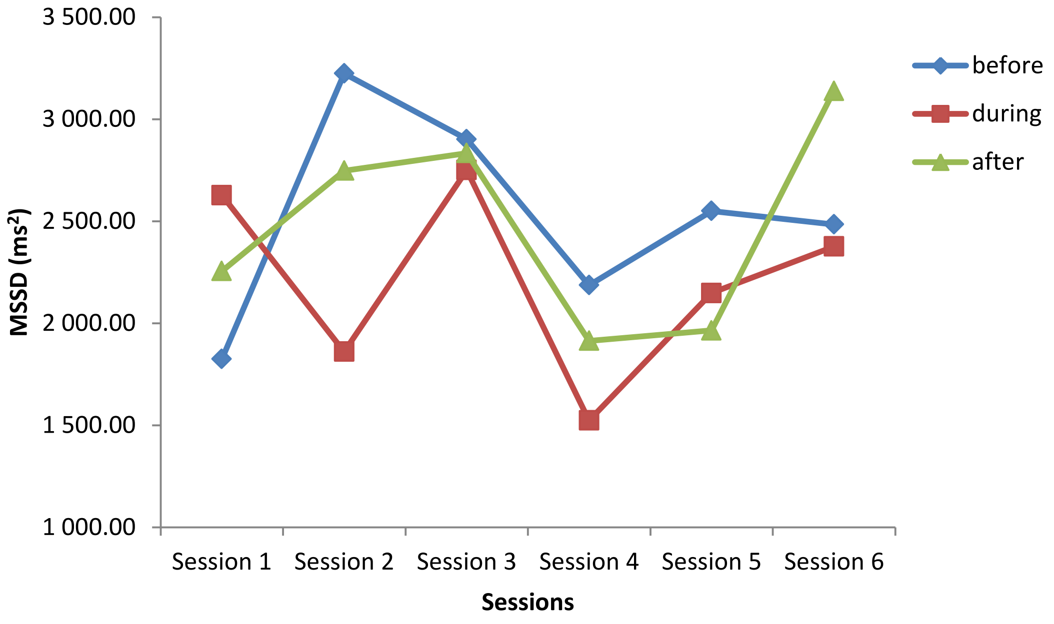

Figure 4.5: Mean squared successive differences (MSSD) between R-R intervals before, during and after THR over six sessions

There were no significant differences in MSSD from session one to session six for pre-, during and post-THR.

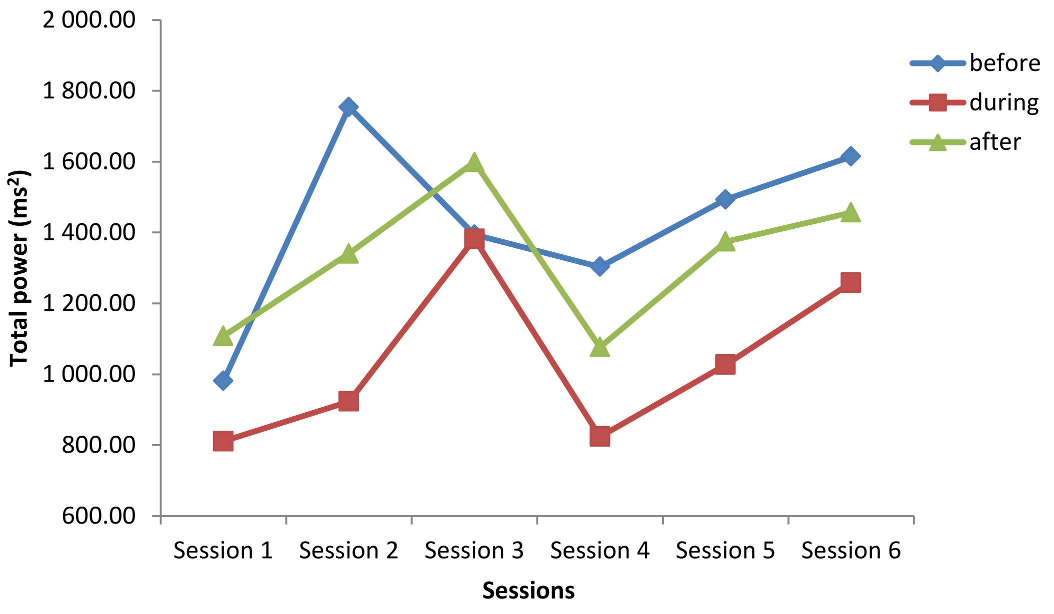

Figure 4.6: Total power before, during and after THR over six sessions

Total power during THR for session three is significantly higher than sessions one ($p=0.044$) and two ($p=0.024$), and session six significantly higher than session four ($p=0.045$). The mean values for total power during riding were 810.55 (±743.49), 923.19 (±772.13), 1381.88 (±1032.73), 824.01 (±625.26) and 1258.31 (±1024.02) for sessions one, two, three, four and six, respectively. There were no significant differences for pre- and post-THR over the six sessions.

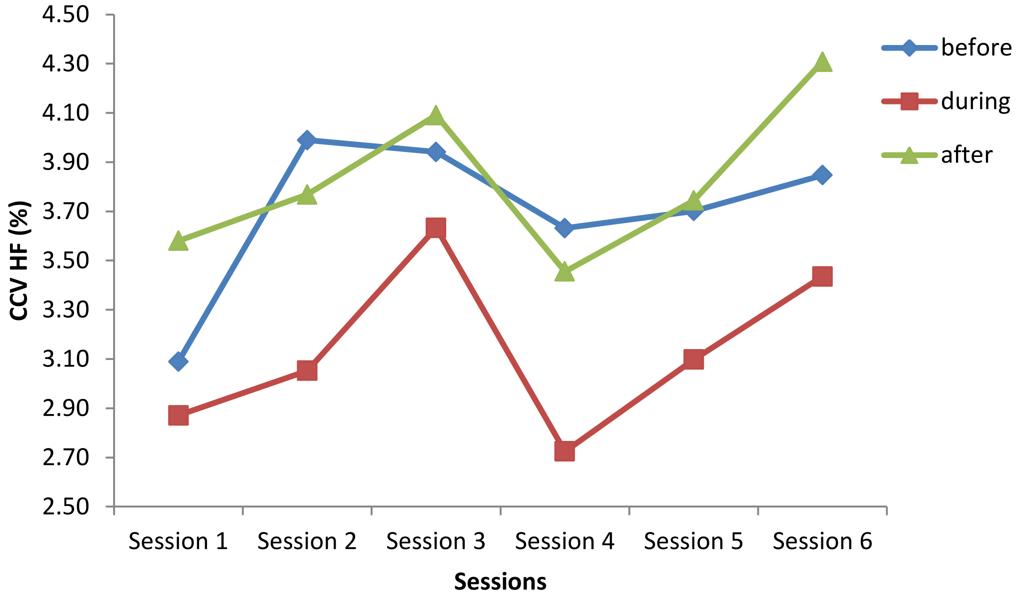

Figure 4.7: CCV for HF before, during and after THR over six sessions

There were no significant differences in CCV from session one to session six for pre-, during and post-THR.

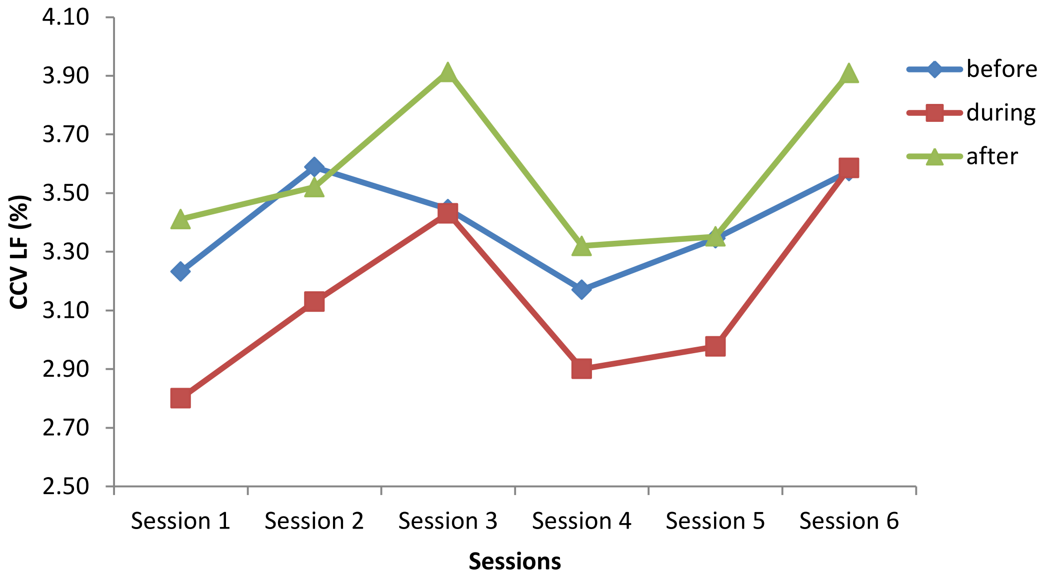

Figure 4.8: CCV for LF before, during and after THR over six sessions

Component coefficient of variation (CCV) for LF during THR is significantly higher in session three than session four (p=0.0006), and session six is significantly higher than sessions one (p=0.022), and four (p=0.011). The mean values for CCV for LF during THR were 2.80 (±1.29), 3.43 (±1.38), 2.90 (±1.12) and 3.59 (±1.44) for sessions one, three, four and six, respectively. There was no statistical significance in sessions two and five.

Further analysis was piloted to examine the differences between pre-, during and post- scores for variables LF/HF, RR interval and TP across the six sessions. LF/HF: Pre – post has a significant effect on these measures across the six sessions (p=0.050). It was found that the average score during riding is significantly larger than the average pre- score (p=0.018).

RR interval: Pre – post has a significant effect on these measures across the six sessions (p<0.0005). It was found that the average score post riding is significantly smaller than both the average pre- score (p<0.0005) and the average riding score (p<0.0005).

Total power: Pre – post has a significant effect on these measures across the six sessions (p=0.004). It was found that the average score during riding is significantly smaller than both the average pre- score (p<0.0005) and the average post- score (p=0.001).

4.3 Occupational performance questionnaire

Eighteen questionnaires were completed by parents/guardians (62% response rate) to assess any changes before a child started with the THR programme and after the THR programme. Parents/guardians were requested to complete the questionnaires voluntarily and were given twelve weeks to complete the questionnaire with a reminder each week. However, some did not return or complete te questionnaire, for no known reason. This section presents general information including the age the child started THR, the presenting disability and any other concurrent treatments received for the disability other than THR. The questionnaire evaluates the biological rhythms including toilet training and sleeping pattern, family adjustments, social and play skills and schooling, before and after involvement on the THR programme.

4.3.1 General information

The mean age at which the participants began THR was reported to be 6.44 (±2.41) years. Eight of the participants presented with autism spectrum disorders (ASD), with three specifying arsperger's syndrome classification of ASD. The remaining 11 participants presented with blindness, fanconi syndrome, cerebral palsy, Down syndrome, pervasive developmental disorder, developmental learning disability (unspecified), and sensory problems (unspecified).

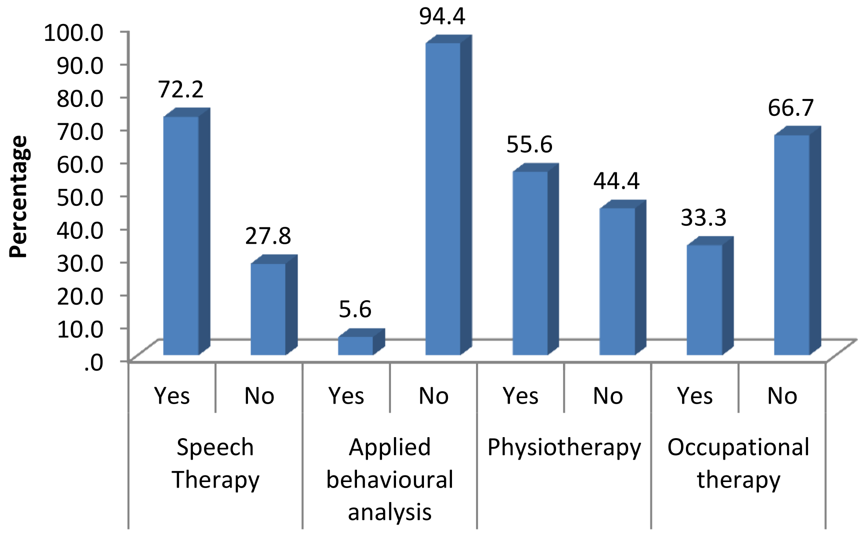

Figure 4.9: Concurrent treatment interventions received

A significant proportion of the sample (94.4%) did not undergo the applied behavioural analysis (ABA), with only 5.6 % attending ABA. A proportion of participants were undergoing speech therapy (72.2%), physiotherapy (55.6%) and occupational therapy (33.3%).

4.3.2 Biological rhythms

Sleeping

A significant proportion of the sample indicated that the child did not have a sleeping problem before THR ($p=0.031$), nor did their sleeping difficulties impact on the family harmony ($p=0.007$). After THR, a significant sample reported no sleeping problems for the child ($p=0.001$), no interrupted sleep in family members ($p<0.005$), and that sleeping difficulties did not impact the family harmony ($p<0.005$).

Toilet training

Significantly more than expected reported that the child was not in a day nappy/diaper before THR [χ^2 (2, n=18)=20.33, $p<0.005$], with no significance in the incidents of bedwetting. After THR, parents significantly reported that the child was not in a day nappy [χ^2 (1, n=18)=14.22, $p<0.005$], and significant proportion reporting no incidents of bedwetting ($p=0.031$).

Feeding

There was no significant reports about children demonstrating feeding issues before THR, with a significant proportion reporting no feeding issues after THR ($p<0.005$).

4.3.3 Family adjustments

Social functions and family gatherings

A significant proportion of respondents reported they were able to take their child to birthday parties ($p=0.008$), restaurants ($p=0.031$), and sustain relationships with other families ($p=0.008$) before THR. After THR, significant proportion reported they were able to take their child to birthday parties ($p=0.001$), restaurants ($p<0.005$), and sustain relationships with other families ($p<0.005$). There was no significant reports regarding taking the child to family gatherings before THR, with a significant proportion reporting they are taking the child to the family gatherings after THR ($p=0.001$).

Impact on individual family members

There were no significant reports about distress in family members because of the child, and no significant reports about the ability of the members to pursue their own interest before THR. A significant proportion reported that family members were still able to continue with their career before THR (p=0.035). After THR, a significant proportion reported the ability of family members to continue with their career (p=0.004) and pursue own interest (p=0.002).

Social interaction

A significant proportion indicated that the child did not exhibit aggressive behaviour before THR (p=0.002) and after THR (p<0.005).

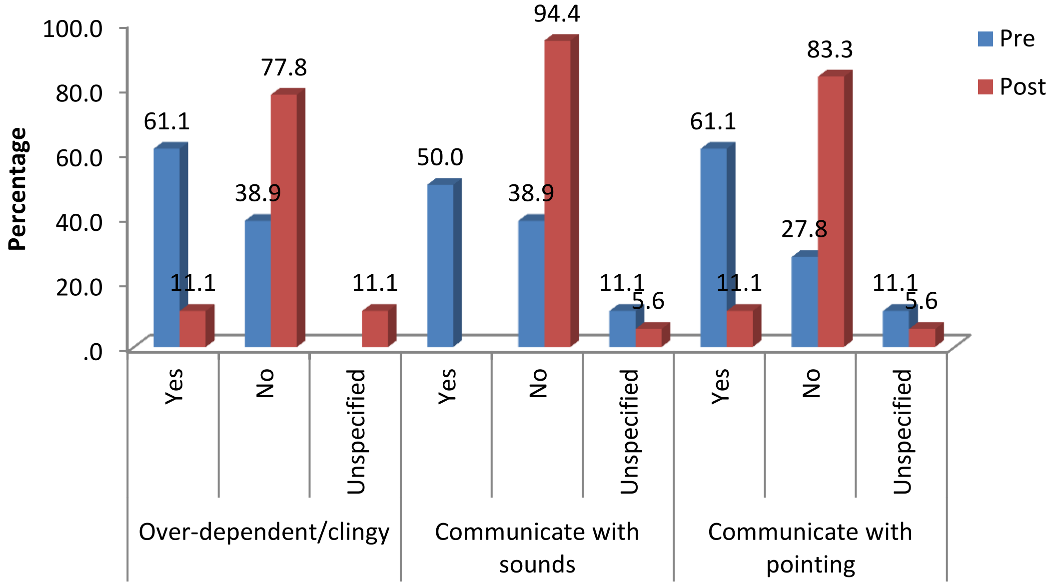

Figure 4.10: Percentage of social interaction pre- and post-THR

Significant differences were noted between pre- and post-THR responses. A significant proportion indicated that their child was not over-dependent on his/her parents or clingy after THR (p=0.002), and that their child was not communicating through sounds (p<0.005) and pointing (p=0.002) after THR.

4.3.4 Play skills/ peer interaction

Free time/ play time

A significant proportion of respondents indicated that the child was not destructive towards toys even before THR (p=0.008), was able to play by himself for more than 30 minutes (p=0.031), was able to play alongside another child (p=0.001) and able to play in familiar settings (p<0.005). A significant proportion indicated that the child was not able to make friends before THR (p=0.031), but able to make friends after THR (p<0.005). Children were not able to participate in structured group play before THR (p=0.002), but were able to after

THR (p<0.005). A significant proportion also indicated that children were able to play in unfamiliar settings after THR (p=0.002), which was not significant before THR.

4.3.5 Schooling

A significant proportion of parents/guardians indicated that their child was not home-schooled before THR (p<0.005) and after THR (p<0.005), not able to attend a regular school before THR (p=0.049) and after THR (p=0.013). A significant proportion attributed improvement in family adjustment (p=0.022) and play skills/peer interactions (p=0.003) to improvement in sensory regulations.

4.4 Summary

Heart rate variability measures indicated no significant changes in CCV HF, MSSD, LF/HF, HF and LF for pre-, during and post-THR. Changes were noted in TP during THR, average RR interval Pre- THR, and CCV LF during THR. Occupational performance indicated positive changes in family adjustments, social interaction and play skills. The following chapter will discuss the results in detail.

Table 4.2: Summary of reported improvements after therapeutic horseback riding

Biological rhythms	**Family adjustments**	**Play skills or interaction**
Improved sleeping for child (p=0.001)	Able to attend birthday parties (p=0.001)	Improved ability to make friends (p<0.005)
No interrupted sleep in family members (p<0.005)	Able to go to restaurants (p<0.005)	Improved ability to play in structured group (p<0.005)
No incidence of bedwetting (p=0.031)	Able to sustain relationships with family members (p<0.005)	Able to play in unfamiliar setting (p=0.002)
No feeding issues (P<0.005)	Parents able to continue with career (p=0.001)	
	Parents able to pursue their own interests (p=0.002)	
	Improved independency and not clingy (p=0.002)	

CHAPTER FIVE – DISCUSSION AND PERSPECTIVE

5.1 Introduction

The aim of this study was to examine the effects of therapeutic horseback riding (THR) on the heart rate variability (HRV) of children with disabilities, via heart rate variability (HRV) testing pre- and post-intervention. The objective was to examine if THR intervention improves HRV of children, hence improving the parasympathetic activity that is associated with a calm and relaxed state. This study also sought to determine the effects of THR on the occupational performance of children with disabilities pre- and post-intervention. Based on the results presented in the previous chapter, this chapter will discuss how these study objectives were achieved.

5.2 Heart rate variability

Heart rate variability refers to the variance in the heartbeat intervals between the consecutive heartbeats (Schroeder et al., 2004). There are no normative values for HRV, but the measurements are individualised. The higher the variability, the healthier the individual is regarded to be, and the lower the variability, the more risks associated such as heart disease and increased stress levels (Michels et al., 2013). Since the heart rate is regulated by the sympathetic nervous system and parasympathetic nervous system (Bilchick & Berger, 2006), the autonomic nervous system (ANS) can be examined through measuring the time and frequency domains of HRV, to determine if there is increased sympathetic neural activity associated with increased stress levels, or increase in parasympathetic neural activity associated with relaxation state. Both time and frequency domains are presented in this study.

With regard to the time domains, the RR interval reflects the overall HRV, and was lower at session one, particularly for pre-THR, which showed significant increases in RR interval scores in sessions two, three and six, respectively (figure 4.4). This may be suggestive of improvements in overall HRV over the six sessions pre-THR. Post-THR, the RR-interval was significantly lower than pre-THR and during THR RR-interval. Decreased RR-interval score post-THR can be associated with increased mental stress (Orsila et al., 2008). This could have been due to restlessness in children during the measurement due to the nature of the disabilities. Children might also have been restless as a result of the excitement and impatience to feed the horses and go back to school, as that is their normal routine. Therefore, as per protocol, to sit down for five minutes could increase the mental stress. There was no change in MSSD (figure4.5), indicating no improvement in parasympathetic activity after the six sessions.

With regard to the frequency domains, there were no significant changes in LF from sessions one to six for pre-, during and post- THR, and no significant differences between pre-, during and post-THR LF scores (figure 4.1). This indicates no increase or decrease in sympathetic activity over the six sessions. High frequency also showed no significant changes over the six sessions and no differences between pre-, during and post-THR scores (figure 4.2), indicating no improvement in parasympathetic activity over the six sessions of THR. LF/HF ratio revealed no significant changes over the six sessions of THR (figure 4.3). Although not significant, observing the trend of LF/HF over the six sessions of THR, there was a slight reduction in LF/HF over the sessions, predominantly post-THR. Thus, increasing the number of THR sessions could possibly result in a significant reduction in the ratio over the number of sessions, possibly resulting in an improvement in parasympathetic activity associated with the relaxation state.

Component coefficient of variance (CCV) for HF showed no significant change over the six sessions (figure 4.7). An increase in CCV HF would have indicated an increase in parasympathetic activity and increase in CCV LF indicates increase in sympathetic activity (Kurosawa et al., 2007). Component coefficient of variance (CCV) for LF showed a significant increase from session three to session four, and session six was also significantly higher than session one and four, during THR (figure 4.8). This increased sympathetic activity can be related to the exercises performed during THR. There was no significant change in CCV LF for pre- and post-THR over the six sessions.

There were no significant changes in total power (TP) over the six THR sessions for pre- and post-THR (figure 4.6). Significance was observed in TP during THR, where session three was significantly greater than sessions one and two, and session six greater than session four. Increased TP at these points could be associated with increased vagal (parasympathetic) activation, as per study by Taskforce (1996). A marked reduction of TP is associated with sympathetic activation, an increase in TP is associated with vagal activation (Taskforce, 1996).

Studies have shown a positive effect of THR on children with disabilities, including improved stereotypic behaviour, hyperactivity (Gabriels et al., 2012), motor skills (Gabriels et al., 2012; Ionatamishvili et al., 2004), improved attention and social motivation (Bass et al., 2009). The findings of this study show that there is a change in HRV after a period of six THR sessions for children with disabilities. However, there was no consistency between time and frequency domains, therefore no conclusive findings can be reported.

Most studies conducted on THR involved intervention of 10-12 weeks to foster significant changes. However, the effect of THR on Down syndrome, spina bifida and autism for a seven week THR intervention had shown significant improvements in gross motor function (Winchester et al., 2002). The current study was conducted for a period of six sessions with THR performed only once a week by participants. The number of the sessions might have not been adequate to bring about significant findings on HRV.

5.3 Occupational performance

The occupational performance questionnaire (OPQ) adapted from Wallace (2009) measured different variables to assess if THR intervention has a positive effect on occupational performance of children with disabilities, thus improving quality of life. Variables included biological rhythms (sleeping, toilet training, feeding), family adjustments (social functions and gatherings, impact on family members, social interaction), play skills and schooling. These variables were evaluated by parents/guardians staying with participating children, through a completion of the OPQ for before and after THR intervention.

There were no problems with biological rhythms including sleeping, toilet training and feeding problems before the THR intervention. There was a significant change in family adjustment, with reports indicating that parents were able to take the child to family gatherings after THR. However, parents were still able to take their child to birthday parties and restaurants even before THR intervention. The ability for parents to take the child to family gatherings can be attributed to improved independency. Social interaction reports indicated that the child was not over-dependent or clingy on parents after THR. This could be linked with the interactions the children had during THR sessions, the sense of achievement gained through riding and therefore increasing the level of self-confidence.

Communication through sounds and pointing significantly dropped after THR. The overall social interaction improved after THR. These findings are in agreement with the study by Stickney (2010) who found improvements in social interaction and communication, increased physicality and modification of inappropriate behaviour following a THR intervention in children with ASD. Similarly, Bass et al. (2009) showed improvements in social motivation, less distractibility, less inattention after a 12-week THR intervention in children with ASD.

However, another study assessed quality of life of children with cerebral palsy before and after a 10-week THR intervention. The study examined variables such physical well-being, psychological well-being, mood and emotions, parents relations to home life, schooling, and the THR intervention showed no significant improvement in gross motor function, health and quality of life of children with cerebral palsy (Davis et al., 2009).

There was an improvement in play skills of children, with the ability to make friends after THR compared to before THR, ability to participate in structured group play and to play in unfamiliar settings after THR. This could be attributed to activities performed during THR, interaction with other children, riding instructors and with the horses. There was no change in the schooling measures after THR intervention, which is in agreement with the study by Davis et al. (2009).

Improvement is evident in selected aspects of occupational performance for children, including social interaction, play skills and family adjustments. However, it should be acknowledged that THR was not the only intervention during the period of data collection, as 72% of the sample was also undergoing speech therapy, 55.6% receiving physiotherapy, 33.3% receiving occupational therapy and 5.6% receiving applied behavioural analysis. It cannot be concluded that THR alone brought the change in occupational performance, but the improvements could be attributed to a combination of all these methods of treatment including THR.

5.4 Conclusion

Therapeutic horseback riding of six sessions shows changes in HRV in children with disabilities. However, inconsistency in the results leads to inconclusive findings as to whether sympathetic activity or parasympathetic activity is predominant. For instance, time domain showed an increase in HRV for pre-THR measured by the RR interval indicating improved vagal activation, whereas frequency domain showed increased sympathetic activity based on CCV LF during THR, and increased parasympathetic activation when assessing TP during THR. However, the quality of life of children was improved in selected aspects. The increase in the RR interval reflects the overall HRV. As the RR interval pre-THR was increased over the six sessions, the hypothesis that THR over the period of six sessions would increase the overall HRV of children with disabilities can therefore be accepted.

5.4.1 Limitations of the study

There was no control group in the study, although the experimental group acted as their own control comparing pre- and post-THR effect. The number of THR sessions in this study was shorter compared to the THR sessions received from other studies. The study involved children with several disabilities, which could have an effect on the reliability and validity. The questionnaires completed were only for eighteen out of the 29 participants therefore the results of occupational performance obtained cannot be generalised for all participants.

5.4.2 Future research work, approach and recommendations

Further research involving an increased number of THR sessions is required to improve the reliability and validity of the study as studies reviewed involved more than six sessions. Heart rate variability in children with disabilities should include an experimental group and children with no disabilities as a control group with both groups involved in THR. HRV in children with disabilities receiving THR (experimental) and those who are not receiving THR (control) would provide more information on HRV changes due to THR. The study could be conducted using children with a single type of disability instead of different disabilities. Subgroup analysis of the disabilities could also be conducted. More interaction with parents/guardians with education on benefits of research could be conducted to improve the response rate on the questionnaires. This could be achieved through presentations and daily reminders.

CHAPTER SIX - CONCLUSION

6.1 Conclusion

Studies have shown a positive effect of THR intervention in children with disabilities including Autism spectrum disorders, cerebral palsy, Down syndrome, spina bifida and developmental delay. There is lack of literature pertaining to THR and its effects on the HRV of children with disabilities. This study assessed such effects. The increase in the RR interval reflects the overall HRV. As the RR interval pre-THR was increased over the six sessions, the hypothesis that THR over the period of six sessions would increase the overall HRV of children with disabilities can therefore be accepted. The findings from this study showed that THR intervention of six sessions elicited a change in HRV of children with disabilities. However, the changes obtained were not adequate to make conclusive measures as to whether sympathetic or parasympathetic activity is predominantly increased after the six sessions. Positively, the THR intervention has been shown to contribute to the improved social interaction, independency, family adjustments and play skills of children with disabilities, hence improving quality of life. Due to the lack of literature on the effects of THR on the HRV of children with disabilities, this study provides a basis for further research to be conducted to obtain more information on THR as a tool to improve the parasympathetic activity of children with disabilities.

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APPENDICES

Appendix Ia: Letter to the owner of Ridge Top Equine Centre

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

18 February 2013

Dear Tracey Cummings

RE: **EFFECTS OF THERAPEUTIC HORSE RIDING ON THE HEART RATE VARIABILITY IN CHILDREN WITH DISABILITIES**

I am currently a masters' Biokinetics students at the University of KwaZulu-Natal. As part of my masters curriculum, I am required to complete a research project. I am aware that you conduct riding lessons with multiple-disability children.

This letter serves to request permission to conduct the above-mentioned study. We would like to set up a meeting with you to discuss the details of the study.

I look forward to a favourable response.

Thanking you

Zingisa Nqwena

University of KwaZulu Natal

Mobile: 0739765901

Dr Rowena Naidoo

(Supervisor)

Mobile: 0837772813

SOUTH AFRICAN RIDING FOR THE DISABLED ASSOCIATION
DURBAN BRANCH
Email: durban@sarda.co.za • P.O. Box 1748, Hillcrest, 3650

Appendix Ib: Permission from the riding school

20th February 2014

Dear Zingisa Nqwena

RE: The effects of therapeutic horse riding on the heart rate variability of children with disabilities

This letter serves to confirm that we have received your request to conduct your study in our premises, with our horses, testing the heart rate variability of children during their normal riding sessions.

We are pleased to inform you that it is our pleasure to give you consent on this. You can proceed with the study as soon as you get ethical clearance from the ethics committee. The testing should however only be performed only to those children whose parents have signed and returned your consent forms and should be conducted with their regular SARDA Durban instructor and volunteers in attendance.

Should you require additional information please contact us on durban@sarda.co.za and we will be happy to assist.

Kind regards

Fiona Muhl
Chairperson SARDA Durban Branch

Tracey Cumming
Senior Instructor/program co-ordinator

Appendix II: Information Sheet, Consent to Parents and assent to children

RE: EFFECTS OF THERAPEUTIC HORSE RIDING ON HEART RATE VARIABILITY IN CHILDREN WITH DISABILITIES

Date: 06 February 2014

Dear parent / guardian

My name is Zingisa Zine Nqwena currently a masters Biokinetics students at the University of KwaZulu-Natal, reachable on the following contact details: 0739765901, email zi4.nqwesh@yahoo.com.

Your child is being invited to consider participating in a study that involves research, where testing involving heart rate monitoring will be conducted during their normal therapeutic horse riding lessons. The aim and purpose of this research is to determine whether the horse riding has an effect on selected activities such as play skills, sleep patterns and social interaction of your child. The objective of the study is to examine if the therapeutic horse riding promotes the activity of the parasympathetic nervous system, putting children in a more calm and relaxed state. The study is expected to enrol 50 participants in total who undergo the horse riding lessons at South African riding for the disabled (SARDA) at Ridgetop Equestrian Centre, Durban.

The testing will involve the following procedures: Two electrodes will be fitted on the chest area and the non-invasive actiheart monitor attached to the electrodes for data collection. The recordings will be taken five minutes before their riding lesson off the horse, recording during their 15-20 minute riding lesson and after the lesson for a period of five minutes, off the horse. The total duration required for the testing per week is 25-30 minutes for each session. The duration of your child's participation if they choose to enrol and remain in the study is expected to be approximately five-months, with measurements taken once a week for that period. Parents/guardians will also be required to complete an Occupational Performance questionnaire (OPQ) to compare any changes in the quality of life of children before a child started the therapeutic horseback riding (THR) and after, to assess any improvements that might be due to the THR. As the parent, you have an option to leave blank any questions you feel are not applicable or are unsure of.

The project is designed to non-invasively read the heart rates of your children with a heart rate monitor and there are no known risks that may harm your child in any way by the heart rate monitor. While horse riding is a physically demanding potentially dangerous activity, due care will be taken to ensure the safety of your child at all times. This will be done by ensuring the sessions are conducted as they currently are, by having qualified instructors and trained volunteers working alongside your child on well trained horses. In case of injuries that might occur, e.g. due to falling, there is a first aid kit available and the instructors have valid First-aid certificates and emergency medical contact numbers are on display at the premises.

The study could be of benefit for you and your child, as the results will show if horse riding is therapeutic and is relaxing for your child through assessing the heart rate. The study could also provide the basis for future studies to build upon as it should provide some indication as to the change in stress levels of children. This could have a great significance for the future of treatment of children with disabilities.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (BF074/14).

In the event of any problems or concerns/questions you may contact the researcher at UKZN on 0739765901 or the UKZN Biomedical Research Ethics Committee, contact details as follows:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: BREC@ukzn.ac.za

Participation is entirely voluntary and participants may withdraw at any point without any disadvantage or penalty. Notifications should be made to the researcher should you wish for your child to withdraw.

There will be no costs incurred by participants as a result of participation in the study and no incentives or reimbursements for participation in the study.

Your child will be allocated a number and alphabetical code to ensure that confidentiality and anonymity is maintained throughout the study.

Results of this project may be published but any data included will in no way be linked to your child. The data collected will be securely stored in such a way that only the researchers will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as in accordance with the University's research policy. Raw data on which the results of the project depend will be retained in a secure storage place for five years, after which will be destroyed by incineration.

All children must have written permission from parents or caregivers before they can participate in the study. If interested, please sign the form consenting for your child to participate in this study. Feedback concerning their heart rate variability and the overall study results will be provided to parents and the riding instructor/s.

Thanking you

Zingisa Nqwena	Dr Rowena Naidoo
University of KwaZulu Natal	(Supervisor)
Mobile: 0739765901	Mobile: 0837772813

Parent consent form for participation

EFFECTS OF THERAPEUTIC HORSE RIDING ON HEART RATE VARIABILITY IN DISABLED CHILDREN

I……………………………………………………………(name of parent/guardian) have been informed about the study entitled Effect of Therapeutic Horse Riding on Heart Rate Variability of Children with Disabilities by Zingisa Zine Nqwena.

I understand the purpose and procedures of the study.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my child's participation in this study is entirely voluntary and that I may withdraw at any time without affecting any treatment or care that I would usually be entitled to.

I have been informed that I am free to leave blank any questions that I feel are not applicable or unsure of, when answering the questionnaire.

I have been informed that there is no compensation or medical treatment if injury occurs to me as a result of study-related procedures.

I have been informed that the results of the project may be published but my anonymity will be preserved.

I have been informed that a copy of the signed consent form will be given to me should I give permission for my child to participate in the study.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at UKZN Westville campus, Department of Sport Science on 0312607669 or mobile on 0739765901.

If I have any questions or concerns about my child's rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: BREC@ukzn.ac.za

________________________ ________________________

Signature of Parent/guardian **Date**

Child assent to participate

I ……………………………………………………..(name of child) give permission to be part of the study. I understand what the researcher wants to figure out and aware of the test that will be done on me, which include monitoring my heart rate during my normal riding lessons. I understand that I have a choice to be part of the study and I can stop participating anytime I want during the study with no disadvantage.

________________________ ___________________

Signature of child **Date**

Appendix III: Ethical Clearance

Appendix IV: Occupational performance questionnaire

Adapted from: Wallace (2009).

Questionnaire

Kindly complete this questionnaire to the best of your ability, particularly noting changes that have been observed since your child started Therapeutic horseback riding (THR).

PART 1. GENERAL INFORMATION

Question number	Response			
1. Has your child ever had THR?	YES		NO	
2. Age when child started THR?	YEARS		MONTHS	
3. Current age of Child	YEARS		MONTHS	
4. Duration of THR in months?	YEARS		MONTHS	
5. Indicate the frequency of THR per week with an X	30 min	45 min	60 min	More
6. Indicate your child's diagnosis with an X if known	Autistic disorder		Asperger's syndrome	Other disability? specify
7. Is your child currently on any prescribed medication?	YES		NO	
8. If yes, specify which medication? Or other medication that is not prescribed				
9. Did he/she have concurrent interventions?	Speech Therapy		Physiotherapy	
	Applied behaviour analysis		Other? specify	
10. How old was your child when he/she slept through the night?	Years		Months	
11. How old was your child when	Years		Months	

he/she was toilet trained in the day?		
12. How old was your child when he/she no longer had to wear a nappy at night?	Years	Months
13. At what age did your child stop having tantrums?	Years	Months

OCCUPATIONAL PERFORMANCE AREAS- BEFORE THERAPEUTIC HORSEBACK RIDING

BIOLOGICAL RHYTHMS											
1	**SLEEPING**										
1.1	Did your child have a sleeping problem before he/she had THR?	YES		NO		Comments					
1.2	How many number times per night did he/she wake?	Almost never		1-2		3-4		5-6		more	
1.3	What did it take to get him/her back to sleep?	Rocking		Humming		Singing		Feeding		Holding	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1.4	As a results, did other family members have a regular incidents of interrupted sleep?	Yes		No		specify					
1.5	Did your child's sleeping difficulty impact on family harmony?	Yes		No		Specify					
2	**TOILET TRAINING**										
2.1	Was your child in a day nappy when he/she started THR?	Yes		NO		OCCASIONALLY specify					
2.2	Was your child still in a nappy at night when	Yes		No		N/A					

	he/she started THR?					
2.3	Were there incidents of bedwetting?	Yes	No	N/A		
2.3.1	How often did accidents occur?	Never	Infrequently	Once a week	Once a month	More
3	**Feeding**					
3.1	Were there feeding issues when your child started THR?	Yes	No	Comments		
3.1.1	Was the variety of food tastes limited?	Yes	No	Specify		
3.1.2	Was the variety of food textures limited?	Yes	No	Specify		
3.1.3	Did this cause disruption in family routine?	Yes	No	Specify		
3.2	Were there difficulties with chewing?	Yes	No	Specify		
3.2.1	Were there difficulties with sucking?	Yes	No	Specify		
3.2.2	Were there difficulties with swallowing?	Yes	No	Specify		
3.2.3	Did your child get used to gag?	Yes	No	Specify		
3.3	Was your child's limited attention span an issue at meal times?	Yes	No	Specify		
3.3.1	Did this limit the quantity of solid food ingested?	Yes	No	Specify		
3.3.2	For how long could your child sit at meals?	1-2 minutes	3-5 minutes	6-10 minutes	Longer	
3.3.3	Did this cause parents frustration/distress?	Yes	No	Comments		
3.3.4	Did it impact on family harmony	Yes	No	Comments		

<table>
<tr><td></td><td>at meal times?</td><td colspan="2"></td><td colspan="2"></td><td colspan="6"></td></tr>
<tr><td colspan="12">FAMILY ADJUSTMENTS</td></tr>
<tr><td>4</td><td colspan="11">SOCIAL FUNCTIONS AND FAMILY GATHERINGS</td></tr>
<tr><td>4.1</td><td>Were you able to take your child to family gatherings?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.2</td><td>Were you able to take your child to birthday parties?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.3</td><td>Were you able to take your child to eat at restaurants?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.4</td><td>Were his/her siblings able to have friends to play?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.5</td><td>Was the family able to sustain relationships with other families during the period prior to starting THR?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5</td><td colspan="11">IMPACT ON INDIVIDUAL FAMILY MEMBERS</td></tr>
<tr><td>5.1</td><td>Did having a child with a disability result in distress in any of the family members?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.1</td><td>Mother?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.2</td><td>Father?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.3</td><td>Siblings?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td rowspan="2">5.2</td><td rowspan="2">Record direct consequences for any family member with an X</td><td colspan="2">Delegation of care?</td><td colspan="2">Withdrwal of one parent?</td><td colspan="2">Depression</td><td colspan="2">Parental separation/divorce</td><td colspan="2">Other</td></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>5.3</td><td>Were you able to continue with your career before your child started THR?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
</table>

5.4	Were you able to pursue your own interests prior your child starting THR?	Yes		NO		Comments				
6	**SOCIAL INTERACTION**									
6.1	Did your child exhibit aggressive behaviour prior to starting THR?	Yes		No		Comments				
6.1.1	Directed towards himself?	Yes		No		Comments				
6.1.2	Directed at others?	yes		No		Comments				
6.1.3	Detail using an X	Bitting?		Pinching?		Hitting?		Other?		
		Yes	No	Yes	No	Yes	No	Yes	No	
6.2	Did your child exhibit tantrums?	Yes		No		Comments				
6.2.1	Did this cause distress to other family members?	Yes		No		Comments				
6.3	Did your child use self-stimulatory behaviour (stimming) to deal with sensory overload?	Yes		No		Comments				
6.3.1	Did "stimming" behaviour in public cause distress to other members of the family?	Yes		No		Comments				
6.3.2	Record with a X	Hand flapping?		Rocking?		Masturbation?		Head banging?		Teeth grinding
		Yes	No	Yes	No	Yes	No	Yes	No	Yes No
		Smelling, sniffing?		Breath holding,		Bitting?		Visual fixing?		Jumping?

				humming?				Spinning objects?			
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
6.4	Did your child struggle to cope with transition between activities?	Yes		No		Comments					
6.4.1	Was this distressing?	Yes		No		Comments					
6.5	Prior to starting THR was your child over-dependent on his/her parents or clingy?	Yes		No		Comments					
6.5.1	Was this distressing?	Yes		No		Comments					
6.6	Prior to starting THR was yelling and screaming by other family members a common occurrence?	Yes		No		Comments					
6.6.1	Was this distressing?	Yes		No		Comments					
6.7	Was your child able to communicate his/her needs prior to starting THR?	Yes				Comments					
6.7.1	Record with X	Talking		Signing		Sounds		Pointing		Crying/screaming	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
PLAY SKILLS / PEER INTERACTION											
7	**FREE TIME/ PLAY BTIME**										
7.1	Was your child destructive towards toys prior to starting THR?	Yes		No		Comments					

7.2	Was your child able to play by him/herself prior to starting THR? (Exclude watching TV)	Yes	No	Comments		
7.2.1	For how long?	1-2 min	2-5 min	5-10 min	10-30 min	More?
7.3	Could your child play alongside another child prior to starting THR?	Yes	No	Comments		
7.4	Was your child able to make friends prior to starting THR?	Yes	No	Comments		
7.5	Was your child able to participate in structured group play prior to starting THR?	Yes	No	Comments		
7.6	Was your child able to play in familiar settings prior to starting THR?	Yes	No	Comments		
7.7	Was your child able to play in unfamiliar settings prior to starting THR?	Yes	No	Comments		
8	**SCHOOLING**					
8.1	Was your child home schooled prior to starting THR?		Was your child at a pre-school for children with special needs prior to starting THR?		Was your child able to attend a regular pre-school prior to starting THR?	
	Yes	No	Yes	No	Yes	No

OCCUPATIONAL PERFORMANCE AREAS- POST THERAPEUTIC HORSEBACK RIDING

<table>
<tr><th colspan="12">BIOLOGICAL RHYTHMS</th></tr>
<tr><td>1</td><td colspan="11">SLEEPING</td></tr>
<tr><td>1.1</td><td>Does your child still have a sleeping problem?</td><td colspan="2">YES</td><td colspan="2">NO</td><td colspan="6">N/A</td></tr>
<tr><td>1.2</td><td>How many number times per night does she now he/she wake?</td><td colspan="2">Almost never</td><td colspan="2">1-2</td><td colspan="2">3-4</td><td colspan="2">5-6</td><td colspan="2">more</td></tr>
<tr><td rowspan="2">1.3</td><td rowspan="2">What does it take to get him/her back to sleep?</td><td colspan="2">Rocking</td><td colspan="2">Humming</td><td colspan="2">Singing</td><td colspan="2">Feeding</td><td colspan="2">Holding</td></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>1.4</td><td>Do other family members have interrupted sleep?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">specify</td></tr>
<tr><td>1.5</td><td>Does your child’s sleeping difficulty impact on family harmony?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Specify</td></tr>
<tr><td>2</td><td colspan="11">TOILET TRAINING</td></tr>
<tr><td>2.1</td><td>Is your child still in a nappy in the day?</td><td colspan="2">Yes</td><td colspan="2">NO</td><td colspan="6">OCCASIONALLY
specify</td></tr>
<tr><td>2.2</td><td>Is your child still in a nappy at night?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">N/A</td></tr>
<tr><td>2.3</td><td>Are there still incidents of bedwetting?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">N/A</td></tr>
<tr><td>2.3.1</td><td>How often do these accidents occur?</td><td colspan="2">Never</td><td colspan="2">Infrequently</td><td colspan="2">Once a week</td><td colspan="2">Once a month</td><td colspan="2">More</td></tr>
<tr><td>3</td><td colspan="11">Feeding</td></tr>
<tr><td>3.1</td><td>Does your child still have feeding issues?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
</table>

3.1.1	Is the variety of food tastes he/she tolerates still limited?	Yes	No	Specify	
3.1.2	Is the the variety of food textures still limited?	Yes	No	Specify	
3.1.3	Is there still a disruption in family routine as a result of atypical eating pattern?	Yes	No	N/A	
3.2	Does your child still struggle to chew a variety of foods?	Yes	No	Specify	
3.2.1	Does your child still struggle to suck through a straw?	Yes	No	Specify	
3.2.2	Does your child still struggle to swallow a variety of foods?	Yes	No	Specify	
3.2.3	Does your child still gag?	Yes	No	N/A	
3.3	Does your child struggle to sit still at meal times due to limited attention span?	Yes	No	Specify	
3.3.1	Does this still affect the quantity of solid food ingested?	Yes	No	Specify	
3.3.2	For how long can your child sit at meals?	1-2 minutes	3-5 minutes	6-10 minutes	Longer
3.3.3	Is your child's attention span at meal times a source of parents' frustration/distress?	Yes	No	Comments	
3.3.4	Does it still impacts on family harmony	Yes	No	Comments	

<table>
<tr><td></td><td>at meal times?</td><td colspan="2"></td><td colspan="2"></td><td colspan="6"></td></tr>
<tr><td colspan="12">FAMILY ADJUSTMENTS</td></tr>
<tr><td>4</td><td colspan="11">SOCIAL FUNCTIONS AND FAMILY GATHERINGS</td></tr>
<tr><td>4.1</td><td>Are you now able to take your child to family gatherings?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.2</td><td>Are you now able to take your child to birthday parties?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.3</td><td>Are you now able to take your child to eat at restaurants?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.4</td><td>Are his/her siblings able to have friends to play?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>4.5</td><td>is the family more able to sustain relationships with other families?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5</td><td colspan="11">IMPACT ON INDIVIDUAL FAMILY MEMBERS</td></tr>
<tr><td>5.1</td><td>Is there a noticeable improvement in the distress level of the family members since your child had THR?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.1</td><td>Mother?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.2</td><td>Father?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td>5.1.3</td><td>Siblings?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
<tr><td rowspan="2">5.2</td><td rowspan="2">Has there been an improvement in the ability of family members to cope with stress? If yes, please detail</td><td colspan="2">Sharing of care?</td><td colspan="2">More involvementof both parents?</td><td colspan="2">Resolution of depression</td><td colspan="2">Parental separation/divorce</td><td colspan="2">Other</td></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>5.3</td><td>Have you been able to resume</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="6">Comments</td></tr>
</table>

<table>
<tr><td></td><td>your career in any way since your child had THR?</td><td colspan="2"></td><td colspan="2"></td><td colspan="4"></td></tr>
<tr><td>5.4</td><td>Have you been more able to pursue your own interests since your child had THR?</td><td colspan="2">Yes</td><td colspan="2">NO</td><td colspan="4">Comments</td></tr>
<tr><td>6</td><td colspan="9">SOCIAL INTERACTION</td></tr>
<tr><td>6.1</td><td>Does your child still exhibit aggressive behaviour?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">N/A</td></tr>
<tr><td>6.1.1</td><td>Is it still directed towards himself?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">N/A</td></tr>
<tr><td>6.1.2</td><td>Directed at others?</td><td colspan="2">yes</td><td colspan="2">No</td><td colspan="4">N/A</td></tr>
<tr><td rowspan="2">6.1.3</td><td rowspan="2">Is there still…</td><td colspan="2">Bitting?</td><td colspan="2">Pinching?</td><td colspan="2">Hitting?</td><td colspan="2">Other?</td></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>6.2</td><td>Does your child still exhibit tantrums?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">Occasionally</td></tr>
<tr><td>6.2.1</td><td>Are tantrums source of distress to other family members?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">Comments</td></tr>
<tr><td>6.3</td><td>Does your child still use self-stimulatory behaviour (stimming) to deal with sensory overload?</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">Comments</td></tr>
<tr><td>6.3.1</td><td>Does “stimming” behaviour still limit your ability to take your child out</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="4">Comments</td></tr>
</table>

	to public places?										
6.3.2	Does your child still use the following to cope with anxiety or sensory overload?	Hand flapping?		Rocking?		Masturbation?		Head banging?		Teeth grinding	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
		Smelling, sniffing?		Breath holding, humming?		Bitting, mouthing? Subvocalising?		Visual fixing? Spinning objects?		Jumping?	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
6.4	Does your child still struggle to cope with transition between activities?	Yes		No		N/A					
6.4.1	Does this still cause distress to family members?	Yes		No		Comments					
6.5	Is your child over-dependent on his/her parents or clingy?	Yes		No		Comments					
6.5.1	Does this still make separations challenging?	Yes		No		Comments					
6.6	Is there still yelling and screaming by other family members since your child started THR?	Yes		No		N/A					
6.6.1	Does this still cause distress to family members?	Yes		No		Comments					
6.7	Is your child able to communicate his/her needs since starting THR?	Yes				Comments					

6.7.1	How does he/she communicate now? Record with X	Talking		Signing		Sounds		Pointing		Crying/screaming	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
PLAY SKILLS / PEER INTERACTION											
7	**FREE TIME/ PLAY BTIME**										
7.1	Is your child still destructive towards toys?	Yes		No		Comments					
7.2	Does your child still struggle to play by him/herself? (Exclude watching TV)	Yes		No		N/A					
7.2.1	For how long?	1-2 min		2-5 min		5-10 min		10-30 min		More?	
7.3	Can your child play alongside another child?	Yes		No		Comments					
7.4	Is your child able to make friends?	Yes		No		Comments					
7.5	Is your child now able to participate in structured group play?	Yes		No		Comments					
7.6	Is your child now able to play in familiar settings?	Yes		No		Comments					
7.7	Is your child now able to play in unfamiliar settings?	Yes		No		Comments					
8	**SCHOOLING**										
8.1	Is your child home schooled?			Is your child at a pre-school for children with special needs?				Is your child able to attend a regular pre-school?			
	Yes	No		Yes		No		Yes		No	
9	**SUMMARY**										

9.1	Do you attribute improvements in biological functions i.e, sleeping, toilet training, feeding to improved sensory regulation?	Yes	No	To what do you attribute improvements?
9.2	Do you attribute improvements in family adjustment to improvements in sensory regulations?	Yes	No	To what do you attribute improvements?
9.3	Do you attribute improvements in play skill and peer interaction to improvements in sensory regulations?	Yes	No	To what do you attribute improvements?

Comments

Please comment on any other effects THR has had in terms of the effect on your and the family's life

____
____
____
____
____
____
____

Thank you for your time and effort in completing this lengthy questionnaire

Appendix V **Manuscript submitted to the African Journal of Disability**
(In printed version)