A RANDOMISED CONTROLLED TRIAL TO ASSESS THE EFFECT OF A BALANCE AND STABILITY TRAINING INTERVENTION ON BALANCE AND FUNCTIONAL INDEPENDENCE IN STROKE PATIENTS

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Author's Declaration

I declare that 'A Randomised Controlled Trial to Assess the Effect of a Balance and Stability Training Intervention on Balance and Functional Independence in Stroke Patients' is my own work and that all sources that were used or quoted have been indicated by means of complete references. This study has not been submitted in any form to another university or institution.

Pooveshni Naidoo

Dedication

- To God, for his guidance in making this project possible
- To Professor T Puckree, for her wisdom and support
- To my parents and brother, for their strength and encouragement

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ABSTRACT

Introduction: Balance dysfunction, particularly in standing, is a devastating sequel to stroke since the ability to balance is one of the most critical motor control factors in daily life. Physiotherapists use a variety of balance and stability techniques as a part of treatment programmes to improve functional independence in patients following a stroke. However more scientific evidence for the effectiveness of these techniques or programs is required. *Purpose:* The purpose of this study was to quantify the effect of a balance and stability training program on stability, balance and functional independence in stroke patients. *Method:* The aims of this study were achieved using a randomised controlled trial. A questionnaire allowed the collection of demographic data from fifty participants who had suffered the first stroke, regardless of gender or race. The Postural Assessment Scale for Stroke patients (PASS), Berg Balance Scale (BBS), Barthel Index (BI) and questionnaire were administered to all fifty participants on the first and last weeks of a twelve week physiotherapy program. For ten weeks twenty five randomly assigned participants in each of the control and experimental groups underwent either normal physiotherapy or stability and balance intervention exercise program respectively. *Data Analysis:* The raw data was normalized by calculating percent changes for each item for each participant and the pooled data subjected to Wilcoxon signed ranks testing, paired samples signed tests and Pearson's correlations. *Results:* PASS, BBS and BI scores increased significantly from pre-test to post-tests in both groups, with greater changes noted in the experimental group, showing improvements in stability, balance and function. In addition a strong and significant correlation between stability scores and balance scores suggested that stability is important to improve balance. Similarly a strong and significant correlation between stability and balance scores with function scores confirms the value of stability and balance in improving function. It was further noted that in addition to a certain degree of spontaneous recovery, traditional physiotherapy programs also result in improvement in stability, balance and function but not to the same extent as with the program of treatment which emphasizes stability and balance exercises. *Conclusion*: A significant improvement in the stability, balance and function in stroke patients was achieved with the balance and stability intervention program. Conventional physiotherapy methods also improved stability, balance and function, but to a lesser extent than the balance and stability training.

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Chapter 1

1.1 Introduction

Stroke was found to be the fourth most common cause of death, accounting for 6% of all deaths in South Africa in 2000 (Connor et al., 1995-2005). According to the World Health Organisation (2010), 15 million people throughout the world suffer a stroke each year. Stroke is the leading cause of disability in the United States (Rittman et al., 2004). Every year, more than 700 000 Americans suffer strokes, two-thirds of whom are left with neurologic deficits (Michael et al., 2005). The incidence of stroke has increased exponentially in recent years. This suggests that the number of survivors with significant residual physical, cognitive and psychological disabilities will continue to increase as the population grows older and more survivors tend to live with the aftermath of stroke (Rittman et al., 2004).

These alarming statistics clearly indicate that stroke is common, with profound consequences. The onset of stroke is a triggering event with the initial concern being survival. Once survival is assured, the survivor is faced with the dilemma of managing the loss of independence that accompanies disruption in the functioning body (Rittman et al., 2004).

Balance dysfunction, particularly in standing, is a devastating sequel to stroke since the ability to balance the body mass over the base of support under different task and environmental conditions is one of the most critical motor control factors in daily life. Training balance and movement may be the most significant component of rehabilitation (Carr et al., 2003). Balance retraining following any neuromuscular insult recruits a range of developmental strategies. These include normalization of tone, proprioceptive and sensation re-education, normal co-contraction of muscles to improve stability, normal length –tension relationships and functional re-education, both dynamic and static. From a physiological standpoint mobility is dependent on stability and stability determines the ability to balance oneself in functional positions. Functional activities can only take place once static and dynamic balance in a functional position is assured (Carr et al., 2003). Almost twenty years ago, Sandin et al (1990) concluded that improved balance in sitting contributed to improved functional ability as the group of patients whose balance improved in sitting had increased Barthel Index (BI) scores.

Physiotherapists use a variety of balance and stability techniques like position changes, weightbearing, gait re-education and balance re-training as a part of treatment programs to improve functional independence in patients following a stroke (Carr et al., 2003). While anecdotal evidence and a few scientific reports (Macko et al., 2008, Sandin et al., 1990, Harley et al., 2006) address the effectiveness of specific rehabilitation programmes on functional retraining following stroke, none have addressed the specific impact of stability and balance training.

In 2008, Macko et al hypothesized that physical activity improves mobility, function and quality of life in chronic hemiparesis. A structured physical activity programme consisting of gait and balance exercises were implemented and subjects were assessed using the Berg Balance Scale, Short Physical Performance Battery Scores and Barthel Index scales. Results showed that in that population, adaptive physical activity improved gait and balance. The shortcoming, however, was that the design was uncontrolled and comparisons regarding the effects of the activity programme were limited.

A thorough search of available physiotherapy and rehabilitation literature revealed no evidence for the effect of balance and stability training on functional independence in South African stroke patients. This information would be valuable to show if the presentation and rehabilitation of local stroke survivors differ from their foreign counterparts. There also was found to be a lack of comparative data using the controlled design in strokes, hence the need for a randomised controlled trial to assess the effect of a balance and stability training intervention on balance and functional independence in stroke patients.

1.2 Purpose

The purpose of this study was to quantify the effect of a balance and stability training programme on stability, balance and functional independence in stroke patients. In addition, information in the form of actual feelings and opinions about barriers to functionality was explored by the use of a questionnaire. These responses were not analysed to present as results but assisted in the understanding of the quantitative data.

1.3 Significance

This study has provided scientific evidence for the use of a specific balance and stability intervention programme to improve stability, balance and function in stroke patients. The importance of improving stability and its effect on balance and function have been highlighted. Physiotherapists and other members of the rehabilitative team will be able to provide effective programmes of exercise to patients, thereby potentially freeing personnel who can then manage more patients in the time available. Any additional evidence on physiotherapy practice will strengthen the profession within the healthcare sector. In a patient population where the rigor of scientific studies can be plagued by a variety of factors which threaten the internal and external validity of the design, this study supports the need for further studies for the development and testing of a variety of programmes aimed to rehabilitate the neurologically affected patient in an environment where scarcity of health care professionals is a reality. The burden of improving service delivery by the Department of Health despite restrictions of time, equipment and health care professional will be relieved as a result of evidence based care.

1.4 Outline of Specific Chapters

Chapter 1 consists of the introduction, purpose and significance. The introduction highlights the need for the undertaking of this research by showing a lack of data on stability, balance and functional independence in stroke patients in South Africa. The purpose shows the aims of the researcher in using a randomised controlled intervention trial to assess the variables stated above whilst the significance explains how the different stakeholders involved in the management of the stroke patient will benefit from this project.

Chapter 2 shows a detailed review of associated literature surrounding the topic. Various aspects were covered including morbidity and mortality rates, impairments found following stroke, assessment tools used to assess stability, balance and function and factors affecting recovery like age and social factors. Recent methods of therapy that were being used by therapists like body weight support and the force platform system were also explored. Based on literature, operational definitions and the hypotheses that were utilised in the thesis were formulated.

Chapter 3 consists of the methods that were used to perform this study under the headings of design, instrumentation, procedures and data analysis. It explains that a randomised controlled trial would be done by measuring dependant variables with validated tools and a questionnaire for qualitative aspects on demographics and lifestyle. The Postural Assessment Scale for Stroke patients (PASS), Berg Balance Scale (BBS), Barthel Index (BI) and questionnaire were administered to all 50 participants on the first and last weeks of a twelve week data collection period, whilst for the remaining ten weeks 25 randomly assigned participants each to a control and experimental group underwent either a normal physiotherapy session or stability and balance intervention exercise programme respectively. Raw data from each of the variables was normalized by calculating percent changes for each item for each participant and thereafter subjected to repeated measures of Wilcoxon signed ranks testing, paired samples signed tests and Pearson's correlations. Tables and graphs were used for the illustration of the results to compare control and experimental groups.

Chapter 4 shows the results of the study. Information collected from control and experimental groups on demographics, history of attack, co-morbidities and assistive devices were analysed. Raw data showed that PASS, BBS and BI scores increased significantly from pre-test to post-tests in both groups, but greater changes were observed in the experimental group, which showed improvements in stability, balance and function. In addition a strong and significant correlation between stability scores and balance scores suggested that stability is important to improve balance. Similarly a strong and significant correlation between stability and balance scores with function scores confirmed the value of stability and balance in improving function. It was further noted that in addition to a certain degree of spontaneous recovery, traditional physiotherapy programs also resulted in the improvement in stability, balance and function but not to the same extent as with the programme of treatment which emphasized stability and balance exercises.

Chapter 5 comprises the discussion. The individuals that made up the control and experimental groups for this study complied with the findings of Shah et al (1989) and Bagg et al (2002), as 88% and 64% of the above mentioned groups were between 50 and 74 years old. Gender differences did not affect the outcome of this study as there was no significant discrepancy in the results of both quantitative and qualitative components in both control and experimental groups. Although gender differences were noted for the incidences of stroke in many of the articles reviewed (Falcone et al., 2007; Rost et al., 2008; Wade et al., 1992), none of them reported correlations of gender with function. In addition to being predisposed to secondary complications, stroke patients often also have predisposing illnesses that have been identified as modifiable risk factors for stroke. These included hypertension, diabetes mellitus, cardiac disease and hyperlipidaemia (Biggs et al., 2008). Only 20% of all the participants indicated that they suffered no medical conditions, with the majority of the remaining 80% of participants in both groups reporting more than one chronic condition.

Results have shown significant improvements in pre-test and post-test values, mean values and percentage changes of the PASS, BBS and BI in both groups, with greater changes noted in the experimental group. This indicated that there were increases in stability, balance and function respectively suggesting that the balance and stability intervention programme in the experimental group was successful. Figures 5 to 7 showed the relationships or trends between the three variables in this study. Strong correlations in the variables were also seen in the Pearson’s correlation coefficient. From the literature reviewed, the three variables of stability, balance and function had not been tested in one study cohort, however in three studies; stability, balance and function were tested separately. In a review done by de Oliveira et al (2008), the researchers concluded that stability and postural control was related to balance when involved in movement strategies. This was also found in this study population where a directly proportional relationship between stability and balance was seen. Macko et al (2008) stated that function and quality of life improved in their participants deduced from increased BBS and BI scores. A different study found a strong positive correlation between BI scores and sitting balance in stroke patients (Sandin et al., 1990).

Chapter 6 consists of the conclusion, recommendations and limitations. The data allowed the researcher to conclude that the program of balance and stability exercises significantly improved stability, balance and function in stroke patients. In this study population, significant relationships between stability, balance and function were made. Conventional physiotherapy methods also improved stability, balance and function, but to a lesser extent than the balance and stability training.

This project indicated that there are vast areas in neurological rehabilitation that are lacking scientific evidence. Information on statistics in South Africa, common practices for physiotherapists and current data on co-morbidities, side affected, side dominance and stroke presentation are needed. It was recommended that future studies be done on relationships between stability, balance and function in stroke patients with larger samples being considered to allow for more comparative analysis. Other areas, including rehabilitation centres should also be considered. Different functional and balance tests could be used to assess their feasibility in the clinical setting. More detailed questionnaires, capturing additional insight into the subject’s lives and well being should be considered.

The three week public servant strike did result in problems with data collection; however the proposed twelve week schedule was fulfilled. Limitations to this study included the small sample size used and time constraints. A greater result could have been obtained if a greater sample size was used. The sample size could have also resulted in only trends and not significant relationships being noted between BI and PASS and BI and BBS. Essential information like the causes of the cerebrovascular accidents (haemorrhagic or ischaemic) lacked in participant’s files.

Chapter 2

Literature Review

2.1 Introduction

A Cerebrovascular Accident (CVA) or stroke is one of the leading causes of death and a major cause of disability globally (American Stroke Association, 2009). The acute injury to the brain in a stroke results from the interruption of blood flow to an area of the brain. Depending on the duration of time that the brain is deprived of the blood flow, the damage may be completely or partly reversible. The crucial factor is rapid diagnosis and appropriate treatment (Hall, 2009).

The clinical presentation following a stroke varies from person to person. The common problems include weakness or paralysis of one side of the body, difficulty with walking or standing, loss of balance, difficulty with speech, difficulty performing everyday tasks, confusion and personality changes (Hall, 2009).

Rehabilitation is a critical part of recovery restoring some or all functional independence in many stroke survivors. Rehabilitation and empowerment helps the patient to return to independent living. Treatment often consists of skills to aid in self-care, mobility, communication and techniques to counteract cognitive and social deficits (American Stroke Association, 2009).

Please note: Although some of the references featured in this review are not recent, they have provided valuable information to the understanding of this topic.

2.2 Prevalence of stroke

According to the World Health Organisation, 15 million people suffer a stroke worldwide each year (WHO, 2010). Approximately 700 000 strokes occur annually in the United States (Forrester et al., 2008). Europe averages about 650 000 stroke reported cases every year (Internet Stroke Centre, 2007).

The South African Stroke Prevention Initiative published the first stroke prevalence study from South Africa. The study was conducted in Limpopo in 2001, with a population of 70 000. The prevalence was 300 per 100 000. Higher figures (348 per 100 000) were found in females compared to males (246 per 100 000) (Connor et al., 1995-2005).

2.3 Anatomical Location of the Lesion on the Brain

Most strokes are caused by arteriosclerotic disturbances that occur in one or more of the major feeder arteries to the brain. For many people who develop strokes, high blood pressure (due to a blood clot, constriction of a vessel or any other cause) results in one or many of the blood vessels rupturing. A haemorrhage then occurs, compressing the local brain tissue and subsequent clotting of the blood leads to increased vessel blockage (Guyton et al., 2004) and impairment.

The neurological effects of the stroke are determined by the area of the brain that has been affected. One of the most common regions to be damaged is the middle cerebral artery that supplies the mid portion of the brain hemispheres. In this case, the person is likely to become almost totally demented with a loss of function in comprehension or inability to speak words due to the damage to the motor area for word formation. Additional interference in neural motor control of the left hemisphere can result in spastic paralysis of most muscles on the opposite side of the body (Guyton et al., 2004).

Blockage of the posterior cerebral artery will cause impairment of the occipital pole, which results in loss of vision. The strokes that can be the most devastating are those that involve the blood supply to both the hindbrain and midbrain. The result of such a stroke leads to the interruptions of nerve conduction in the major pathways between the brain and the spinal cord, causing sensory and motor abnormalities (Guyton et al., 2004).

2.4 Classification of Stroke

The fundamental cause of any type of stroke is the interruption of blood supply to a part of the brain. A mention must be made on the “temporary warning stroke”, called a Transient Ischaemic Attack (TIA). When such a stroke occurs, the effects are reversed within 24 hours. The TIA is considered a medical emergency, as it is common for the attack to recur if not correctly managed (Hall, 2009).

Stroke can be broadly classified as haemorrhagic or ischaemic (Hall, 2009), (Paolucci et al., 2003). However, the classification can only be determined by the cause of the stroke.

A haemorrhagic stroke is caused by a bleed, most often resulting from a ruptured blood vessel. This type of stroke occurs either inside the brain tissue itself (intracerebral) or into one of the surrounding membranes (subarachnoid) (Hall, 2009).

The ischaemic stroke is usually due to some form of blockage. It can be caused by either a clot forming in the brain or surrounding arteries (thrombosis) or a clot or other particle from elsewhere in the body lodging in a brain or surrounding arteries (embolus). Ischaemic strokes make up 80% of all strokes (Hall, 2009).

A case controlled study with 270 stroke survivors compared the functional outcome of patients with haemorrhagic and ischaemic strokes. The Canadian Neurological Scale, Barthel Index and Rivermead Mobility Index were used to assess functional abilities. Results showed that haemorrhagic patients had significantly higher Canadian Neurological Scale and Rivermead Mobility Index scores at discharge. They also showed a higher response to the Barthel Index. This study concluded an improved functional prognosis in stroke survivors with a haemorrhagic stroke (Paolucci et al., 2003).

2.5 Symptoms of Stroke

The symptoms of a stroke vary, depending on the type of stroke that has occurred and the area of the brain that has been affected. The symptoms usually manifest contra-laterally, where the physical presentation will be on the side of the body opposite to the side of the brain that has been affected (Hall, 2009).

Some of the symptoms following the stroke may include a sudden numbness to the face or limbs, weakness or paralysis of one side of the body, and difficulty with standing, walking, and other activities of daily living. Loss of balance, co-ordination and understanding also often occurs. Problems with speech, swallowing, reading, writing, drooling and interferences with sight can also be present (Hall, 2009).

The World Health Organisation (WHO) (2010) advises clinicians to divide the symptoms of a stroke into definite focal signs and unspecified focal signs. Definite focal signs are clinical presentations that last more than 24 hours and include unilateral or bilateral motor or sensory impairment, aphasia or dysphasia, perception deficit of acute onset and ataxia/apraxia of acute onset. Unspecified focal signs are not adequate enough for a diagnosis and must be confirmed with additional evidence. They include dizziness, vertigo, blurred vision, dysarthria, seizures and impaired cognitive function.

2.6 Predisposing Factors

The predisposing factors can be divided into variables that can be controlled and those which are uncontrollable (Hall, 2009).

2.6.1 Controllable Factors

2.6.1.1 Hypertension

This is the most common factor in stroke development (Hall, 2009). Hypertension causes the walls of the arteries to become thicker, thus narrowing the passage for efficient blood flow throughout the body, especially the brain. Weakening of the walls of the arteries can also occur due hypertension (Guyton et al., 2004).

2.6.1.2 Cardiovascular Disease

Artheroma is a common cause of narrowing of the arteries. High cholesterol counts can result in heart attacks or heart failure, which will have an increased risk of forming clots (emboli) which could lodge in the brain (Guyton et al., 2004).

2.6.1.3 Diabetes

Poorly controlled diabetes increases the rate and severity of artheroschlerosis (hardening of the arteries) and promotes blood clotting, which is associated with hypertension (Guyton et al., 2004; Hall, 2009).

2.6.1.4 Smoking

Smoking is an established risk factor for a stroke, mainly because it promotes artheroma and increases the clotting ability of the blood. Nicotine also causes the arteries to constrict and raises the pulse rate and blood pressure. All these factors increase the workload of the heart and eventually reduce the blood flow to the brain (Guyton et al., 2004).

2.6.1.5 Blood disorders

Although blood and blood coagulation disorders are not common primary causes for strokes, they must be considered.

a) Polycythaemia :This is a condition in which there is an excess of red blood cells: the hyperviscosity is a risk for clot formation (Guyton et al., 2004).

b) Sickle cell Anaemia : This genetically determined abnormality can result in excess clot formation, especially in the small vessels (Guyton et al., 2004).

c) Clotting Disorders : Genetic deficiency of some clotting factors increase the risk of bleeding (Guyton et al., 2004).

2.6.1.6 Others

The use of oral contraceptives, especially in smokers, is associated with an increased risk of stroke. The use of stimulants like amphetamines and cocaine are also known causes of stroke (Hall, 2009).

2.6.2 Uncontrollable Factors

2.6.2.1 Age

Risks of having a stroke are greater as age increases. About 75% of all people who have had a stroke are 55 years or older (Hall, 2009).

2.6.2.2 Family History

Hereditary factors are known to contribute to the risk of strokes (Hall, 2009).

2.7 Factors affecting Recovery

Although the treatment of a stroke can be well planned by the multi disciplinary team, various factors like neurological recovery, functional status post discharge from hospital, severity of attack, age, neuropsychological problems, emotional status and moral support influence the actual recovery from the attack. Many of these factors can sometimes be uncontrollable (Biggs et al., 2008).

2.7.1 Neurological Recovery

Resorption of haemorrhagic material and reduction of inflammatory responses could account for a better functional recovery observed in patients with intra cerebral haemorrhage compared to those with cerebral infarction in whom neural plastic changes account for increased or reduced function.

Neurological deficits from intra cerebral haemorrhage may be caused from brain compression and as the haematoma resolves, neurological function recovers, hence improving functional status (Paolucci et al., 2003).

Neurological and functional recovery is believed to occur most rapidly in the first to third month following a stroke. Independence in self care activities of daily living improves for 88% of patients within 3 weeks of the stroke onset and 24 to 53% of survivors improve 6 months to 5 years after their stroke (Rittman et al., 2004).

2.7.2 Functional Status Post Discharge from Hospital

Functional independence cannot always be attributed to the duration of hospital stay, however it has been established that immediate intensive rehabilitation during the acute care stage post stroke can reduce the length of hospital stay while yielding better functional outcomes at discharge. A recent study established that South African stroke patients in private hospitals have a hospital stay of 30-34 days whilst the average stay at a government hospital was twelve days. It was concluded that South African stroke patients maybe discharged before they were functionally independent (Mamabolo et al., 2009).

2.7.3 Severity of Actual Attack

Incontinence within the first 24 hours, facial palsy, visual deficit, sensory inattention, swallowing problems, expressive dysphasia and use of the urinary catheter are all predictive of a poorer outcome following a stroke (Walker et al., 2003).

2.7.4 Age

There is often the assumption that an older patient who has a stroke will have a poor prognosis with regards to recovery. Age alone does not affect the outcome of rehabilitation as approximately 75% of stroke patients are 65 years or older, yet 95% of these patients can be functional (Collins, 1981).

Bagg et al (2002) conducted a study to determine the effect of age on functional outcomes after stroke rehabilitation. The Functional Independence Measure (FIM) instrument was taken at admission and discharge of 640 subjects at the Canadian Rehabilitation Hospital. Results suggested that there was no justification to deny patients access to rehabilitation solely because of advanced age, as a significant percentage of the subjects were 60 years and older, yet they had performed well in their rehabilitation. However, these conclusions are questionable when considering the six year data collection period and possibility of changes in trained personnel taking FIM readings during this period.

Although age itself may not be a significant factor in identifying those patients who will benefit from rehabilitation, it may serve as an indicator of those who will fail to retain the maximum benefit of rehabilitation. Age associated factors like co-morbidities can result in decreased functional outcome in stroke (Bagg et al., 2002).

2.7.5 Neuropsychological Problems

Neuropsychology attempts to understand the relationship between brain and behaviour. In a clinical setting, it aims at determining the pattern of neuropsychological impairment that the patient has suffered. It tests general knowledge, comprehension, vocabulary and arithmetic. Components of neuropsychology include memory function (the registration and retrieval of information) and attention (the cognitive ability of sustained concentration and processing) (Edwards, 2002).

2.7.6 Emotional Status

The emotional wellbeing of the stroke patient is essential for an effective recovery. The degree and rate of recovery depends on the ability of the patient to remain emotionally stable and positive throughout the rehabilitation process (Collins, 1981).

A study examined the phenomenon of post-stroke depression and evaluated its impact on rehabilitation outcome. Sixty four patients in a rehabilitation programme were evaluated for depression through self-report measures and staff ratings. Physical and occupational therapists provided measures of functional impairment at admission and discharge. A high prevalence of depression was found in this population. This study concluded that depression is associated with functional impairment in stroke and that it may have a negative impact on the rehabilitation process and outcome (Sinyor et al., 1986).

2.7.7 Moral Support

Moral support is defined as the support that the patient receives both emotionally and physically to assist with their determination to be as independent as possible. Moral support for the stroke patient has been emphasized in many of the articles reviewed. The patient most often seeks comfort and encouragement from those closest to him/her. This means that the care-givers play an integral role in the rehabilitation of the patient. Being motivated is the key to obtaining a successful outcome with rehabilitation. Family and friends need to assist in this regard (Biggs et al., 2008).

However if the motivation and encouragement is inadvertently confused with sympathy and pity, this will impact negatively on the patient. Over protective care-givers causes a reduction in functional independence because of the lack of opportunity to practice functional activities (Mamabolo et al., 2008).

2.7.8 Social Factors

Although individuals are encouraged to part-take in a normal life post-stroke, they are often faced with many uncontrollable obstacles. One of these obstacles is physical barriers. Many patients have difficulties coping with the infra-structures of their homes and public places like shopping malls. The use of public transport also poses a problem for some patients (Biggs et al., 2008). Financial constraints can also impact negatively on recovery as the patient may not be able to take full advantage of the resources needed for rehabilitation (Biggs et al., 2008).

2.8 Morbidity and Mortality

The prognosis following any major disease is dependant on a number of factors. Most importantly in a stroke the actual site of the lesion on the brain will give a good indication of the patient's prognosis (Walker et al., 2003).

Death is not always the destination for the stroke patient. Worldwide, comparisons have been made on statistics regarding mortality rates for stroke patients. A study in Gambia from 1990-1994, where mortality and quality of recovery was investigated in which the subjects were monitored on a six month basis for four years showed that mortality was 27% at one month, 44% at six months and 25% at the final follow up (Walker et al., 2003).

Between 1992 and 1995, the Wits Rural Public Health and Health Transition Research Unit found stroke caused 5.5% of all deaths in a rural population of 63 000 in Limpopo Province. Stroke was the commonest cause of death in the 55-74 year age group and the second commonest cause of death in the 35-54 year and over 75 year age groups. The overall crude stroke mortality rate was 127 per 100 000 (Connor et al., 1995-2005). Based on England and Wales statistics in 1993 where the mortality rate per 100 000 was 122 in males and 115 in females, stroke mortality in South Africa , as stated above, is higher (Connor et al., 1995-2005).

2.9 Impairments

2.9.1 Changes in Tone due to Reciprocal Innervation

Tone can be described as the resistance felt when a part of the body is moved passively. Normal tone is characterised as an appropriate amount of resistance, allowing for the movement to proceed through the range of motion smoothly and without interruption (Davies, 2000).

Hypotonus is felt as too little or no resistance to movement, making the limb limp and floppy. When released, the part being moved will fall in the direction of the pull of gravity. Hypertonus is felt as an increased resistance to the passive movement, making the limb feel heavy (Davies, 2000).

Damage of the primary motor cortex alone causes hypotonia or hypertonia. This is due to the fact that the primary motor cortex normally exerts a stimulatory effect on the motor neurons of the spinal cord. When this stimulatory effect is removed, hypotonia results whilst if the stimulatory effect is continuous, hypertonia presents (Guyton et al., 2004).

Reciprocal innervation is the graded and synchronous interaction of the agonists, antagonists and synergists throughout the body. The constant postural adjustments and interaction between the muscle groups provides the automatic adaptation of the body in response to the functional goal and to the changes in the environment. It is suggested that the nervous system combines related muscles into units called muscle synergies. This is the functional coupling of groups of muscles such that they are constrained to act together as a unit, thereby simplifying the control demand by the central nervous system (Edwards, 2002).

Once neurological damage has set in, the patient with abnormal tone generally illustrates impaired reciprocal innervations. This could be as a result of hypotonus which causes inadequate stability due to reduced activity or hypertonus where excessive activity prevents tonal adaptations**.** A disabled person with a neurological impairment which adversely affects trunk and pelvic stability may be able to adapt to perform the function with a great amount of effort. Therefore compensatory strategies would be necessary (Edwards, 2002).

2.9.2 Skeletal muscle changes

The disability of stroke leads to physical inactivity which results in reduced muscle mass and function. Immobilised muscle eventually has decreased eccentric, concentric and isometric control which could be due to structural and metabolic changes in skeletal muscle after stroke. Muscle alterations include gross atrophy of the upper and lower limbs, with the latter resulting in gait deficit (Hafer-Macko et al., 2008).

2.9.3 Changes in Central Nervous System Plasticity

The central nervous system comprises plastic neural networks that are continuously involved in reorganization due to movements of the muscles. Due to damage to the neural system following stroke or spinal cord injury, changes in neural plasticity occurs. These changes can affect cortical, subcortical and cerebellar pathways which play a significant role in lower limb movements and gait (Forrester et al., 2008).

A review on lower limb plasticity undertaken by Forrester et al in 2008 concluded that neuroplasticity may be improved if the paretic lower limb is actively engaged in movement, which includes high volumes of repetition and if the practised movements have an element of problem-solving like paretic limb stepping. Treadmill training has been suggested for neurological patients, as it delivers repetitive sensory inputs to the spinal cord, which could initiate locomotor learning and improve neural plasticity through the process of sensory motor integration (Visintin et al., 2003; Forrester et al., 2008).

2.9.4 Balance and Stability

A state of equilibrium in the body, resulting in complete balance and stability, is made up of three components, namely vestibular feedback, proprioceptive and visual input (Guyton et al., 2004). The controls for each of these aspects are located in the brain.

2.9.4.1 Vestibular Sensations

The vestibular apparatus is the sensory organ that detects sensations of equilibrium. The maculae operate to maintain equilibrium during linear acceleration (moving forward). When the body is thrust forward, the statoconia fall backward on the hair cells and information on the imbalance is sent to the nerve centres via the vestibular nerve, causing the person to feel like he/she is falling backward. This immediately causes the person to lean forward, resulting in an anterior shift of the statoconia. At this point, the nervous system detects a state of equilibrium and no further movement of the body is needed (Guyton et al., 2004).

The semi circular canals, utricle and saccule comprise the peripheral receptors of the vestibular system. The vestibular nuclei receive input from the peripheral labyrinth receptors, the reticular formation and the cerebellum. The output from these nuclei is primarily to motor neurons within the spinal cord, specifically, to motor neurons innervating proximal muscles and muscle spindles of the back and neck (Young, 2004).

2.9.4.2 Proprioception

Proprioception can be explained as the awareness of movement and body position. It is sometimes defined as the body's joint positioning system. Effective proprioceptive processes are dependent upon the ability of the brain to integrate information from all sensory systems, including feedback from muscles, joints, the tactile sense, visual and vestibular systems (Balametrics, 2004).

Proper control of muscle function requires not only excitation of the muscle by the anterior motor neuron, but also continuous feedback of sensory information from each muscle to the spinal cord. There are two types of sensory receptors, namely muscle spindles (which are distributed along the belly of the muscle and transfer information depicting the muscle length) and Golgi tendon organs (which are located in muscle tendons and transmit information involving tendon tension). These two receptors carry information to the spinal cord, cerebellum and cerebral cortex, helping each area in their respective function for controlling muscle contraction (Guyton et al., 2004).

Joint stabilisation is the ability of the muscles that have been appropriately activated to stabilise a joint (Balametrics, 2004). One of the most important functions of the muscle spindle system is to stabilise body position during motor action when the spindles on both sides of each joint are activated at the same time. Therefore reflex excitation of the skeletal muscles on both sides of the joint also increases, producing tight, tense muscles. The net effect is that the position of the joint becomes stabilised (Guyton et al., 2004).

Hence the process of joint stabilisation is critical to performance and the prevention of falls and injury. Balance activities that combine the visual, auditory, kinaesthetic, tactile and vestibular senses have the effect of improving the proprioceptive processes that help to reduce injuries and improve performance. These improvements are noticed when combined sensory activities increase the effectiveness and efficiency of the neural processes of the brain. As the neural capability increases, a variety of other benefits involving timing, vision, a sense of balance, mental processing, reaction time and proprioception occur (Balametrics, 2004).

2.9.4.3 Visual input

After destruction of the vestibular apparatus and even loss of most proprioceptive information from the body, a person can still use their visual mechanisms effectively to maintain equilibrium. Even slight linear or rotational movement of the body instantaneously shifts the visual image on the retina. Some people with a dysfunctional vestibular system have almost normal equilibrium as long as their eyes are open. However, when moving rapidly or when the eyes are closed, equilibrium is immediately lost (Guyton et al., 2004).

In patients with stroke, balance and stability impairments are often common. Abnormal interactions between the three components of equilibrium could be the source of abnormal postural reactions. Sometimes stroke patients inappropriately become dependent on one particular system over the others, in an effort to compensate for their deficits. Once they learn to rely on a particular system, abnormal adaptations arise and, hence, balance disturbances occur (de Oliveira et al., 2008).

2.9.5 Weight bearing

The ability to maintain an erect posture requires considerable adjustment from the postural muscles of the trunk to control the long mobile lever of the vertebral column. Being upright also requires adequate muscle activity in the lower limbs to bear the weight of the body (Davies, 1990). Body alignment in standing is considered to occur when the head is balanced on level shoulders, upper body is erect, shoulders are over hips in front of ankles and feet are approximately ten centimetres apart. Sitting erect is when the head is balanced on level shoulders, upper body is erect, shoulders are over hips and feet are and knees are a few centimetres apart (Carr et al., 2003).

Analysis of the biomechanical forces acting on the body provides information on the components affected by gravity. The centre of gravity (COG) or centre of pressure (COP) is the point in the body at which the most pressure is exerted by gravity. In an upright position, the COG is approximately around the sacral vertebrae. The COG changes with a change in position. The base of support is the supporting area beneath the body. It includes the parts of the body in direct contact with the surface (feet and walking aids) and the area enclosed by the contact points (area between the feet or the area between the feet and walking aid) (Carr et al., 2003). These are essential components which are useful and should be considered during treatment of neurologically impaired patients.

The consequences of repetitive disuse of the paretic lower limb in a stroke could result in weight asymmetry and impaired balance. Gradually continued weightbearing asymmetry may persist and fostrer further disuse, despite the fact that improved function in the lower limb has occurred (Aruin et al., 2000).

Aruin et al (2000) reported a study that evaluated whether a shoe lift on the non paretic foot would affect weight bearing and therefore balance in a stroke patient. A balance master computerised force platform system was used to measure balance. Three shoe lifts ranging from seven to thirteen millimetres were used. This study concluded that compelled weight bearing (in this case using the shoe lift) may contribute to improved postural control and gait performance in persons with hemiparesis.

2.9.6 Movement Strategies

The human body has postural strategies that are general sensorimotor reactions for postural control and include the hip and ankle strategies. These strategies involve muscle synergies, movement patterns, joint torques and contact forces. In the ankle strategy, muscle activation occurs distal to proximal and the centre of mass is moved with torques mainly in the ankle. In the hip strategy, muscle activation occurs mainly in the hip and trunk, adding torques to the hip, knee and ankle joints. The ankle strategy depends more on somatosensory information, while the hip strategy requires adequate vestibular information (de Oliveira et al., 2008).

Patients with stroke often use compensatory techniques like holding onto objects or walls to assist balance deficits. In order to maintain their base of support, it has been noted that patients with stroke predominantly use the hip strategy (de Oliveira et al., 2008).

Muscle adaptation can also be used to compensate for stroke related difficulties to activities. Often a patient suffering from stroke may prefer to use the unaffected side, using only the stroke affected side when absolutely necessary or if physically possible. However, evidence has shown that by the training of the affected side, fewer compensatory movements will be required because more effective movement is possible on the stroke side. Optimum quality of movements needs to be emphasized (Edwards, 2002).

2. 10 Effects on stability and balance post stroke

Stability is described as not being at risk for immediate loss of position whilst balance is a term used to describe the ability to maintain or move within a weight-bearing posture without falling. Balance can be divided into three different aspects, namely steadiness, symmetry and dynamic stability. Steadiness refers to the ability to maintain a given posture with minimal movement (sway). Symmetry is used to describe equal weight distribution between the weight-bearing components (feet in a standing position and buttocks in a sitting position). Dynamic stability is the ability to move within a given posture without the loss of balance. All of these components are often found to be disturbed following a stroke (Nichols, 1997).

Some studies have argued that an evaluation of one or many functional aspects in a stroke patient can be helpful in anticipating functional status at discharge (Biggs et al., 2008; Paolucci et al., 2003). Sandin and Smith (1990) evaluated sitting balance to test the hypothesis that recovering stroke patients with initially good sitting balance or those who develop good sitting balance during rehabilitation, perform better functionally than recovering stroke patients whose sitting balance is consistently poor. Sitting balance, which is a pre-requisite for most functional activities, was scored using a four-point scale of the Barthel Index evaluating static and dynamic balance on admission to the rehabilitation unit and weekly until discharge. It was concluded that those patients whose sitting balance improved during rehabilitation, had higher Barthel Index scores and were more functional. These findings will not allow for generalisation to all stroke patients as the sample comprised of only 24 participants and the average stay in the rehabilitation centre for some of these participants was 17 days, which could indicate less impaired individuals.

Michael et al (2005) deduced that low cardiovascular fitness, by testing the rate of oxygen consumption, resulted in balance deficits and reduced ambulatory activity in their project. This was concluded using the Berg Balance Scale and stride counts for balance and ambulatory activity respectively. A small sample size of 50 and conducting the study on only mild to moderately hemiparetic participants does not allow this study to represent the complete stroke population.

Stability and balance recovery in post stroke patients is characterised by a reduction in postural sway and instability as well as a reduction in visual dependency (de Haart et al., 2004). The restoration of these characteristics may be important factors in the relearning of independent standing and walking abilities

(Nichols, 1997). Stability and balance training is an important component of stroke rehabilitation as the changes in balance ability significantly affects function (Mao et al., 2003), (Visintin et al., 1997).

2.11 Assessment tools for stability

The ability to maintain a given posture and ensure equilibrium in changes of the posture requires control and co-ordination (Benaim et al., 1999). Hemiplegic and hemiparetic patients frequently present with disturbances of postural control and stability following their attacks (de Oliveira et al., 2008). Assessment and treatment of stability difficulties are therefore an integral component of stroke rehabilitation.

A thorough search of literature has shown a lack of assessment tools for stability in stroke patients. The only scale found was the Postural Assessment Scale for Stroke Patients (described below). This scale was used for the assessment of stability in this study.

2.11.1. The Postural Assessment Scale for Stroke Patients (PASS)

The PASS (appendix 9) was developed by Benaim et al in 1999 by adapting items of the Fugl-Meyer (FM) assessment and formulating a new scale. This was done on a cohort of 30 healthy and 70 stroke subjects on days 30 and 90 after stroke onset. PASS is applicable to all stroke patients, even those with very poor postural performance (Benaim et al., 1999). It contains twelve items with a four level scoring system that grades performance for situations of varying difficulty in maintaining or changing a given lying, sitting or standing posture. It's score ranges from zero to 36 (Mao et al., 2003). The PASS takes five to ten minutes to administer and the equipment required is a Bobath plinth and pencil (Benaim et al., 1999)

A study in Taiwan between 1999 and 2000 compared the psychometric properties of PASS, Berg Balance Scale (BBS) and the balance subscale for the Fugl-Meyer test (FM-B). It was found that the items of the PASS were better distributed as it included four items on bed mobility, showing that it could be used for stroke patients from the early recovery stages. The study showed high levels of inter-rater reliability, internal consistency and validity of the PASS. The researchers also found that the FM-B and PASS were quicker and simpler to administer and rate (Mao et al., 2003).

2.12. Assessment tools for Balance

Various tools have been identified for the assessment of balance; however there was a lack of critical information. Two of these tools are noted below.

2.12.1. The Balance component of the Fugl-Meyer Scale (FM-B)

The FM-B is one of six subscales of the FM scale, which was designed to evaluate impairment in balance after a stroke. It contains seven items, three for sitting and four for standing. The score ranges from zero to 14 (Mao et al., 2003). Conflicting information regarding this scale was found in the literature, as the American Stroke Association (2007) noted 30-40 minutes for the FM-B to be administered, the Internet Stroke Centre (2007) considered this scale too complex and time consuming whilst Mao et al (2003) regarded it quick and simple to administer and rate. A detailed guide on the items and levels of scoring of this scale could not be located.

2.12.2 The Berg Balance Scale (BBS)

The BBS (appendix 14) evaluates a person's performance on 14 activities (one in sitting and 13 in standing) which assesses balance in either functional activities or components of functional activities like sit to stand, stair climbing and standing unsupported. The score ranges from zero to 56, with a four point scoring system. It takes roughly 15 minutes to complete and requires equipment like a step, two chairs, a stopwatch and a ruler (Mao et al., 2003: Langely et al., 2003). Mao et al (2003) reported high inter-rater reliability, internal consistency and validity of the BBS in 128 subjects. According to the Internet Stroke Centre (2007), the BBS is easily administered and comprehensive to the user. The BBS was utilised to assess balance in this study.

2.13 Effects on function post stroke

The loss of independence in daily activities is one of the most difficult transitions post stroke. Difficulties with walking, getting into and out of bed, maintaining a sitting position, eating and sphincter and bladder control often results in additional problems with recovery (Rittman et al., 2004).

The findings from one stroke related study indicated that independence in self care activities was poorest post discharge from hospital, showed better recovery three weeks post discharge but improved drastically between six months to five years. This indicated that the body endures disruptions which brings about significant changes and challenges to the stroke survivor and improvements could take many years of hard work (Rittman et al., 2004).

Samsa et al (2004) reported on the relationship between functional status and quality of life among persons with stroke. Functional status using the Barthel Index and quality of life using the Direct Scale and Time Trade Off Scale were assessed telephonically at one, six and twelve month intervals following the stroke. From the 1073 subjects that participated at the start of the study, only 329 of them completed the data collection process. Results showed that although a higher functional status was associated with a better quality of life, the quality of life following stroke depends on more than just level of physical function. This study may have yielded stronger findings if there had been better subject compliance or if data collection was done more objectively, rather than telephonically.

In 2006 Harley et al assessed whether sitting balance would be an indicator of cognitive and functional recovery in stroke patients. With the application of the Barthel Index for function and testing postural sway in sitting, dual task interference between cognitive and motor tasks were analysed. The study concluded that the extent of postural instability correlated with function. The sample of 36 stroke participants compared to 21 control participants shows some bias in the sample selection. Participants were also assessed cognitively by word repetitions however no mention was made of assessment of the sample regarding speech difficulties prior to data collection. Again the Barthel Index scores were taken telephonically, allowing for inaccuracy in scores.

The functional independence of a patient is an important indicator of their health status. Independent mobility is also a key factor in determining progress in rehabilitation or readiness for discharge (de Morton et al., 2008).

2.14 Assessment tools for Function

There have been many tools that have been used to assess the different stages of improvement in functional abilities over the years by physiotherapists and other members of the rehabilitation team. These tools are often chosen according to personal preference by the therapist, time constraints or limited resources (Hsueh et al., 2002).

From the literature reviewed, it was not clear whether many physiotherapists routinely utilise any standardised tools to assess stroke patients. However, it was evident that the need for objective assessments in clinical practise was becoming more common (Hsueh et al., 2002; Macko et al., 2008).

Some of the more commonly described tools are described below.

2.14.1 The Barthel Index (BI)

The BI is a widely used functional scale which quantifies ten activities of daily living including feeding, grooming, bowel and bladder care and stair climbing (appendix 19). The scores range from zero to 100. The higher scores imply full functional independence but not necessarily normal status (Hsueh et al., 2002; Paolucci et al., 2003). It takes approximately five to ten minutes to administer and requires a Bobath plinth, chair and stairs. The Internet Stroke Centre (2007) claims that the BI boasts high levels of reliability and validity. Shah et al (1989) and Shah et al (1990) have regarded the BI as superior to other scales because of its effectiveness, the ease of statistical analysis and proven reliability and validity from other studies. BI was used by Sandin et al (1990) because of its ease of administration and proven reliability in the functional evaluation of stroke patients.

Most recently the BI was assessed for validation on 100 Portuguese patients by Minosso et al (2010). This instrument was considered valid and reliable after repeated testing of ten subjects per item.

In 1995, a project was undertaken to compare 21 classifications and scales that are used to measure handicap and disability in stroke. Reliability, validity and consistency were studied on all scales. It was found that the BI is the most reliable instrument used in the clinical measurement in stroke (D'Olhaberriague et al., 1996).

The BI scale was therefore chosen to assess independence regarding the activities of daily living in this study.

2.14.2 Functional Independence Measure (FIM)

The FIM is an 18 item scale and is scored from 18 (complete assistance in all areas) to 126 (complete independence in all areas). It consists of 13 motor and five social-cognitive items, assessing self-care, sphincter control, transfers, locomotion, communication, social interaction and cognition (Hsueh et al., 2002). The FIM shows high levels of reliability, validity and internal consistency according to a study done by Hsueh et al (2002). Training is needed to administer the FIM scale (Wright, 2000).

The functional assessment measure (FAM) consists of twelve items including cognitive, behavioural, and communicative and community functioning measures. FAM is intended to accompany the FIM to give a functional complete assessment. FIM and FAM are a 30 item scale, which takes approximately 35 minutes to complete (Wright, 2000).

The BI and the FIM are the most widely used measures of disability in Europe. The FIM was developed to be a more comprehensive and responsive measure of disability than the BI (Hsueh et al., 2002).

A study was done to make a comparison of the psychometric characteristics (reliability, validity and internal consistency) of the BI and FIM in subjects with stroke. One hundred and eighteen subjects at a rehabilitation centre in Taiwan participated in the study. Subjects were tested with the FIM and BI scales at admission and before discharge from the centre. The reliability, validity and internal consistency of each measure were examined. Results showed that the BI and FIM have similar psychometric characteristics regarding reliability and internal consistency however BI showed poor validity on admission but fair to high validity on discharge of the subjects. The results suggested that although the FIM was more detailed and had a wider scoring range than the BI, the FIM had no advantage over the BI in this study (Hsueh et al., 2002).

2.14.3 <u>The FUNC Score</u>

Components like intra-cerebral haemorrhage (ICH) volume, age, ICH location, Glascow Coma Scale and pre-ICH cognitive impairment are measured with this test. The score ranges from zero to eleven, where eleven indicates strong likelihood of functional independence.

Rost et al (2008) determined the effectiveness of the FUNC score to predict functional outcome in patients with intra-cerebral haemorrhage. The FUNC score was applied to 629 patients at the Massachusetts General Hospital. After 90 days the subjects were reviewed to compare their predictive status (using the FUNC score) with their actual status at the time. Results showed that 80% of the subjects with a FUNC score of eleven did reach functional independence and subjects with a score of less than four had no independence. From this study, it was concluded that the FUNC score can be used to predict the likelihood of functional independence of patients, provided that the patient has had an intra-cerebral haemorrhage and survives to 90 days. Conversely, despite surviving 90 days, those patients with a FUNC score of less than four will have no chance of functional independence.

It was not feasible to use this scale in this study as the information needed to test this scale was not readily available in the participant's charts.

2.14.4 The Elderly Mobility Scale (EMS)

Seven items make up this scale. Functional abilities like lying-to-sitting, sitting-to-lying, sitting-to-standing, gait and functional reaching are assessed. The score ranges from zero to twenty, where a maximum score indicates independent mobility. This test can take five or more minutes to be administered (de Morton et al., 2008). The EMS is used for a number of generalised mobility conditions in geriatrics and is not specific to the neurological patient. It was therefore not used in this study.

2.14.5 The Hierarchical Assessment of Balance and Mobility (HABAM)

In the original version, HABAM consists of 27 items, with scores ranging from zero to 24. Different stages of mobility, transfers and balance are evaluated. This assessment can take anything from two to six minutes to be completed (de Morton et al., 2008). A clear format of the scoring of this scale and how it is administered could not be found; hence it was not used in this study.

2.14.6 The Physical Performance Mobility Examination (PPME)

The PPME tests six items including bed mobility, transfers, standing balance and ambulation. A maximum score of twenty indicates total independence in mobility. Ten minutes is needed to complete the PPME (de Morton et al., 2008). A format of the items contributing to this scale and the levels of scoring could not be found, hence this scale was not utilised in this study.

In an attempt to find one physical performance instrument to accurately measure and monitor mobility in medical patients, a systematic review of various assessment tools was done. Numerous assessment instruments were found via a general search. These were then compared on similar mobility tasks and scoring methods. Three of the instruments, namely the EMS, HABAM and PPME, were identified as being the most efficient in a clinical setting. An in-depth analysis of each followed. The EMS was found to have no formal studies of feasibility or acceptability, although it was highly recommended by many practitioners. The HABAM showed to result in a 'ceiling effect', where ambulant patients easily reached the highest score possible. The PPME was reported to be impractical as staff could not incorporate this eight to ten minute assessment into their daily routines (de Morton et al., 2008)

2.14.7 The Functional Ambulation Category (FAC)

The FAC distinguishes six levels of required support during gait. Scoring ranges from level zero, where the patient cannot walk at all and needs the support of two people or more to level six, where the patient can walk anywhere independently (Hesse et al., 1999).

2.14.8 The Rivermead Motor Assessment (RMA)

Motor functions are tested in a hierarchical order with ten manoeuvres including sitting, transfers, walking ten meters, climbing, running and hopping (Hesse et al., 1999).

2.14.9 The Motoricity Index (MI)

The MI is a quantified motor strength of the affected upper and lower limb, graded from zero to 100 (Hesse et al., 1999). It takes five minutes to be administered (Internet Stroke Centre, 2007).

The FAC, RMA and MI are not very well known tools and therefore have little information on their use and proven effectiveness. They were not used in this study.

2.14.10 The Modified Ashworth Spasticity Scale (MASS)

The MASS grades muscle tone from zero to five, where grade zero indicates no increase in muscle tone and grade five indicates a rigid joint (Hesse et al., 1999).

The FAC, RMA, MI and MASS were used as assessment instruments in a study involving treadmill training with partial body weight support in stroke patients, which will feature later in this review.

2.15 Management of the stroke patient

Intervention following an attack depends on the severity of the stroke and it therefore includes various health professionals who contribute using their expertise and field of expertise (Bupa's Health Information Team, 2009).

2.15.1 Medication

Bupa's Health Information Team (2009) stipulated that depending on the cause of the stroke, appropriate medication should be administered to control the effects of the attack and prevent further episodes (Hall, 2009). Medications could include anti-hypertensives, anti-coagulants and treatment for co-morbidities (Hall, 2009).

2.15.2 Lifestyle Adjustments

The onset of stroke could produce deficits in mental status, sensation, perception, communication, motor ability, social status and subsequently alter one's lifestyle. These deficits, separately or combined, will determine the total disability of the patient. It is therefore of utmost importance that a holistic approach with all of the above aspects be considered in the planning of a treatment program (Jimenez et al., 1976). A well balanced diet, cessation of smoking, moderate alcohol consumption and regular exercise is also advised (Jimenez et al., 1976).

2.15.3 Rehabilitation

The two aims of rehabilitation are to restore function to as near normal to pre-stroke abilities as possible and to prevent further attacks (Hall, 2009). An extensive rehabilitation team is responsible for the holistic management of the stroke patient (American Stroke Association, 2009).

2.15.3.1 Physiotherapy

Early physiotherapy is an essential element to the stroke rehabilitation process (Carr et al., 2003). Chest physiotherapy, correct positioning, pressure care and passive range of motion exercises from the day of the attack prevent detrimental setbacks like infections and contractures (Davies, 2000). Abductor rolls and slings are used to prevent subluxed shoulders (Collins, 1981).

Techniques to normalise tone abnormalities, active exercising (Collins 1981), strength training (Patten et al., 2004), weight-bearing via sitting and standing (Davies, 2000), balance education and gait re-training (Collins, 1981) constitute some of the conventional strategies used for stroke patients by physiotherapists. Other methods of treatment like matwork routines and ball therapy are used for more independent patients (Carr et al., 2003).

In London, forty patients were interviewed regarding the benefits of physiotherapy post stroke. Twenty four of the patients had received physiotherapy and believed it had brought about functional improvement. The exercise component was valued because it was aimed to keep the subjects active and busy. The subjects felt that the exercise programmes were easy to follow in the absence of the therapists. The therapists were considered a good source for advice and information (Pound et al., 1994).

Further studies were done in 1992 to determine whether the intervention of physiotherapy improved mobility in patients one year or more following their stroke. It was found that after a period of recovery, patients who have had a stroke do experience a decline in mobility. It was also found that it may be of benefit to treat a patient with problems with mobility for a longer period of time, even long after the stroke has occurred. The degree of improvement and how quickly one's condition changes will vary from patient to patient (Wade et al., 1992).

2.15.3.2 Other rehabilitative methods

Other members of the rehabilitative team include occupational therapists, speech therapists and dieticians, psychologists, psychiatrists and social workers. Attention and motivation from each professional will contribute to the holistic treatment of the stroke patient (Collins, 1981).

2.16 Recent treatment options in physiotherapy

2.16.1 Body Weight Support (BWS) using Treadmill Training

The ability to weight-bear effectively on both lower limbs following a stroke poses a problem for many patients. This is the reason why alternative methods were sought to enable the patient to begin weight-bearing as soon as possible (Hesse et al., 1999).

The idea of body weight support for stroke patients is becoming increasingly popular (Visintin et al., 1997). The approach used by Visintin et al consists of using an overhead suspension system and harness to support a percentage of the patient's body weight as the patient walks on the treadmill. The amount of body weight support is then progressively reduced as the patient's gait pattern improves. The BWS provides a symmetrical removal of weight from the lower extremities, thereby facilitating walking in patients with neurological conditions who are typically unable to cope with bearing full weight on their lower limbs. This strategy provides a dynamic and task-specific approach that integrates three essential components of gait (weight-bearing, stepping and balance) while the patient is walking on the treadmill

(Visintin et al., 1997). Although this approach could be useful for initiating gait in patients who are able to stand but have weight-bearing problems, it could be difficult to use with stroke patients who are unable to stand. The body weight support system is therefore not beneficial to all stroke patients.

One study intended to compare the effects of gait training with BWS and with no BWS on patients with stroke. One hundred subjects were randomised to receive one of two treatments while walking on the treadmill: fifty subjects were trained to walk with up to 40% of their body weight supported by the BWS system (the BWS group). Another fifty subjects were trained to walk full weight bearing on their lower extremities (the no BWS group). Treatment outcomes were assessed on the basis of four variables, namely functional balance, motor recovery, over-ground walking speed and over-ground walking endurance. This study served to prove that re-training gait in patients with a stroke, while a percentage of their body weight was supported, resulted in better walking abilities compared to patients having gait training bearing their full weight (Visintin et al., 1997).

In a similar study done in 1999, gait training was tested using partial BWS on the treadmill. Variables were assessed using the Functional Ambulation Category (FAC), Rivermead Motor Assessment (RMA), Motricity Index (MI) and the Modified Ashworth Spasticity Scale (MASS). All subjects had three separate phases of treatment, each lasting three weeks. Firstly there was treadmill training with partial BWS, then regular physiotherapy and lastly another treadmill training component. The results showed that the gait capability of all the patients improved. Motor functions tested by the RMA significantly increased. The MI, which assesses muscle strength showed no change. Muscle tone was slightly higher within the respective ranges, but this could have been due to internal and external factors that were not under the control of the investigators. Overall, this study concluded that treadmill training was effective with regard to restoration of gait ability and walking velocity. The researchers proposed that treadmill training with BWS be used as an additional tool in the re-education of gait (Hesse et al., 1999)

2.16.2 Force Platform Systems

Advances in technology have resulted in the availability of numerous force platform systems for the re-training of gait function in patient populations. Typical force platform bio-feedback systems consist of at least two force plates to allow the weight on each foot to be determined, a computer and monitor allows for visualization of the centre of force or centre of pressure and software that provides data analysis (Nichols, 1997).

A study in the Netherlands in 2004 looked at the characteristics of the restoration of quiet standing balance in a sample of stroke survivors. Thirty seven subjects were admitted to re-train standing balance and walking. Centre of pressure fluctuations were registered under each foot using a dual-plate force platform. The first balance measurements took place as soon as the patients were able to stand unassisted for thirty seconds. Readings were then taken two, four, eight, and twelve weeks later. Quiet standing was assessed with and without visual midline reference and with the subject's eyes closed. The results showed excessive postural sway and instability, particularly in the frontal plane. The degree of visual dependency showed a significant decrease in time. Weight-bearing asymmetry diminished considerably during the follow up period (de Harrt et al., 2004).

In a similar study, researchers investigated whether the addition of force plate training could enhance the effects of other physiotherapy interventions on balance and mobility following a stroke. Subjects were assigned randomly to either an experimental or a control group. Both groups received physiotherapy interventions two to three times a week designed to improve balance and mobility. The experimental group trained on the NeuroCom Balance Master for fifteen minutes each and had physiotherapy for the rest of the session. The control group had fifty minute physiotherapy sessions. Results indicated an improvement in balance and mobility; however a comparison revealed no differences between the two groups. In this study population, force plate training on stroke patients had no additional effects to the improvement of balance and mobility (Geiger et al., 2001). The failure in this study could have been due to the fact that both the control and experimental groups had physiotherapy interventions as part of their programme. The study may have yielded better results if one group did not receive intervention and received balance master training only. Another shortcoming of this study could have been that the fifty minute session for both experimental and control groups were too strenuous and resulted in fatigue of these subjects.

2.17 Conclusion

From the literature reviewed, it is apparent that a stroke is one of the most disabling conditions that can occur. The consequences post-stroke have many far-reaching effects on both the patient and family concerned. A big part of the rehabilitation process is based on improving the functioning of the patient with the activities of daily life. Standing, balance re-education and ambulation is the focus of most physiotherapists when treating stroke patients (Hall, 2009).

Although many of the references used were not taken from current sources, they have provided numerous valid discussion points. It has, however, shown a severe lack of current data on various stroke related topics. In addition, only a small portion of literature reported on stroke related studies done in South Africa. More importantly, no data on the relationship between stability, balance and function was found in South African stroke patients.

2.18 Operational Definitions

1. CVA/Stroke: A rapidly developing clinical manifestation of a focal loss of cerebral function lasting more than 24 hours (Shah et al., 1990). It is an acute injury to brain tissue, resulting from an interruption of blood flow to that area of the brain (Hall, 2009).

2. Disability: Any restriction or lack of ability to perform an activity in a manner that is considered to be normal for a human being (Hornby, 2001). Disability refers to the incapacity to perform a task and entails performance (D'Olhaberriague et al., 1996).

3. Handicap: It is a disadvantage that limits or prevents the fulfilment of a role that was normal for that individual (D'Olhaberriague et al., 1996).

4. Impairment: Any loss or abnormality of psychological, physiological, anatomical structure or function (Hornby, 2001).

5. Independent: Free to do activities without needing assistance from people (Hornby, 2001) or a device (Jimenez et al., 1976).

6. Functionally Independent: Ability to do activities of daily living without assistance (Jimenez et al., 1976).

7. Dependent: To need help from a subject for a particular purpose (Hornby, 2001).

8. Functionally Dependent: Needing assistance for activities of daily living (Jimenez et al., 1976).

9. Rehabilitation: To help a subject to have a normal, useful life again after they have been ill for a long period of time (Hornby, 2001). Rehabilitation has 2 aims: restoring function to as near normal to pre-stroke abilities and preventing further attacks (Hall, 2009).

10. Balance: It involves the regulation of movement of linked body segments over supporting joints and the base of support (Carr et al., 2003). The ability to maintain or move within a weight bearing posture without falling (Nichols, 1997).

11. Stability: not being at risk for immediate loss of position (Nichols, 1997).

2. 19 Hypotheses

H_{A1} : A program of physiotherapy focussed on balance and stability training leads to significant improvement in balance, stability and function compared with standard physiotherapy programs in stroke patients.

H_{O1} : A program of physiotherapy focussed on balance and stability training leads to no significant improvement in balance, stability and function compared with standard physiotherapy programs in stroke patients.

Chapter 3: Methods

3.1 Design

The purpose of this study was achieved using a randomised controlled trial. The measurement of dependent variables using validated tools as described in the literature review was done. A questionnaire which allowed for the collection of demographic and social information from the participants was also utilised. The clinical reasoning behind this type of design was based on a study by Macko et al (2008) who studied the effect of physical activity on function and quality of life in hemiparesis. Their study presented them with limitations due to a non-controlled design, hence the result was that they were unable to compare findings to a controlled group of subjects. Similarly, this was also true for the study conducted by Michael et al (2005) whose project on balance, ambulatory activity and cardiovascular fitness was restricted, due the lack of a control group. However, on the other hand, Geiger et al (2001) used a controlled design to show how force plate training would improve balance and mobility in a specific group of participants when compared to another group who received physiotherapy intervention alone. This study made it evident that projects using intervention in the form of training allowed for good comparison when a controlled trial was utilised.

3.2 Population and Sample

The population for this study consisted of all patients with stroke who reported for therapy at the Phoenix Assessment and Therapy Centre for the period of May to November 2010. These patients were diagnosed by general practitioners in private practices and doctors at public clinics or hospitals.

The sample was a consecutively selected subset of the population who presented to the centre for the period of four months from the date on which ethical approval was obtained. Only patients who suffered a first stroke as a result of ischaemic or haemorrhagic incidents were included for participation. From these patients, only those who signed fully informed consents (appendices 5 and 6) were included in the randomisation process for inclusion in either the control or experimental groups. Patients who were aphasic but appeared cognitively functional (they responded to instructions in an acceptable manner by obeying instructions) were also included in the study. Randomisation was computer generated which resulted in the placement into the control or experimental groups. Any individual, who did not give their permission or refused to participate in the study, was excluded. Patients were also excluded if they had suffered more than one stroke, had any previous lower limb fractures or were unable to participate in low intensity exercise programmes due to severe complications from co-morbidities. Lastly, patients were excluded if they were diagnosed as being HIV positive due to being unable to control the manifestation of the disease and thus consequent uncontrolled variables in the project.

This study was conducted in the Phoenix Assessment and Therapy Centre in KwaZulu Natal as it was convenient to the researcher. This centre is an out-patient facility, operating five days a week from 7.30am to 16.00pm. The Phoenix Assessment and Therapy Centre is managed by the Mahatma Gandhi Memorial Hospital under the control of the KwaZulu Natal Department of Health. Physiotherapists, occupational therapists, speech therapists, psychologists, a social worker, a doctor and a nurse form the multi-disciplinary team. Patients who are seen at this institution are referred via one of the provincial hospitals, clinics or nearby general practitioners. Patients have to reside in the Phoenix, Inanda, KwaMashu, Verulam or surrounding area to be treated at this centre.

The physiotherapy program for stroke patients at the centre consists of a one hour long, fortnightly session. Treatment comprises of either individual therapy by therapists or standardised group therapy administered by therapists or assistants. Patients who are able to mobilise independently, either with or without an assistive device, and require minimal individual attention are treated in the stroke group. At the end of each session, the patient is given their next appointment date.

Sample size:

Since no previous studies utilizing the same methodology as this study could be found in the literature, and it was difficult to estimate the size of the effect of the intervention on the outcomes, it was decided to use a sample size which was practical for the researcher given the constraints of the availability of participants, which was fifty participants in total. Thus it was not guaranteed that statistical significance would be achieved or if a clinically important effect of the intervention would be found. It was possible that the sample size of fifty would have been insufficient to adequately power the study to detect an effect if the effect size was moderate or small. In this case, the absolute changes and trends will be observed and commented on in order to assess the effect of the intervention.

3.3 Instrumentation

The instruments for this study allowed for the quantification of stability, balance and functional independence pre-test and post-test. Stability and balance were monitored pre-test and post-test using the Postural Assessment Scale for Stroke Patients (PASS) and The Berg Balance Scale (BBS) (appendices 9 and 14) respectively. The Barthel Index (BI) (appendix 19) as described earlier was used to assess functional independence. The PASS, BBS and BI have been described in the literature review. Validity and reliability of these tools were achieved using a pilot study, which will be discussed later in the thesis.

Validation of the above tools and various others were done by de Morton et al in 2008 whereby all scales were assessed according to the same criteria namely, feasibility for all patients (bed bound or ambulating), response potions, scoring systems, equipment requirements and time to administer.

In 2003 Mao et al concluded that the PASS and BBS showed high levels of reliability, validity and consistency as previously mentioned. Similarly, Minosso et al (2010) recently found that the BI was reliable and valid.

The participant's demographic profile was captured in a data information sheet (appendix 7) wherein all personal details were coded.

A questionnaire consisting of open-ended and closed ended questions, based on the literature (Mamabolo et al, 2008; Pound et al, 1994; Rittman et al, 2004), was drawn up (appendices 24 and 25). The purpose of the questionnaire was to gather information about the participant's functional abilities and daily living. The results of the questionnaire were not analysed for purposes of the desired outcome of the study, but merely considered to assist the understanding of the quantitative data. Validity and reliability of the questionnaire was assured by the same pilot study as the other tools, described later in the thesis.

The control and experimental groups had to undertake a normal physiotherapy session or an intervention program respectively for a twelve week period. The control group received the normal physiotherapy session (appendix 27) as usual for thirty minutes with three breaks of two minutes every ten minutes in each session. The experimental group received the stability and balance correcting techniques and weight-bearing exercises which made up the intervention program (appendix 26). Both groups received the same duration of session and number of breaks. The control group received physiotherapy to ensure that ethical principles were not violated by removing a minimal standard of care.

A pilot study was carried out to validate the instruments used for this study. Four randomly selected stroke participants were assessed over a three week period with one intervention or exercise session per week at the Phoenix Assessment and Therapy Centre. This was done from April-May 2010, before the process of data collection for the project took place. The participants were randomly divided into experimental and control groups, resulting in two participants per group. The reason for this particular time frame for the pilot study was so that the researcher could carry out the pre-tests, post-tests and intervention or exercise program in that period. On the first and last week, the PASS, BBS, BI pre-test and post-test scores and questionnaires were taken, whilst on the second week a portion of the balance and stability intervention program and physiotherapy exercise program was carried out. The component of the balance and stability intervention program that was used for the pilot study was chosen as the first item that appeared on the list (appendix 25). Equipment and the location utilised were exactly the same as those required for the study. No modifications were made to the three instruments used and participants were assessed according to the respective scoring as indicated (appendices 8, 13 and 18). The purpose of using the tools for pre-test and post-test scores were achieved in this pilot study, making all three tools valid as previously mentioned by Mao et al., 2003 and Minosso et al., 2010.

3.4 Procedures

Ethical clearance was obtained from the Bio-Medical Research Ethics Committee of the University of Kwa-Zulu Natal (appendix 1). Approval from the Department of Health, the Hospital Manager of the Mahatma Gandhi Memorial Hospital and the Acting Rehabilitation Co-ordinator at the Phoenix Assessment and Therapy Centre (appendices 2, 3 and 4) was also requested and obtained.

Two treatment rooms in the physiotherapy department at the Phoenix Assessment and Therapy Centre were allocated for the data collection. One room was assigned to the control group and the other to the experimental group to avoid participants conversing and tainting results. Both rooms were well ventilated and spacious with non-slippery flooring. The room for the control group was equipped with a mirror, railing and gym mats whilst the room for the experimental group contained two chairs, a bobath plinth, a bed side stool and a gym mat. The difference in the equipment in the two rooms was due to the different requirements of each rehabilitation programme. During data collection it was ensured that the doors of both rooms were closed to ensure privacy and confidentiality of the participants.

Recruitment of participants was done by the researcher obtaining the appointment book for stroke patients at the physiotherapy department of the Phoenix Assessment and Therapy Centre. All patients were screened using inclusion and exclusion factors. Fifty potential participants were identified and all fifty participants consented voluntarily. These participants were then randomly assigned (25 each) to the experimental and control groups.

The researcher carried out all subsequent demographic information collection, PASS, BBS and BI scale assessments and implementation of both intervention and normal physiotherapy activities. On the first visit, the Postural Assessment Scale, the Berg Balance Scale, Barthel Index and demographic questionnaire were administered. Physiotherapy for both the experimental and control groups continued for 12 sessions, fortnightly, for six months. On the last day of data collection the post-test scores for the Postural Assessment Scale, the Berg Balance Scale, Barthel Index and questionnaire was taken again. On the last day, participants were also asked to verbalise their thoughts and feelings as per the questionnaire (appendices 24 and 25). This assisted the understanding of the quantitative aspect of the study

3.5 Data Analysis

The SPSS package was used for analysis of qualitative and quantitative data**.** The raw data was normalized by calculating percentage changes for each item for each participant. Data was normalized to eliminate variations between participants because it was not possible to obtain a baseline with minimal variation. Normalized values were subjected to repeated measures of Wilcoxon signed ranks testing and paired samples signed tests to assess the effect of the intervention relative to the control. Pearsons correlations allowed the determination of correlations between PASS and BBS, PASS and BI and BBS and BI. A p value ≤ 0.05 was considered as statistically significant. Tables and graphs allowed for the illustration of the results comparing control and experimental groups.

Chapter 4: Results

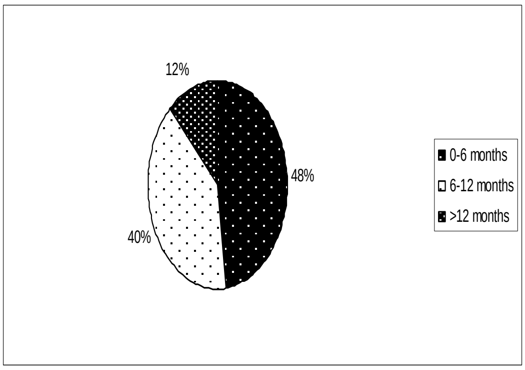
Fifty participants completed the study protocol, 25 in each of the control and experimental groups. A disruption to the data collection occurred for a three week period due to the public servants strike. Participants did not attend appointments during this time. This will be discussed further later in the thesis. The demographic profile of the participants is reflected in Table 1.

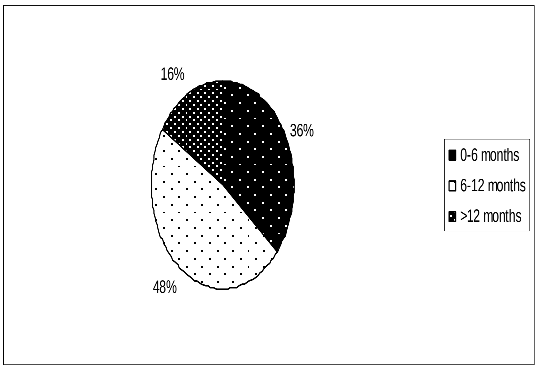
Table 1: Demographic Information of participants comprising of the control and experimental groups

	Control group	**Experimental group**	**p Values (between control and experimental groups)**
Side affected: (R) hemiplegia- (R) dominant	3 (12%)	1 (4%)	p=0.03
(R) hemiplegia- (L) dominant	1 (4%)	2 (32%)	
(R) hemiparesis- (R) dominant	5 (20%)	- (0%)	p=0.02
(R) hemiparesis- (L) dominant	5 (20%)	3 (12%)	
(L) hemiplegia- (R) dominant	2 (8%)	2 (8%)	
(L) hemiplegia- (L) dominant	7 (28%)	3 (12%)	
(L) hem paresis- (R) dominant	2 (8%)	5 (20%)	p=0.02
(L) hemiparesis- (L) dominant	- (0%)	3 (12%)	p=0.01
	25(100%)	**25(100%)**	
Age: 0-34 yrs	0	1 (4%)	
35-49 yrs	2 (8%)	6 (24%)	
50-74 yrs	22 (88%)	16 (64%)	p=0.01
> 75 yrs	1 (4%)	2 (8%)	
	25(100%)	**25(100%)**	
Sex: Male	11 (44%)	15 (60%)	
Female	14 (56%)	10 (40%)	p=0.02
	25(100%)	**25(100%)**	
	p<0.05	p<0.05	
Race: Black	4 (16%)	6 (24%)	p=0.04
Indian	21 (84%)	19 (76%)	
	25(100%)	**25(100%)**	
	p>0.05	p>0.05	

As shown in Table 1, significantly different proportions of hemiplegic patients by side affected and hand dominance made up the groups. Significantly more of the participants were male and over the age of 34 in the experimental group. The participants were predominantly Indian in both groups (p> 0.05).

When considering the dates of when the cerebrovascular attacks occurred, a large percentage of the participants in the control group reported between two weeks and six months, whilst the majority in the experimental group reported the attack between six to twelve months ago (p<0.05). One of the participants from the control group suffered the attack three years ago and four participants had their attack over a year ago, with two having had the attack two years and two and a half years ago from the experimental group. This is illustrated in figure 1 below.



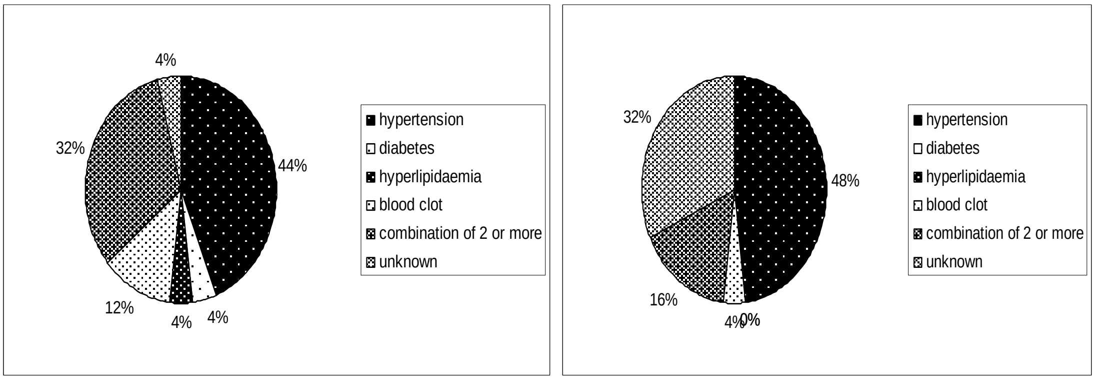


CONTROL GROUP **EXPERIMENTAL GROUP**

Figure 1: Proportion of participants in each category of duration of stroke from date of the cerebrovascular attacks in the control and experimental groups respectively

Participants indicated that they were not aware of the stroke subtype (ischaemic or haemorrhagic) which resulted in their cerebrovascular incidents. However, they did provide information on the resulting problems which was explained to them by medical personnel attending to them at the time of their attacks.

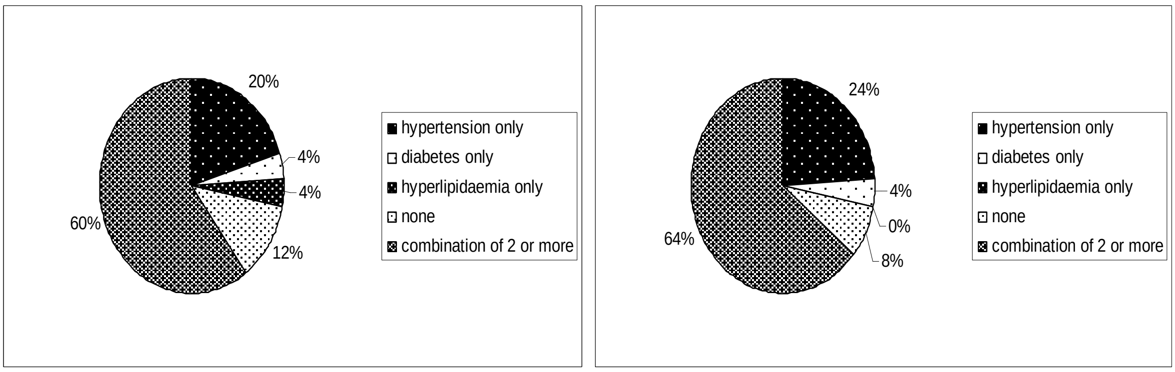
As seen in figure 2 that follows, in both control and experimental groups, hypertension was reported as a significant cause of the attack. Other co-morbidities like Diabetes Mellitis, Hyperlipidaemia and blood clots were also mentioned. A small percentage of participants in both groups reported having no known cause to their attacks.



<u>CONTROL GROUP</u> **<u>EXPERIMENTAL GROUP</u>**

<u>Figure 2</u>: Proportions of participants in each group presenting with conditions that caused the cerebrovascular attacks

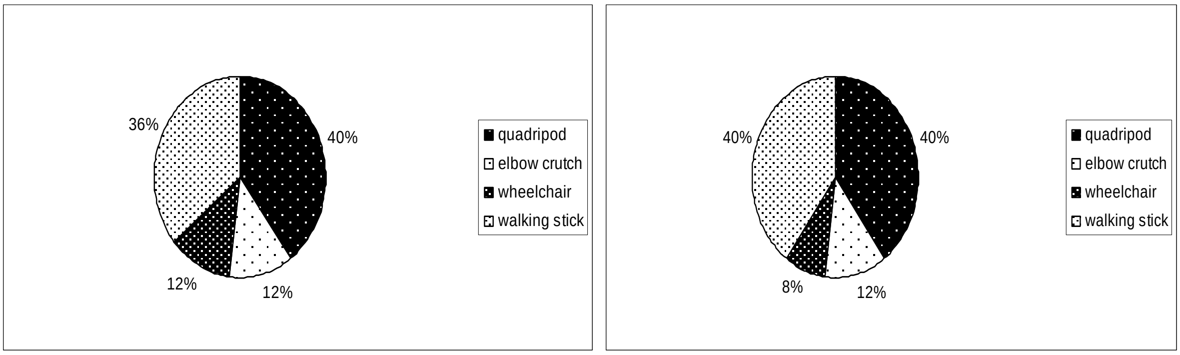
The figure 3 below shows the co-morbidities suffered by the participants in percentages for the control and experimental groups. In both groups a significantly large percentage of the participants reported having a combination of two or more medical conditions which included cardiac problems, obesity and arthritis. Three participants (two from control, one from experimental) reported suffering from chronic depression.



<u>CONTROL GROUP</u> **<u>EXPERIMENTAL GROUP</u>**

<u>Figure 3</u>: Proportions of participants in the control and experimental groups who suffered selected co-morbidities

The majority of the participants from both groups needed the assistance of either a quadripod or walking stick. A small percentage of the participants were wheelchair dependant. One of the experimental group participants did not comply with a suggested rehabilitation program, (reported by his caregiver) and performed very poorly in all pre-tests and post-tests.



CONTROL GROUP **EXPERIMENTAL GROUP**

Figure 4: Proportions of control and experimental group participants who required different assistive devices

When considering case history, participants from both groups sought medical attention from either the private or public sectors or their local clinics or doctors at the time of their attacks. Eleven and nine from the control and experimental groups respectively reported having no tests and investigations done. Reasons that were stated for having no investigations included 'the machines were out of order', 'tests were too expensive' and 'medical funds had run out.' When asked why the eight participants from the control group and six from the experimental group had not attended a hospital following their attacks, three reported 'having no finances' whilst eight complained about the 'long queues at the hospitals.'

Assessment of Stability

The Postural Assessment Scale for Stroke Patients (PASS) was used to test stability. Detailed scoring for the fifty participants and the percentage changes of both groups can be found in the appendices 10 and 11.

Table 2 shows the summary of the numbers of participants in each group who improved or had no changes in their scores on the PASS. A significantly higher number of participants had an increase in scoring between pre-test and post-test in the experimental group.

For item three (standing with no support), nineteen participants from the experimental group and eight from the control group showed an increase in scoring. Twenty three participants from the experimental group compared to six from the control group had increased scores for item five (standing on paretic limb). Another twenty participants from the experimental group and three from the control group had higher scoring for item eight (supine to sitting) whilst eighteen from the experimental group and four from the control group showed increases in item ten (sit to stand without support).

Item one (sitting with no support) showed no changes in both groups. One participant from the experimental group had an increase of two points for item four (standing on the non paretic limb).

Table 2: Summary of the numbers of participants in each group who improved or had no changes in their scores on the PASS

Item	Change	Control	Experimental
1	Increased	0	0
	No change	25	25
2	Increased	1	9
	No change	24	16
3	Increased	8	19
	No change	17	6
4	Increased	3	13
	No change	22	12
5	Increased	6	23
	No change	19	2
6	Increased	3	15
	No change	22	10
7	Increased	5	11
	No change	20	14
8	Increased	3	20
	No change	22	5
9	Increased	3	21
	No change	22	4
10	Increased	4	18
	No change	21	6
11	Increased	3	18
	No change	22	7
12	Increased	5	17
	No change	20	8

Table 3 shows the comparisons between the mean control and experimental scores. Percentage changes (appendices 12 and 13) and standard deviations are also shown. Percentage changes in the experimental group scores are noted to be significantly higher than control group for all items, except item one (sitting without support) where there was no significant percentage change noted. Overall percentage changes were significantly higher in the experimental group. Significant differences were found in post-test values compared to pre-test values for item three (standing with no support), item five (standing on paretic limb), item eight (supine to sitting) and item nine (sitting to supine) for both groups.

Table 3: Pre-test and post-test PASS scores by item, percentage change, means and standard deviation for control and experimental groups, p values by item and overall p values showing comparison between percentage change in control versus experimental pre-test and post-test values.

		Cont(mean)	% changes (pr÷po×100)	Exp (mean)	% changes (pr÷po×100)	p values (control vs experimental)
ITEM 1	Pr	2.84	0	2.96	0	0.001
	Po	2.84		3		
ITEM 2	Pr	2.48	1.33	2.28	13.32	0.002
	Po	2.6		2.68		
ITEM 3	Pr	1.64	10.66	1.72	22.64	0.002
	Po	2.04		2.44		
ITEM 4	Pr	2.04	2.66	2	19.68	0.001
	Po	2.16		2.6		
ITEM 5	Pr	1.48	9.32	1.4	30.64	0.016
	Po	1.72		2.28		
ITEM 6	Pr	2.12	4.0	2.16	15.98	0.002
	Po	2.24		2.64		
ITEM 7	Pr	1.8	6.66	1.84	14.65	0.018
	Po	2.08		2.28		
ITEM 8	Pr	1.92	4.0	1.6	26.64	0.002
	Po	2.04		2.44		
ITEM 9	Pr	1.92	4.0	1.56	27.97	0.003
	Po	2.04		2.4		
ITEM 10	Pr	1.4	5.33	1.4	23.98	0.002
	Po	1.56		2.12		
ITEM 11	Pr	1.48	4.0	1.44	23.98	0.001
	Po	1.6		2.12		
ITEM 12	Pr	1.2	6.66	1.16	21.31	0.015
	Po	1.4		1.84		
TOTAL MEAN	Pr	22.4	4.89	21.52	18.09	
	Po	24.12		28.56		
STANDARD DEVIATION	Pr	±0.47	-	±0.5	-	
	Po	±0.42		±0.31		
SIGNIFICANCE		.000		.000		

Assessment of Balance

The Berg Balance Scale (BBS) was used to assess balance. Information on the breakdown of this scale, the detailed scoring and percentage changes of each participant making up the two groups can be found in the appendices 15 and 16.

Table 4 shows the summary of the numbers of participants in each group who improved or had no changes in their scores on the BBS. A significantly higher number of experimental group participants increased their scoring in thirteen items on the BBS. A significantly higher number of participants had an increase in scoring between post-test and pre-test in the experimental group.

One participant from the experimental group had an increase of two points for item four (transferring from one chair to another chair), item ten (turning trunk with feet fixed), item eleven (retrieving objects from the floor), item twelve (turning 360 degrees) and item fourteen (reaching forward while standing).

Table 4: Summary of the numbers of participants in each group who improved or had no changes in their scores on the BBS.

Item	Change	Control	Experimental
1	Increased	0	0
	No change	25	25
2	Increased	10	25
	No change	15	0
3	Increased	9	23
	No change	16	2
4	Increased	2	13
	No change	23	12
5	Increased	4	18
	No change	21	7
6	Increased	0	14
	No change	25	11
7	Increased	0	14
	No change	25	11
8	Increased	3	18
	No change	22	7
9	Increased	3	18
	No change	22	7
10	Increased	2	15
	No change	23	10
11	Increased	2	14
	No change	23	11
12	Increased	1	18
	No change	24	7
13	Increased	3	21
	No change	22	4
14	Increased	3	16
	No change	22	9

Table 5 shows the comparisons between the mean control and experimental scores. Percentage changes (appendices 17 and 18) and standard deviations are also shown. Percentage changes in the experimental group scores were noted to be significantly higher than control group for all items, except item one (sitting unsupported) where no percentage change was noted. Overall percentage changes for the experimental group were significantly higher. Significant differences were found in post-test values compared to pre-test values for item three (standing to sitting), item nine (standing on one limb) and item thirteen (stool stepping) for both groups.

<u>Table 5</u>: Pre-test and post-test BBS scores by item, percentage change, means and standard deviation for control and experimental groups, p values by item and overall p values showing comparison between percentage change in control versus experimental pre-test and post-test values.

		Cont(mean)	% changes (pr÷po×100)	Exp (mean)	% changes (pr÷po×100)	p values (control vs experimental)
ITEM 1	Pr	3.76	0	4	0	0
	Po	3.76		4		
ITEM 2	Pr	1.8	10.0	1.76	25.0	0.002
	Po	2.2		2.76		
ITEM 3	Pr	1.8	9.0	1.76	25.0	0.002
	Po	2.2		2.76		
ITEM 4	Pr	1.64	1.0	1.6	14.0	0.001
	Po	1.68		2.2		
ITEM 5	Pr	1.88	4.0	1.76	19.0	0.016
	Po	2.04		2.48		
ITEM 6	Pr	1.52	2.0	1.44	15.0	0.015
	Po	1.64		2		
ITEM 7	Pr	1.72	0	1.68	14.0	0.001
	Po	1.72		2.24		
ITEM 8	Pr	1.88	2.0	1.8	17.0	0.002
	Po	1.96		2.48		
ITEM 9	Pr	1.32	4.0	1.28	15.0	0.016
	Po	1.56		1.92		
ITEM 10	Pr	1.84	3.0	1.88	16.0	0.001
	Po	2		2.52		
ITEM 11	Pr	1.32	2.0	1.28	15.0	0.001
	Po	1.4		1.4		
ITEM 12	Pr	1.6	2.0	1.52	17.0	0.015
	Po	1.68		2.08		
ITEM 13	Pr	1.72	3.0	1.52	21.0	0.002
	Po	1.84		2.36		
ITEM 14	Pr	1.24	3.0	1.16	17.0	0.002
	Po	1.4		1.88		
TOTAL	Pr	24.72	3.21	24.36	16.43	0.003
	Po	26.6		33.4		
STANDARD DEVIATION	Pr	±0.61	-	±5.9	-	
	Po	±0.59		±8.03		
SIGNIFICANCE		.000		.000		

Assessment of function

The Barthel Index (BI) was used to assess function in this project. The data representing pre-test and post-test BI scores and percentage changes for all participants in the control and experimental groups is included in appendices 20 and 21.

Table 6 shows the summary of the numbers of participants in each group who improved or had no changes in their scores on the BI. A significantly higher number of participants had an increase in scoring for six items between post-test and pre-test in the experimental group. Items that tested dressing, toilet use, transfers and mobility on level surfaces showed significant increases for the experimental group.

Table 6: Summary of the numbers of participants in each group who improved or had no changes in their scores on the BI

Item	Change	Control	Experimental
1	Increased	0	0
	No change	25	25
2	Increased	0	1
	No change	25	24
3	Increased	0	4
	No change	25	21
4	Increased	1	9
	No change	24	16
5	Increased	0	0
	No change	25	25
6	Increased	0	0
	No change	25	25
7	Increased	1	8
	No change	24	17
8	Increased	3	23
	No change	22	2
9	Increased	4	23
	No change	21	2
10	Increased	6	6
	No change	19	19

Table 7 shows the comparisons between the mean control and experimental scores. Percentage changes (appendices 22 and 23) and standard deviations are also shown. Percentage changes in the experimental group scores are noted to be significantly higher than control group for six of the ten items. For item one (feeding), item five (bowel control), item six (bladder control) and item ten (stairs) there was no significant percentage change noted. Overall percentage changes were significantly higher in the experimental group.

<u>Table 7</u>: Pre-test and post-test BI scores by item, percentage change, means and standard deviation for control and experimental groups, p values by item and overall p values showing comparison between percentage change in control versus experimental pre-test and post-test values.

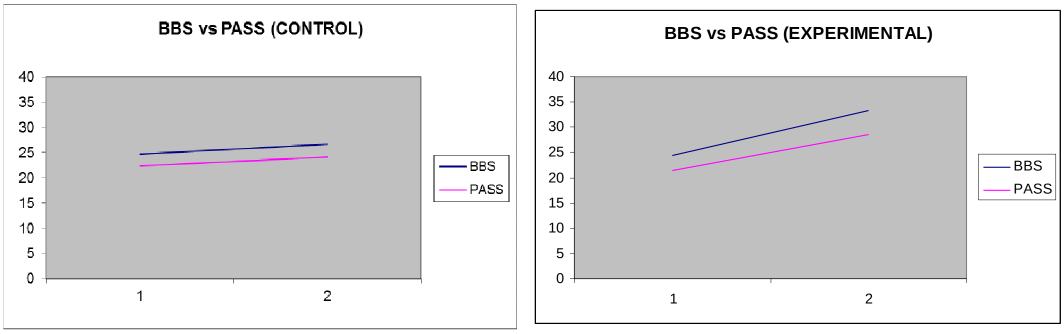
		Cont (mean)	% changes (pr÷po×100)	Exp (mean)	% changes (pr÷po×100)	p values (control vs experimental)
ITEM 1	Pr	8.8	0	9.4	0	0
	Po	8.8		9.4		
ITEM 2	Pr	3.2	0	3	2.0	0.011
	Po	3.2		3.2		
ITEM 3	Pr	2.8	0	2.4	8.0	0.001
	Po	2.8		3.2		
ITEM 4	Pr	5	1.33	4.2	11.99	0.001
	Po	5.2		6		
ITEM 5	Pr	9.6	0	9.6	0	0
	Po	9.6		9.6		
ITEM 6	Pr	9.2	0	9.6	0	0
	Po	9.2		9.6		
ITEM 7	Pr	7	1.33	6	11.99	0.001
	Po	7.2		7.8		
ITEM 8	Pr	8.6	3.0	7.6	23.0	0.002
	Po	9.2		12.2		
ITEM 9	Pr	8.8	4.0	7	23.0	0.002
	Po	9.4		11.4		
ITEM 10	Pr	4.1	7.99	4.2	7.99	0
	Po	5.4		5.4		
TOTAL	Pr	67	1.77	63	8.79	0.003
	Po	70.2		78		
STANDARD DEVIATION	Pr	±2.7	-	±2.8	-	
	Po	±2.7		±3.2		
SIGNIFICANCE		.000		.000		

The table on the next page denotes the values for the Pearson's correlation coefficient for the three scales. It shows correlations of pre-test and post-test scores within the experimental and control groups as well as between the two groups.

<u>Table 8:</u> Pearson's correlation coefficients for pre-test and post-test scores of control and experimental groups for the PASS, BBS and BI

	PASS	**BBS**	**BI**
Exp Pr vs Exp Po	1.94	0.94	0.96
Cont Pr vs Cont Po	0.99	0.99	0.99
Exp Pr vs Cont Pr	-0.22	-0.11	-0.20
Exp Po vs Cont Po	-0.19	-0.02	-0.16

<u>Relationship between balance (BBS) and stability (PASS)</u>



<u>Figure 5</u>: Mean values of control and experimental groups showing the relationship between BBS and PASS

The figure above showed that BBS scores were directly proportional to PASS scores, indicating that balance was dependant on stability. Based on the average scores of the pre-test and post-test of BBS and PASS, the experimental group showed better increases in values. There was also a greater difference in pre-test and post-test values in the experimental group, showing an improvement in balance and stability. The Pearson's correlation coefficient for BBS and PASS was 0.34.

Relationship between function (BI) and stability (PASS)

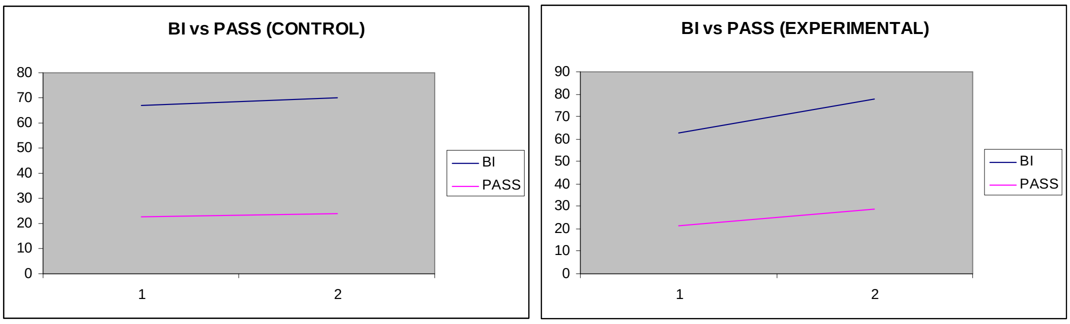


Figure 6: Mean values of control and experimental groups showing the trend between BI and PASS

In the above figure it can be seen that there is a trend between BI and PASS mean values, where function seems to depend on stability. BI and PASS mean values were higher in the experimental group. It also showed a greater difference in pre-test and post-test values in the experimental group, showing an improvement in function and stability. The Pearson's correlation coefficient for BI and PASS was 0.98.

Relationship between function (BI) and balance (BBS)

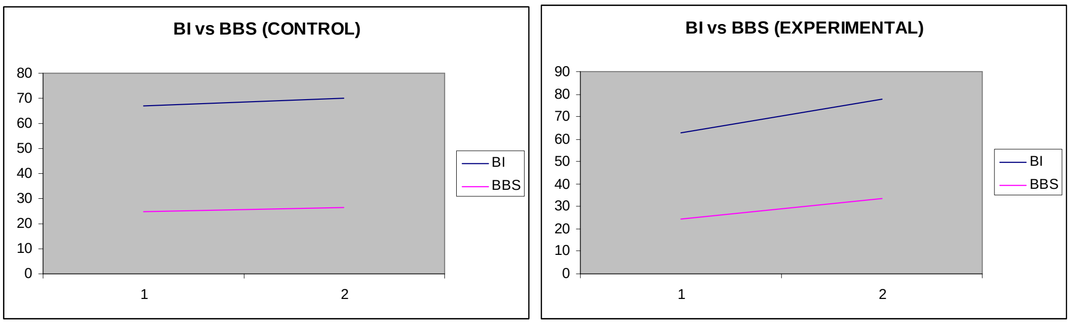


Figure 7: Mean values of control and experimental groups showing the trend between BI and BBS

From the data produced in this study, it was seen that there was a trend between BI and BBS, where function seems to be dependent on balance. BI and BBS were higher in the experimental group. It was also evident that there was a greater difference in pre-test and post-test scores in the experimental group, showing better improvement in both function and balance. The Pearson's correlation coefficient for BI and BBS was 0.97.

Interview Responses

Sitting without support:

All participants stated that they could sit without support, however, if the height of the seat from the floor varied, participants from the control group and experimental group reported they would have difficulty getting into and out of the chair. These responses did not change in the post-test interview.

Standing without support:

Responses from participants in both the control and experimental groups ranged from initially needing support to stand at all times in the pre-test interview to needing only some support when standing or being able to stand unsupported for longer periods in the post-test interview.

Assistive devices:

Proportions of the participants from both groups who required assistive devices are noted in figure 4 earlier in the results. Following the stability and balance intervention program in the experimental group, some participants had reported being able to mobilise independently or with less difficulty using their devices. No changes were reported in the use of the devices with the control group.

Eating:

Participants from both groups reported needing their ‘food being cut up’ when eating. No changes were reported in the post test interview.

Bathing:

Methods of bathing reported by the participants from both groups included being seated in a bath tub or shower or having a wipe in bed. Responses of some of the control and experimental groups ranged from being totally dependent on their caregiver for bathing initially to needing assistance with ‘shaving’ and ‘brushing of teeth’ in the post-test interview.

Dressing

Degrees of difficulty with dressing reported by the participants of both groups included being unable to fasten **'**buttons', 'zips' or 'tie shoe laces.'

Perceptions of stability and balance:

Participants stated that their balance when they walked and stood was 'poor', verbalising that since the stroke, 'they are less confident when walking as they lose balance very often', however in the post-test interview, they reported a 'great improvement' in their standing balance. Participants reported 'stumbling' and 'forgetting about the stroke side' as their biggest hurdles when doing daily activities. Balance when performing duties like sitting down and standing up from a toilet and getting into and out of a bath or shower posed a problem in the pre-test interview.

Chapter 5: Discussion

The most important finding of this project revealed that a balance and stability intervention programme improved balance, stability and function in a group of randomly selected stroke patients. The results and findings were achieved using specifically formulated physiotherapy assessment tools, based on the literature for stability, balance and function, evidence was provided that for this group of participants there was a significant increase found in the above-mentioned variables tested.

Demographic Information

Literature reviewed for this project showed a trend with regard to age of participants. Shah et al (1989) showed a mean age of 67 years with their subjects, whilst the research done by Bagg et al in 2002 showed participants to fall within the 50 to 70 year age bracket. Likewise, the individuals that made up the control and experimental groups for this study also complied with these findings, as 88% and 64% of the above mentioned groups were between 50 and 74 years old respectively (table 1). Although a comparatively larger percentage of the control group was middle to older aged, this did not negatively impact on this study as initial functional, balance and stability scores did not show discrepancies based on ages in either of the two groups. This suggested that age was not a determining factor of independence in stroke patients which was also concluded by Soyuer et al in 2005 who found that age was an independent parameter in patients with stroke.

Forty four percent and 60% of the participants were male in the control and experimental groups respectively (table 1). Gender differences did not affect the outcome of this study as there were no significant differences in the results of both quantitative and qualitative components regarding gender in both control and experimental groups. Although gender differences were noted for the incidences of stroke in many of the articles reviewed (Falcone et al., 2007; Rost et al., 2008; Wade et al., 1992), none of them reported correlations of gender with function.

Hemiplegia or hemiparesis are common presentations secondary to a stroke. These varying degrees of disability are based on a number of factors which affect the sufferer with functional ability (Nichols, 1997). In the randomised selection of participants that formulated the groups for this study, both left and right hemiparesis and hemiplegia with the related side dominances were represented in differing numbers (table 1). All four presentations were found in both control and experimental groups in varying severities.

There were no significant relationships between side affected, type of presentation or side dominance with stability, balance or function that could be made in this sample but is recommended for exploration in another project.

Conditions that caused Cardiovascular Attacks

Stroke subtype is one of the characteristics that can be identified and compared with functional ability (Mamabolo et al., 2008). Although stroke subtype has been shown to have an influence on functional independence in some studies, (Rost et al., 2008, Hurwitz et al., 1972), these could not be established in this study as it was not common practise for patients to be diagnosed or classified according to stroke subtype in the referral hospitals included in this study. When requiring information from the participants on the cause of their attacks, it could not be established as to whether ischaemic or haemorrhagic strokes were encountered as this was neither known to the participants nor was it found on referral letters. The information that was gathered from participants was the response of the individual's body to the actual cause. Poorly managed medical conditions like hypertension, hyperlipidaemia, diabetes melittus and cardiac complications together with inadequate circulation caused by blood clots are broadly related to causing strokes (Bupa's Health Information Team, 2009). Both groups reported that uncontrolled hypertension lead to the onset of their strokes with eleven participants justifying this with not taking their medication routinely. Four participants mentioned never being diagnosed as hypertensive before their attacks. A further 16% from the experimental group stated that the cause of their attack was unknown as they were medically stable at the time of their attacks and experienced no symptoms preceding their attacks (figure 2).

Co-morbidities

Inevitably the occurrence and severity of secondary conditions can limit the person's ability to perform essential tasks and social roles. In addition to being predisposed to secondary complications, stroke patients often also have predisposing illnesses that have been identified as modifiable risk factors for stroke. These include hypertension, diabetes mellitus, cardiac disease and hyperlipidaemia (Biggs et al., 2008). Only 20% of all the participants indicated that they suffered no medical conditions, with the majority of the remaining 80% of participants in both groups reporting more than one chronic condition (figure 3). This finding was similarly highlighted by Biggs et al in 2008, who stated that patients suffering more than one co-morbidity are at a higher at risk of a stroke.

UNIVERSITY OF
KWAZULU-NATAL

RESEARCH OFFICE
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
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
Website: http://research.ukzn.ac.za/ResearchEthics/BiomedicalResearchEthics.aspx

25 May 2010

Professor. L Puckree
c/o Ms P Naidoo
Dept. of Physiotherapy
Westville Campus
University of KwaZulu- Natal

Dear Prof Puckree

PROTOCOL: A randomised controlled trial to assess the effect of a balance and stability training intervention on balance and functional independence in stroke patients.
REF: BFC018/010

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application.

The study was approved by a quorate meeting of BREC on 09 February 2010 pending appropriate responses to queries raised. Your responses dated 23 May 2010 to queries raised on 29 April 2010 have been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given full ethics approval and may begin as from 25 May 2010.

This approval is valid for one year from **25 May 2010.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2004), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC

Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/ResearchEthics11415.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The following Committee members were present at the meeting that took place on 09 February 2010:

Professor D Wassenaar	Chair
Professor V Rambiritch	Pharmacology
Professor D J Pudifin	Medicine
Mrs P Naidoo	External
Dr Z Khumalo	KZN Health (External)
Ms T Esterhuizen	Faculty of Medicine
Dr U Govind	Private Pract. - Gen. Practitioner
Professor T E Madiba	General Surgery
Ms J Hadingham	HEARD
Dr T Hardcastle	Surgery - Trauma
Mr R Moore	IPO - Research Office
Ms T Makhanya	External
Prof Puckree	Physiotherapy
Dr M A Sathar	Medicine
Prof R Bhimma	Paediatrics and Child Health
Dr R Govender	Family Medicine
Dr S Paruk	Psychiatry

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

PROFESSOR D R WASSENAAR
Chair: Biomedical Research Ethics Committee

HEALTH
KwaZulu-Natal

Health Research & Knowledge Management sub-component
10 – 102 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 395 2805
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference: HRKM081-10
Enquiries: Mr X. Xaba
Telephone: 033-395 2805

02 June 2010

Dear Ms P. Naidoo

Subject: Approval of Research

1. The research proposal titled **"A randomised controlled trial to assess the effect of a balance and stability training intervention on balance and functional independence in stroke patients"** was reviewed by the KwaZulu-Natal Department of Health. The proposal is hereby **approved** for research to be undertaken at the Phoenix Assessment and Therapy Centre

2. You are requested to undertake the following:
   a. Make the necessary arrangement with identified facility before commencing with your research project.
   b. Provide an interim progress reports and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za.

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

Dr. S.S.S. Buthelezi
Date: 04. 06. 2010
Chairperson: Provincial Health Research Committee
KwaZulu-Natal Department of Health

HEALTH
KwaZulu-Natal

MAHATMA GANDHI MEMORIAL HOSPITAL
Postal Address: Private Bag X 13, Mount Edgecombe, 4300
Physical Address: 100 Phoenix Highway, Phoenix 4068
Tel. 031 502 1719 Fax. 031 502 1869
Email.:shaylin.govender@kznhealth.gov.za
www.kznhealth.gov.za

ENQUIRIES: Dr. C. Persad
TELEPHONE: 031 502 1719 Ext 2011
DATE: 18 May 2010

MS. P. NAIDOO
SENIOR PHYSIOTHERAPIST
MAHATMA GANDHI MEMORIAL HOSPITAL

RE: PERMISSION TO CONDUCT STUDY (RANDOMISED CONTROLLED TRIAL TO ASSESS THE EFFECT OF A BALANCE AND STABILITY TRAINING INTERVENTION ON BALANCE AND FUNCTIONAL INDEPENDENCE IN STROKE PATIENTS

I wish to inform you that permission is hereby granted for you to conduct the above mentioned study at Phoenix Assessment and Therapy Centre provided that permission is granted by KZN Department of Health and full ethics approval is obtained.

Kindly submit proof of permission from the KZN Department of Health and ethical approval so that the necessary arrangements can be made.

YOURS FAITHFULLY

C Persad

DR. C. PERSAD
MEDICAL MANAGER
MAHATMA GANDHI MEMORIAL HOSPITAL

Appendix 4

The Acting Rehabilitation Manager
The Phoenix Assessment and Therapy Centre

29 March 2010

Dear Sir/Madam

I am a Master's student in Physiotherapy from the University of Kwa-Zulu Natal (Westville campus). I am conducting a research study and would greatly appreciate your assistance.

Stroke is one of the leading causes of death and a major cause of disability globally. It often affects the performance of daily activities that are necessary to live a normal life. Balance and stability is critical in the development of motor function. Various treatment/rehabilitation strategies have been developed using the principle that stability precedes movement not only in the developing child but also in the brain impaired adult. However in many instances, therapists have to subscribe to post graduate courses before being able to implement these therapies. Physiotherapists however also rely on simple balance and stability training in everyday rehabilitation and no evidence for the effectiveness of these in improving function and quality of life in stroke patients exists.

Ethical clearance will be received prior to data collection. Approval from the Department of Health, Hospital Manager and Medical Manager of Mahatma Gandhi Memorial Hospital will also be requested.

This study will be conducted at The Phoenix Assessment & Therapy Centre. 50 subjects will be randomly chosen. Each subject will be required to complete a consent form and all personal information will be confidential. Subjects will be asked to attend 12 sessions for this study. On the 1st day, they will be asked to do 2 balance tests (which includes testing their balance in positions like sitting, standing, bending and climbing stairs) and an activity test (which includes bathing, feeding, dressing and standing). They will also be asked a few questions on their lifestyle and coping with activities at home on the same day. They will then be divided into 2 groups for the study.

One group will be taught different balance exercises and asked to continue these exercises for 10 sessions. The other group will continue with their normal physiotherapy at the physiotherapy department. On the last day of the study, the 2 balance tests and the activity test will be taken again. This will allow us to see if the balance exercises have helped the 1 group in doing their daily activities at home.

I would kindly appreciate your permission to conduct this research project and look forward to your urgent reply.

Please find attached a copy of the research proposal with all relevant documents. Should you have any queries, please feel free to contact either myself or my research supervisor.

Yours faithfully,

____________________   ____________________

Ms P Naidoo
UKZN-Westville Campus
Registration No: 200204620
Cell : 083 7506 852
Tel (H) : 031 505 0668

Professor T Puckree
Research Supervisor
Physiotherapy
Tel (W): 031-2607977

Appendix 5: Consent form-English

STUDY: A randomized controlled trial to assess the effect of a balance and stability training intervention on balance and functional independence in stroke patients

Information about the Study

Dear Patient/Care-giver

I am a Master's student in Physiotherapy from the University of Kwazulu Natal (Westville Campus). I am conducting a research study and would greatly appreciate your assistance.

Stroke is one of the causes of death. It often affects the patient performing daily activities that are necessary to live a normal life like bathing, eating and dressing.

In this study, I would like to see if a balance exercise programme will help a patient in performing daily activities more easily. I would like you to participate in this study.

This study will take place in a treatment room in the Phoenix Assessment and Therapy Centre (PATC). It will be carried out on your appointment days at the Centre, so no further inconvenience will be asked.

You will be asked to attend 12 sessions for this study. On the 1st day, you will be asked to do 2 balance tests (which includes testing your balance in positions like sitting, standing, bending and climbing stairs) and an activity test (which includes bathing, feeding, dressing and standing). You will also be asked a few questions on your lifestyle and coping with activities at home on the same day. You will then be divided into 2 groups for the study.

One group will be taught different balance exercises and asked to continue these exercises for 10 sessions. The other group will continue with their normal physiotherapy at the physiotherapy department. On the last day of the study, the 2 balance tests and the activity test will be taken again. This will allow us to see if the balance exercises have helped the 1 group in doing their daily activities at home.

There will be a total of 50 people in this study who will all be from South Africa and from the Phoenix Assessment and Therapy Centre.

There is no risk or discomfort involved.

Those who participate in this study will be given information on the study and the results of the study once completed. Your participation in this study is voluntary and you may withdraw at any time. Refusal to participate will involve no penalty or loss of benefit.

Every effort will be made to keep personal information confidential. Your participation in this study will aid in our understanding of balance and how it affects stroke patients.

Thank you for your time.

STUDY: A randomized controlled trial to assess the effect of a balance and stability training intervention on balance and functional independence in stroke patients

Consent to participate in the Study

Dear Patient/Care-giver

I am a Master's student in Physiotherapy from the University of Kwazulu Natal (Westville Campus). I am conducting a research study and would greatly appreciate your assistance.

Stroke is one of the causes of death. It often affects the patient performing daily activities that are necessary to live a normal life.

In this study, I would like to see if a balance exercise programme will help a patient in performing daily activities more easily. I would like you to participate in this study.

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One group will be taught different balance exercises and asked to continue these exercises for 10 sessions. The other group will continue with their normal physiotherapy at the physiotherapy department. On the last day of the study, the 2 balance tests and the activity test will be taken again. This will allow us to see if the balance exercises have helped the 1 group in doing their daily activities at home.

There will be a total of 50 people in this study who will all be from South Africa and from the Phoenix Assessment and Therapy Centre.

You may contact me, Pooveshni Naidoo (Researcher) on 0837506852 or Professor T Puckree (Supervisor) on 031 2607977 at any time if you have any questions about the study.

You may contact the Biomedical Research Ethics Office on 031 2604769/2601074 if you have any questions about your rights as a research participant. Your participation in this research is voluntary and you will not be penalized or lose benefits if you refuse to participate or decide to sop at any time.

The research study, including all the above information, has been described to me orally. I understand what my involvement in this study means and I voluntarily agree to participate.

________________________________ ____________________

Signature of Patient/Care-giver Date

________________________________ ____________________

Signature of Witness Date

Appendix 6: Consent form-isiZulu

IFOMU LOKUVUMA

Sawubona Sigulo/Mnakekli

Ngiwumfundi we Physiotherapy wasenyuvesi yakwa Kwazulu Natal. Ngenza uphenyo kanti ngingakuthokozela ukuthola usizo kuwe.

Isifo sohlangothi enye yezimbangela zokufa. Isifo esijwayele ukukhubaza umzimba eketheni usebenza ngendlela ejwayelekile yansuku zonke, ngengokwenza izinto ngengokugeza, ukudla, ukugqoka.

Kuloluphenyo lokufunda ngifisa ukubona noma ukuthola ukuthi uhlelo lokujima luzosiza yini isiguli sikwazi ukwenza ebesijwayele ukukwenza kalulu. Ngingathanda ubambisane nami kulokukufunda.

Lokukufunda kuzokwenzelwa ePATC. Kuzokwenziwa ngezikhathi zama aphoyimenti, ngakho ngeke kubekhona ukuphazamiseka.

Uzocelwa ukuba uze izikhathi eziwu 12. Kolwokuqala usuku uzocelwaukuba wenze isibivinyo sokuzimelela (okufaka_ukuma, ukuhlala, ukugobakanye nokugibela izitebhisi) kanfi uzocelwa futhi ukuba wenze ithesti yokusebenza (ngengo kugeza, ukudle ukugqoka kanye nokuma). Uzophinde ubuzwe imibuzo embalwa ngempilo yakho nokuthi uzenza kanjani izinto ekhaya. Nizobeke senihlukaniswa amaqembu amabili.

Elokuqala iqembu lizofundiswa ukuzimelela beselicelwa ukuqhubeka nalokho izigamu eziwu 10 kanti elinye lizoqhubeka nokwelashwa kwe Physio okujwayelekile. Ngosuku lokugcina kuzokwenziwa konke futhi ndawonye. Lokhu kuzokhombisa uma okufundiswe kusizile ezigulini ukuba zenze okujwayelekile kangcono kunakuqala. Kuzobe kuneziguli eziwu 50. Kulokukufunda ezizobe ziqhanwka eSouth Afrika ePATC.

Akukho ubungozi noma ukungakhulul eki kulokhu.

Labo abazozi mbandakanya kulesisifundo bazonikwa ulwazikanye enmiphumela uma sekuphele konke. Ukuzimbandakanya kwakho kuloku ukufunda kuwukuzinekela ungaphuma noma inini masuthanda noma nini. Ukuqaba ukungena kulokhu kufunda angeke kukulahlekisele ngalutho. Kuzokwenziwa konke okusemandleni ukugcina ulwazi luyimfihlo. Ukuzimvandakanya kulokhu kufunda kuzosisiza sibone ukuthi kusize kanjani iziguli ezine /stroke/ukufa kohlangothi.

Ngiyabonga ngesikhathi sakho.

Sawubona Sigulo/Mnakekli

Ngiwumfundi we Physiotherapy wasenyuvesi yakwa Kwazulu Natal. Ngenza uphenyo kanti ngingakuthokozela ukuthola usizo kuwe.

Kuloluphenyo lokufunda ngifisa ukubona noma ukuthola ukuthi uhlelo lokujima luzosiza yini isiguli sikwazi ukwenza ebesijwayele ukukwenza kalulu. Ngingathanda ubambisane nami kulokukufunda.

Lokukufunda kuzokwenzelwa ePATC. Kuzokwenziwa ngezikhathi zama aphoyimenti, ngakho ngeke kubekhona ukuphazamiseka.

Uzocelwa ukuba uze izikhathi eziwu 12. Kolwokuqala usuku uzocelwaukuba wenze isibivinyo sokuzimelela (okufaka_ukuma, ukuhlala, ukugobakanye nokugibela izitebhisi) kanfi uzocelwa futhi ukuba wenze ithesti yokusebenza (ngengo kugeza, ukudle ukugqoka kanye nokuma). Uzophinde ubuzwe imibuzo embalwa ngempilo yakho nokuthi uzenza kanjani izinto ekhaya. Nizobeke senihlukaniswa amaqembu amabili.

Elokuqala iqembu lizofundiswa ukuzimelela beselicelwa ukuqhubeka nalokho izigamu eziwu 10 kanti elinye lizoqhubeka nokwelashwa kwe Physio okujwayelekile. Ngosuku lokugcina kuzokwenziwa konke futhi ndawonye. Lokhu kuzokhombisa uma okufundiswe kusizile ezigulini ukuba zenze okujwayelekile kangcono kunakuqala. Kuzobe kuneziguli eziwu 50. Kulokukufunda ezizobe ziqhanwka eSouth Afrika ePATC.

Unangithinta mina Pooveshni Naidoo (umphenyi) ku 083 750 6852 noma uProf T. Puckree ku 031 260 7977 noma nini uma unemibuzo.

Ungathinta umyango we biomedical research ethics office ku 031 260 4769/260 1074 uma unemibuzo ngamlungelo akho njengo phathekayo kuloluphenyo.

Ukuzimbandakanya kwakho kuloku ukufunda kuwukuzinekela ungaphuma noma inini masuthanda noma nini. Ukuqaba ukungena kulokhu kufunda angeke kukulahlekisele ngalutho.

Uphenyo kanye nakho konke kuchaziwe kimi ngendlela. Ngiyagonda ukungena kwami akuphoqiwe. Ngiyavuma ukuba yingxenyi.

________________________________ ____________________

Sayina (ozimbandakanyile) Usuku

________________________________ ____________________

Sayina (ufakazi) Usuku

Appendix 7: Information Sheet

DATE: ______________________________

FILE NUMBER: ______________________________

AGE: ______________________________

DIAGNOSIS: ______________________________

1. Side affected: ____
2. Date of attack/incident: ____
3. Cause of Stroke: ____
4. Hospitalisation: ____
    - If yes, where and how long: _______________________________________
    - Have you had any scans or tests done regarding your stroke? ______________

    ____
5. Do you have any other health problems? ___________________________________
6. How long have you been attending rehabilitation (PT/OT/ST): _______________
7. How do you feel about your progress? ______________________________________
8. Do you have difficulty in performing the following at home? If yes, state the extent of difficulty.

    Bathing yourself: ____

    Dressing yourself: ____

    Going to use a toilet by yourself: ____

    Cooking/cleaning: ____

    Getting into and out of your transport: ____________________________________

	name	file no	age	sex	race	group	side affected	date of attack	cause	other diseases	hospitalisation	t/i	attending rehab	w/aid
1	B Kalideen	500212	60yrs	F	I	exp	R hemiplegia	Apr-10	HPT	HPT, DM	Osind	nil	2 months	Quadripod
2	N Mdunjani	341127	76yrs	F	B	cont	R hemiparesis	Jan-10	HPT	HPT, DM, Cardiac	MGMH	nil	6 months	w/stick
3	S Maharaj	510927	59yrs	M	I	cont	L hemiplegia	May-10	HPT	HPT, DM, Chol	MGMH	nil	2 months	Quadripod
4	L Ramthan	381111	72yrs	F	I	exp	L hemiplegia	Feb-10	HPT	HPT only	MGMH	nil	3 months	w/stick
5	M Pillay	570322	53yrs	M	I	cont	R hemiparesis	Dec-08	bld clot	HPT only	Dr	nil	36 months	Quadripod
6	D Hiramen	530629	57yrs	M	I	cont	L hemiplegia	Jun-09	HPT	HPT, DM, Chol,Arth	MGMH	nil	6 months	w/stick
7	R Rugbar	420102	68yrs	F	I	cont	R hemiplegia	Mar-10	DM	DM only	Dr	nil	2 weeks	e/crutch
8	K Govender	451222	65yrs	F	I	cont	L hemiplegia	Sep-09	HPT	HPT only	MGMH	nil	12 months	Quadripod
9	M Biyela	530707	57yrs	F	B	cont	L hemiplegia	May-10	HPT	HPT only	Dr	nil	6 months	w/stick
10	M Naidoo	300525	80yrs	F	I	exp	R hemiplegia	Jan-10	HPT	HPT, Arth	Mnt Edge	MRI	3 months	Quadripod
11	N Mlambi	740101	36yrs	M	B	exp	L hemiparesis	Jan-09	HPT	HPT only	Dr	nil	12 months	w/stick
12	J Nzimande	520627	58yrs	M	B	exp	L hemiplegia	Nov-09	HPT	HPT only	Dr	nil	6 months	w/chair
13	R Janikaram	400925	70yrs	F	I	cont	L hemiparesis	Jan-10	DM, HPT	HPT, DM, Chol,Arth	MGMH	nil	4 months	Quadripod
14	I Gunpath	570625	53yrs	F	I	exp	R hemiparesis	Apr-10	unknown	nil	Dr	nil	2 months	w/stick
15	R Rampur	631124	47yrs	M	I	exp	L hemiplegia	Dec-09	HPT, Chol	HPT, Chol, Cardiac	MGMH	CT	7 months	Quadripod
16	P Paul	540704	56yrs	M	I	exp	L hemiparesis	Aug-09	HPT	HPT,DM	MGMH	CT	8 months	Quadripod
17	M Samson	490303	61yrs	M	I	cont	R hemiparesis	Feb-10	Chol	Chol only	MGMH	Bld Tests	4 months	w/stick
18	S Mbatha	631203	47 yrs	F	B	exp	R hemiplegia	Oct-09	HPT	HPT only	MGMH	nil	6 months	w/stick
19	D Ramnarain	530121	57yrs	M	I	cont	R hemiplegia	Jun-10	bld clot	nil	Umhl	nil	1 month	Quadripod
20	S Uthum	560213	54yrs	M	I	exp	R hemiplegia	Apr-08	HPT, DM	HPT, DM, Chol,Arth	McCords	CT	24 months	Quadripod
21	G Rambhajen	420110	68yrs	F	I	cont	R hemiparesis	May-10	HPT	HPT only	MGMH	CT	2 months	w/stick
22	Y Hassen	391018	71yrs	M	I	cont	R hemiplegia	Dec-09	HPT	HPT, DM, Dep	Dr	nil	6 months	w/stick
23	M Padayachee	540825	56yrs	M	I	cont	R hemiplegia	Feb-10	HPT	HPT, DM, Cardiac	MGMH	nil	3 months	Quadripod
24	J Buthelezi	540406	56yrs	M	B	exp	L hemiparesis	Nov-09	unknown	HPT, DM	MGMH	CT	10 months	w/stick
25	B Naidoo	520903	58yrs	F	I	exp	R hemiplegia	May-10	HPT, DM, Chol	HPT, DM, Chol	McCords	CT	3 months	Quadripod
26	J Pillay	450514	65yrs	M	I	exp	R hemiplegia	Dec-08	HPT	HPT, DM, Arth	Umhl	nil	36 months	w/stick
27	S Haniff	610224	49yrs	M	I	exp	R hemiplegia	Dec-09	HPT, DM	HPT, DM	MGMH	nil	6 months	w/chair
28	D Kana	590410	51yrs	M	I	exp	L hemiplegia	Apr-10	HPT, DM	HPT, DM	Dr	nil	2 months	Quadripod
29	I Govender	770425	33yrs	F	I	exp	R hemiplegia	Jun-10	HPT	nil	Entab	nil	1 month	e/crutch
30	O Deokunandan	610930	48yrs	F	I	cont	L hemiplegia	May-09	HPT, Chol	HPT, Chol,Obese	MGMH	nil	12 months	Quadripod
31	G Naidoo	541005	56yrs	F	I	cont	R hemiparesis	Mar-10	HPT	HPT, DM, Chol	Adding	CT	3 months	Quadripod
32	S Reddy	450808	65yrs	M	I	exp	L hemiparesis	Apr-10	HPT	HPT, DM	MGMH	Nil	3 months	w/stick
33	I Govender (2)	641107	46yrs	F	I	cont	R hemiparesis	Apr-10	unknown	nil	Dr	nil	3 months	e/crutch
34	D Ranjit	440607	66yrs	F	I	cont	L hemiplegia	Dec-09	HPT, DM	HPT, DM, Chol, Arth	Dr	nil	6 months	Quadripod
35	S Naidoo	460417	64yrs	M	I	cont	L hemiparesis	Jan-10	HPT, DM	HPT, DM, Cardiac	Dr	nil	8 months	w/stick
36	M Raghubar	440315	66yrs	M	I	cont	R hemiparesis	Jun-10	HPT	HPT only	MGMH	CT	2 months	w/stick
37	D Ramdhal	520222	58yrs	F	I	cont	R hemiparesis	Sep-09	HPT, DM, Chol	HPT, DM, Chol	Dr	nil	12 months	Quadripod
38	N Chetty	400105	60yrs	F	I	exp	R hemiparesis	Jan-10	HPT, DM	HPT, DM	MGMH	MRI	8 months	Quadripod
39	C Mshengu	530224	57yrs	M	B	exp	L hemiparesis	May-10	HPT	HPT only	Entab	MRI	2 months	Quadripod
40	T Ganas	631029	47yrs	F	I	exp	L hemiparesis	Dec-09	bld clot	HPT, DM, Chol	MGMH	nil	7 months	e/crutch
41	K Ramparsad	460810	64yrs	M	I	exp	L hemiparesis	Nov-09	HPT	HPT, DM, Arth	MGMH	CT	6 months	w/stick

	name	file no	age	sex	race	group	side affected	date of attack	cause	other diseases	hospitalis ation	t/i	attending rehab	w/aid
42	S Naidoo (2)	670806	43 yrs	M	I	exp	R hemiplegia	Jan-09	unknown	DM only	Osind	nil	36 months	Quadripod
43	S Sooknundan	490710	61yrs	F	I	exp	L hemiplegia	Dec-09	DM, HPT, Chol	HPT, DM, Chol	MGMH	nil	6 months	e/crutch
44	D Bechan	410614	69yrs	M	I	exp	R hemiparesis	Jan-10	HPT, DM	HPT, DM	Dr	nil	6 months	w/stick
45	S Chotu	561018	54yrs	F	I	cont	R hemiparesis	Feb-10	bld clot	HPT, DM	Entab	MRI	4 months	e/crutch
46	S Mkhize	421010	68yrs	F	B	cont	L hemiplegia	Jan-09	HPT	HPT, DM, Chol, Obese	MGMH	CT	6 months	w/chair
47	D Ndlovu	330208	77 yrs	M	B	exp	L hemiparesis	Apr-10	HPT	HPT only	Dr	nil	3 months	w/stick
48	N Govender	581016	52yrs	M	I	cont	L hemiplegia	Jun-10	HPT, DM	HPT, DM	Umhl	nil	3 months	Quadripod
49	P Mahabeer	461225	64yrs	M	I	cont	R hemiparesis	Mar-10	HPT,DM	HPT, DM	MGMH	nil	3 months	w/stick
50	P Maphumulo	400909	70yrs	F	B	cont	L hemiplegia	Jun-09	HPT, DM	HPT, DM, Arth	MGMH	nil	12 months	w/chair

Appendix 9: The Postural Assessment Scale for Stroke Patients (PASS) (Benaim et al., 1999)

1. SITTING WITHOUT SUPPORT WITH FEET TOUCHING THE FLOOR 0 = cannot sit 1 = sits with slight support eg 1 hand 2 = sits for > 10 sec without support 3 = sits for 5 minutes without support	7. **ROLL FROM SUPINE TO NON AFFECTED SIDE** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help
2. STANDING WITH SUPPORT 0 = cannot stand, even with support 1 = stands with support of 2 people 2 = stands with moderate support of 1 person 3 = stands with support of 1 hand	8. **SUPINE TO SITTING AT EDGE OF BED/TABLE** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help
3. STANDING WITHOUT SUPPORT 0 = cannot stand without support 1 = stands without support for 10 sec or leans heavily on 1 leg 2 = stands without support for 1 minute or stands slightly asymmetrically 3 = stands without support for > 1 minute and can perform arm movements at the same time	9. **SITTING AT EDGE OF BED TO SUPINE** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help
4. STANDING ON NON-PARETIC LEG 0 = cannot stand on non-paretic leg 1 = stands on non-paretic leg for a few seconds 2 = stands on non-paretic leg for > 5 sec 3 = stands on non-paretic leg for > 10 sec	10. **SITTING TO STANDING UP WITHOUT ANY SUPPORT** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help
5. STANDING ON PARETIC LEG 0 = cannot stand on non-paretic leg 1 = stands on non-paretic leg for a few seconds 2 = stands on non-paretic leg for > 5 sec 3 = stands on non-paretic leg for > 10 sec	11. **STANDING UP TO SITTING DOWN WITHOUT ANY SUPPORT** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help

6. ROLL FROM SUPINE TO AFFECTED SIDE 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help	12. **STANDING TO PICK UP A PENCIL FROM THE FLOOR WITHOUT ANY SUPPORT** 0 = cannot perform the activity 1 = performs activity with much help 2 = performs activity with little help 3 = performs activity without help

Appendix 10: Pre-test and Post-test scores for PASS for the control group

Particip	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item 10		Item 11		Item 12		Totals	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po
1	3	3	2	2	1	1	1	1	1	1	2	2	1	1	2	2	2	2	2	2	2	2	1	1	20	20
2	3	3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	8	8
3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	13	13
4	2	2	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	5
5	2	2	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	5
6	3	3	2	3	3	3	3	3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	29	29
7	3	3	3	3	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	27	27
8	3	3	3	3	2	3	2	2	1	1	2	2	2	2	2	2	2	2	1	2	1	2	1	1	21	24
9	1	1	2	2	0	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	7	10
10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	33	36
11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	3	33	36
12	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	33	36
13	3	3	3	3	2	3	2	3	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	30	33
14	3	3	3	3	2	3	3	3	2	2	2	3	2	3	3	3	3	3	2	2	2	2	2	2	29	32
15	3	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	2	3	2	2	2	2	2	2	30	33
16	3	3	3	3	2	2	3	3	2	2	3	3	2	3	2	3	2	3	2	2	2	2	2	2	28	31
17	3	3	3	3	2	2	2	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	23	24
18	3	3	3	3	1	2	2	2	1	1	1	1	1	1	2	2	2	2	1	1	1	1	0	0	18	19
19	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	35	36
20	3	3	2	2	1	1	2	2	1	1	2	2	2	3	2	2	2	2	0	1	2	2	2	2	21	22
21	3	3	3	3	2	3	3	3	2	2	3	3	2	3	3	3	3	3	2	2	2	2	1	1	29	31
22	3	3	1	1	0	1	1	1	0	0	1	2	1	1	1	1	1	1	0	0	0	0	0	0	9	11
23	3	3	3	3	2	3	3	3	2	2	2	3	2	3	2	2	2	2	2	2	2	2	2	2	28	30
24	3	3	2	3	3	3	3	3	2	3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	28	30
25	3	3	2	2	1	2	2	2	0	1	2	2	2	2	1	2	1	2	2	2	2	2	0	1	18	22

Appendix 11: Pre-test and Post-test scores for PASS for the experimental group

Particip	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item 10		Item 11		Item 12		Totals	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po
1	3	3	2	3	1	2	1	2	1	2	1	2	0	1	1	2	1	2	0	1	0	1	0	1	11	22
2	3	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	1	2	24	35
3	3	3	3	3	2	3	3	3	2	3	3	3	2	3	2	3	2	3	2	2	2	2	1	2	27	33
4	3	3	3	3	2	3	2	3	2	3	3	3	2	2	2	3	2	3	1	2	1	2	1	2	23	29
5	3	3	3	3	2	3	2	3	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2	3	28	34
6	3	3	3	3	2	3	2	3	2	3	3	3	2	3	3	3	3	3	2	3	2	3	2	2	29	35
7	3	3	1	1	0	1	1	2	0	1	0	1	0	0	1	1	1	1	0	1	0	1	0	1	7	14
8	3	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	2	3	2	3	2	3	2	3	29	36
9	3	3	3	3	3	3	2	3	2	3	3	3	3	3	2	3	2	3	2	3	2	3	2	3	29	36
10	3	3	2	2	0	1	1	1	0	1	1	2	1	1	1	2	1	2	0	1	0	1	0	1	10	18
11	3	3	1	2	0	0	0	1	0	0	1	2	0	1	1	2	1	2	0	1	0	1	0	0	7	15
12	3	3	2	3	1	2	2	3	1	2	2	3	1	2	0	1	0	1	0	1	0	1	0	0	12	20
13	3	3	3	3	2	3	3	3	2	3	2	3	3	3	2	3	2	3	2	3	2	3	1	2	27	35
14	2	3	3	3	2	3	3	3	2	3	3	3	2	3	1	2	1	2	1	2	1	2	1	2	23	31
15	3	3	3	3	2	3	3	3	2	3	3	3	2	3	2	3	2	3	2	3	2	3	2	3	28	36
16	3	3	3	3	2	3	2	3	2	3	3	3	3	3	2	3	2	3	2	3	2	3	2	3	28	36
17	3	3	2	3	2	2	2	2	1	2	2	3	2	2	2	3	2	3	2	3	2	3	2	2	24	31
18	3	3	2	2	1	2	1	2	0	1	2	2	1	2	1	2	1	2	2	3	2	3	1	2	17	26
19	3	3	3	3	2	3	2	3	1	2	2	3	1	2	2	2	2	2	2	3	2	3	2	3	24	32
20	3	3	3	3	1	2	0	2	1	2	1	2	1	2	1	2	0	1	1	2	2	2	0	1	14	24
21	3	3	0	0	0	1	1	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	7
22	3	3	2	3	2	3	3	3	2	3	2	3	3	3	2	3	2	3	2	2	2	2	1	2	26	30
23	3	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	2	3	2	2	2	2	2	2	29	33
24	3	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	2	3	2	2	2	2	2	2	29	33
25	3	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	2	3	2	2	2	2	2	2	29	33

Appendix 12: Percentage changes between pre-test and post-test PASS scores for the control group

Participants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10	Item 11	Item 12
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	33.3	0	0	0	0	0	0	33.3	33.3	0
9	0	0	33.3	0	33.3	0	33.3	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	33.3	33.3	33.3
11	0	0	0	0	0	0	0	0	0	33.3	33.3	33.3
12	0	0	33.3	0	33.3	0	0	0	0	0	0	33.3
13	0	0	33.3	33.3	33.3	0	0	0	0	0	0	0
14	0	0	0	0	0	33.3	33.3	0	0	0	0	0
15	0	0	0	0	33.3	0	0	33.3	33.3	0	0	0
16	0	0	0	0	0	0	33.3	33.3	33.3	0	0	0
17	0	0	0	33.3	0	0	0	0	0	0	0	0
18	0	0	33.3	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	33.3
20	0	0	0	0	0	0	0	0	0	33.3	0	0
21	0	0	33.3	0	0	0	33.3	0	0	0	0	0
22	0	0	33.3	0	0	33.3	0	0	0	0	0	0
23	0	0	0	0	33.3	33.3	0	0	0	0	0	0
24	0	33.3	0	0	33.3	0	33.3	0	0	0	0	0
25	0	0	33.3	0	33.3	0	0	33.3	33.3	0	0	33.3
MEAN	0	1.33	10.66	2.66	9.32	4.0	6.66	4.0	4.0	5.33	4.0	6.66

Overall mean for all items = 4.89

Appendix 13: Percentage changes between pre-test and post-test PASS scores for the experimental group

Partici pants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10	Item 11	Item 12
1	0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
2	0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
3	0	0	33.3	0	33.3	0	33.3	33.3	33.3	0	0	33.3
4	0	0	33.3	33.3	33.3	0	0	33.3	33.3	33.3	33.3	33.3
5	0	0	33.3	33.3	33.3	0	0	0	33.3	0	0	33.3
6	0	0	33.3	33.3	33.3	0	33.3	0	0	33.3	33.3	0
7	0	0	33.3	33.3	33.3	33.3	0	0	0	33.3	33.3	33.3
8	0	33.3	0	0	33.3	0	0	33.3	33.3	33.3	33.3	33.3
9	0	0	0	33.3	33.3	0	0	33.3	33.3	33.3	33.3	33.3
10	0	0	33.3	0	33.3	33.3	0	33.3	33.3	33.3	33.3	33.3
11	0	33.3	0	33.3	0	33.3	33.3	33.3	33.3	33.3	33.3	0
12	0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	0
13	0	0	33.3	0	33.3	33.3	0	33.3	33.3	33.3	33.3	33.3
14	0	0	33.3	0	33.3	0	3.33	33.3	33.3	33.3	33.3	33.3
15	0	0	33.3	0	33.3	0	33.3	33.3	33.3	33.3	33.3	33.3
16	0	33.3	0	33.3	33.3	0	0	33.3	33.3	33.3	33.3	33.3
17	0	33.3	0	0	33.3	33.3	0	33.3	33.3	33.3	33.3	0
18	0	0	33.3	33.3	33.3	0	33.3	33.3	33.3	33.3	33.3	33.3
19	0	0	33.3	33.3	33.3	33.3	33.3	0	0	33.3	33.3	33.3
20	0	0	33.3	66.6	33.3	33.3	33.3	33.3	33.3	33.3	33.3	0
21	0	0	33.3	33.3	0	33.3	0	0	0	0	0	0
22	0	0	33.3	0	33.3	33.3	0	33.3	33.3	0	0	33.3
23	0	33.3	0	0	33.3	0	0	33.3	33.3	0	0	0
24	0	33.3	0	0	33.3	0	0	33.3	33.3	0	0	0
25	0	33.3	0	0	33.3	0	0	33.3	33.3	0	0	0
MEAN	0	13.32	22.64	19.68	30.64	15.98	14.65	26.64	27.97	23.98	23.98	21.31

Overall mean of all items= 18.09

Appendix 14: The Berg Balance Scale (BBS) Novelguide.com, 2007)

BERG BALANCE SCALE	
1	SITTING UNSUPPORTED
2	SITTING TO STANDING
3	STANDING TO SITTING
4	TRANSFER FROM 1 CHAIR TO ANOTHER
5	STANDING UNSUPPORTED
6	STANDING WITH EYES CLOSED
7	STANDING WITH FEET TOGETHER
8	STANDING WITH 1 FOOT IN FRONT OF THE OTHER
9	STANDING ON 1 LEG
10	TURNING TRUNK WITH FEET FIXED
11	RETREIVING OBJECTS FROM FLOOR
12	TURNING 360 DEGREES
13	STOOL STEPPING
14	REACHING FORWARD WHILE STANDING

Scoring

0 = cannot perform

0 = maximal difficulty experienced

1 = some difficulty experienced

2 = minimal difficulty experienced

4 = normal performance

Appendix 15: Pre-test and Post-test scores for BBS for the control group

Particip	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item 10		Item 11		Item 12		Item 13		Item 14		Totals	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	Pr	po	pr	po
1	4	4	2	2	2	2	2	2	1	1	1	1	1	1	2	2	1	1	2	2	1	1	2	2	2	2	1	1	24	24
2	4	4	2	2	2	2	2	2	0	0	0	0	0	0	2	2	1	2	1	2	1	1	1	1	1	1	0	0	16	18
3	4	4	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1	1	0	0	12	12
4	2	2	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
5	2	2	0	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
6	4	4	2	2	2	2	2	2	3	3	2	3	3	3	3	3	2	2	3	3	2	2	2	2	2	2	2	2	34	34
7	4	4	2	2	2	2	2	2	3	3	2	2	2	2	2	2	1	2	3	3	2	2	2	2	3	3	2	2	30	30
8	4	4	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	2	2	2	2	2	1	2	2	2	2	2	27	30
9	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	4	7
10	4	4	2	3	2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	39	42
11	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3	2	2	3	3	3	3	2	3	39	42
12	4	4	2	3	2	3	2	2	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	29	32
13	4	4	3	4	3	4	3	3	3	4	3	3	3	3	3	4	2	2	3	3	2	2	2	2	3	3	3	3	40	44
14	4	4	2	2	2	2	2	2	3	3	2	2	2	2	3	3	2	2	3	3	2	2	3	3	3	3	2	3	35	36
15	4	4	2	3	2	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	2	2	36	39
16	4	4	2	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2	2	3	2	2	2	2	2	2	2	2	30	34
17	4	4	2	2	2	2	2	2	2	3	2	2	2	2	2	2	1	1	2	2	1	1	2	2	2	2	1	1	27	28
18	4	4	1	1	1	1	0	1	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11	13
19	4	4	3	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	42	43
20	4	4	2	2	2	2	2	2	1	1	0	0	1	1	1	1	0	0	1	1	0	1	0	0	1	1	0	1	13	13
21	4	4	2	3	2	3	2	2	2	3	1	1	1	1	2	2	2	2	3	3	1	1	2	2	2	2	1	1	27	30
22	4	4	1	2	1	2	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	10	12
23	4	4	2	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	31	33
24	4	4	2	2	2	2	2	2	3	3	2	2	3	3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	33	33
25	4	4	2	2	2	2	1	1	2	2	1	1	1	1	1	2	1	2	2	2	2	2	2	2	1	2	1	1	23	26

Appendix 16: Pre-test and Post-test scores for BBS for the experimental group

Particip	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item 10		Item 11		Item 12		Item 13		Item 14		Totals	
	Pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	Pr	po	pr	po
1	4	4	2	3	2	3	2	3	1	2	1	2	1	2	2	3	0	1	2	2	0	1	1	2	1	2	0	1	19	31
2	4	4	2	3	2	3	1	2	1	2	1	2	1	2	2	3	1	2	2	3	1	2	2	3	2	3	1	2	23	36
3	4	4	2	3	2	3	2	2	2	3	2	3	2	3	2	3	1	2	2	3	1	2	1	2	1	2	1	2	25	38
4	4	4	2	3	2	3	2	3	2	3	1	1	1	1	1	1	0	1	2	2	2	3	1	1	1	2	1	2	21	27
5	4	4	2	3	2	3	2	2	2	3	2	3	2	3	2	3	2	2	2	3	2	2	2	3	2	3	1	2	27	39
6	4	4	2	3	2	3	2	3	3	3	3	3	3	3	2	3	2	3	2	3	2	2	2	3	2	3	2	2	33	41
7	4	4	0	1	0	1	1	2	0	1	0	1	0	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	7	18
8	4	4	2	3	2	3	2	3	3	3	2	3	2	3	2	3	2	2	3	3	2	3	2	3	2	2	2	3	32	41
9	4	4	3	4	3	4	2	3	3	3	3	3	3	4	3	4	3	4	2	3	3	3	3	3	3	4	2	3	40	49
10	4	4	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	1	1	2	0	0	0	0	0	1	0	1	9	14
11	4	4	1	2	1	2	0	1	0	0	0	0	0	0	1	2	1	1	1	2	0	0	0	0	0	1	0	0	9	15
12	4	4	2	3	2	3	1	1	1	2	1	2	2	2	2	2	0	1	2	2	0	0	1	1	1	1	0	0	19	24
13	4	4	2	3	2	3	2	2	2	3	2	3	2	3	2	3	2	2	2	3	1	2	2	3	2	3	1	2	28	39
14	4	4	2	3	2	3	2	2	2	3	1	2	1	2	2	3	1	2	2	3	2	3	2	3	2	3	2	3	27	39
15	4	4	2	3	2	3	2	3	3	3	2	3	2	3	2	3	2	2	3	3	2	3	2	3	2	3	2	3	32	42
16	4	4	2	3	2	3	2	3	3	4	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	31	44
17	4	4	2	3	2	3	2	2	2	2	2	2	2	3	2	3	2	2	3	3	2	2	2	3	2	3	2	2	31	37
18	4	4	2	3	2	3	2	3	2	3	2	3	2	3	1	2	2	3	1	2	2	3	2	3	2	3	1	2	27	40
19	4	4	2	3	2	3	2	3	2	3	1	2	1	2	2	3	1	2	2	3	1	2	1	2	2	3	2	3	23	35
20	4	4	2	3	2	3	1	3	2	3	2	2	2	2	2	2	1	2	0	2	0	2	0	2	1	2	0	2	19	34
21	4	4	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	7
22	4	4	2	3	2	3	2	2	2	3	0	1	2	2	2	2	0	1	2	2	1	2	1	2	2	2	1	2	25	32
23	4	4	2	3	2	3	2	2	2	3	2	2	3	3	3	3	2	2	3	3	2	2	2	2	2	3	2	2	33	37
24	4	4	2	3	2	3	2	2	2	3	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2	3	2	2	32	38
25	4	4	2	3	2	3	2	2	2	3	2	2	3	3	3	3	2	3	3	3	2	2	2	2	2	3	2	2	33	38

Appendix 17: Percentage changes between pre-test and post-test BBS scores for the control group

Participants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10	Item 11	Item 12	Item 13	Item 14
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	25	25	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	25	25	0	0	0	0	0	0	0	0	0	0	0
5	0	25	25	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	25	0	0	25	0	0	25	0	0
9	0	0	0	0	0	0	0	0	0	0	25	25	25	0
10	0	25	25	0	0	0	0	0	0	0	0	0	0	25
11	0	0	0	0	0	0	0	0	25	25	0	0	0	25
12	0	25	25	0	0	0	0	0	0	0	25	0	0	0
13	0	25	25	0	25	0	0	25	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	25
15	0	25	25	0	25	25	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	25	0	0	0	0
17	0	0	0	0	25	0	0	0	0	0	0	0	0	0
18	0	0	0	25	0	0	0	0	0	0	0	0	25	0
19	0	25	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	25	25	0	25	0	0	0	0	0	0	0	0	0
22	0	25	25	0	0	0	0	0	0	0	0	0	0	0
23	0	25	25	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	25	25	0	0	0	25	0
Mean	0	10.0	9.0	1.0	4.0	2.0	0.0	2.0	4.0	3.0	2.0	2.0	3.0	3.0

Overall mean of all items= 3.21

Appendix 18: Percentage changes between pre-test and post-test BBS scores for the experimental group

Partici pants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10	Item 11	Item 12	Item 13	Item 14
1	0	25	25	25	25	25	25	25	25	0	25	25	25	25
2	0	25	25	25	25	25	25	25	25	25	25	25	25	25
3	0	25	25	0	25	25	25	25	25	0	25	25	25	25
4	0	25	25	0	25	25	0	0	0	25	25	0	25	0
5	0	25	25	0	25	25	25	25	0	25	0	25	25	25
6	0	25	25	25	0	0	0	25	25	25	0	25	25	0
7	0	25	25	25	25	25	25	25	0	0	25	25	25	25
8	0	25	25	25	0	25	25	25	0	0	25	25	0	25
9	0	25	25	25	0	0	25	25	25	25	0	0	25	25
10	0	25	25	25	25	0	0	25	25	25	0	0	25	25
11	0	25	25	25	0	0	0	25	0	25	0	0	25	0
12	0	25	25	0	25	25	0	0	25	0	0	0	0	0
13	0	25	25	0	25	25	25	25	0	25	25	25	25	25
14	0	25	25	0	25	25	25	25	25	25	25	25	25	25
15	0	25	25	25	0	25	25	25	0	0	25	25	25	25
16	0	25	25	25	25	25	25	25	25	25	25	25	25	25
17	0	25	25	0	0	0	25	25	0	0	0	25	25	0
18	0	25	25	25	25	25	25	25	25	25	25	25	25	25
19	0	25	25	25	25	25	25	25	25	25	25	25	25	25
20	0	25	25	50	50	0	0	0	25	50	50	50	25	50
21	0	25	25	0	0	0	0	0	0	25	0	0	0	0
22	0	25	25	0	25	25	0	0	25	0	25	25	0	25
23	0	25	25	0	25	0	0	0	0	0	0	0	25	0
24	0	25	25	0	25	0	0	0	25	25	0	0	25	0
25	0	25	25	0	25	0	0	0	25	0	0	0	25	0
Mean	0	25.0	25.0	14.0	19.0	15.0	14.0	17.0	15.0	16.0	15.0	17.0	21.0	17.0

Overall mean of all items= 16.43

Appendix 19: The Barthel Index (Mahoney et al., 1965)

FEEDING 0 = unable 5 = needs assistance with cutting, etc 10 = independent	BLADDER 0 = incontinent or catheterized 5 = occasional accident 10 = continent
BATHING 0 = dependent 5 = independent	TOILET USE 0 = dependent 5 = needs some assistance 10 = independent
GROOMING 0 = needs assistance with teeth, hair, shaving, etc 5 = independent	TRANSFERS (BED TO CHAIR) 0 = unable, no sitting balance 5 = major assistance (physical help with 1 or 2 people) 10 = minor assistance (verbal or physical) 15 = independent
DRESSING 0 = dependent 5 = needs assistance 10 = independent (including buttons, zips, laces, etc)	MOBILITY (ON LEVEL SURFACES) 0 = immobile or < 50 yards 5 = wheelchair independent, > 50 yards 10 = walks with assistance (verbal or physical) of 1 person, >50 yards 15 = independent (even with use of walking aid), > 50 yards
BOWELS 0 = incontinent 5 = occasional accident 10 = continent	STAIRS 3 = unable 5 = needs assistance (verbal, physical or and aid) 10 = independent

Appendix 20: Pre-test and Post-test scores for BI for the control group

Participants	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item10		Totals	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	Po	pr	po
1.	10	10	5	5	0	0	0	0	10	10	10	10	5	5	5	5	10	10	5	5	60	60
2.	10	10	0	0	0	0	5	5	10	10	10	10	5	10	5	5	5	5	5	5	55	60
3.	5	5	0	0	0	0	0	0	10	10	5	5	5	5	5	5	10	10	5	5	45	45
4.	5	5	0	0	0	0	0	0	5	5	5	5	5	5	5	5	0	0	0	0	20	25
5.	5	5	0	0	0	0	0	0	5	5	5	5	5	5	5	5	0	0	0	0	25	25
6.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	10	5	5	85	85
7.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	15	5	5	85	90
8.	10	10	5	5	5	5	5	5	10	10	10	10	10	10	10	10	15	15	5	10	85	90
9.	5	5	0	0	0	0	0	0	10	10	5	5	0	0	5	5	0	0	0	5	25	30
10.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	10	5	5	85	90
11.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	10	5	5	85	90
12.	10	10	5	5	5	5	5	5	10	10	10	10	10	10	15	15	10	10	5	10	85	90
13.	10	10	5	5	5	5	5	5	10	10	10	10	10	10	10	10	10	10	5	5	80	85
14.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	15	5	5	85	90
15.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	15	5	5	85	90
16.	10	10	5	5	0	0	0	0	10	10	10	10	5	5	5	5	5	5	5	5	55	55
17.	10	10	0	0	0	0	0	5	10	10	10	10	0	0	5	5	10	10	5	5	50	55
18.	10	10	0	0	0	0	5	5	10	10	10	10	5	5	5	10	5	5	5	5	55	60
19.	10	10	5	5	5	5	5	5	10	10	10	10	10	10	15	15	15	15	5	10	90	95
20.	10	10	5	5	0	0	0	0	10	10	10	10	5	5	10	10	10	10	5	5	65	65
21.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	10	5	5	85	85
22.	5	5	0	0	0	0	0	0	10	10	10	10	0	0	5	5	10	10	0	5	40	45
23.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	15	15	15	15	5	10	95	100
24.	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	10	5	5	85	85
25.	5	5	0	0	5	5	5	5	10	10	10	10	5	5	10	10	10	10	5	5	65	65

Appendix 21: Pre-test and Post-test scores for BI for the experimental group

Participants	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6		Item 7		Item 8		Item 9		Item10		Totals	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po	pr	Po	pr	po
1	10	10	0	0	0	0	0	0	10	10	10	10	5	5	5	10	5	10	0	5	45	60
2	10	10	0	0	0	5	0	5	10	10	10	10	10	10	10	15	10	15	5	10	65	90
3	10	10	5	5	0	5	5	5	10	10	10	10	10	10	5	10	5	10	5	5	65	80
4	10	10	5	5	0	5	0	5	10	10	10	10	5	5	10	15	10	10	5	5	65	80
5	10	10	5	5	5	5	5	5	10	10	10	10	10	10	5	10	5	10	5	5	70	80
6	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	10	85	100
7	5	5	0	0	0	0	0	5	5	5	5	5	0	5	5	5	0	0	0	0	20	35
8	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	5	85	95
9	10	10	5	5	5	5	5	5	10	10	10	10	5	10	10	15	10	15	5	5	75	90
10	10	10	0	0	0	0	0	5	10	10	10	10	0	5	5	10	5	10	0	5	40	65
11	10	10	0	0	0	0	0	5	10	10	10	10	0	5	0	5	0	5	0	5	30	55
12	5	5	0	0	0	0	0	0	10	10	10	10	0	5	5	10	5	10	5	5	40	55
13	10	10	0	5	0	5	0	5	10	10	10	10	10	10	5	10	10	15	5	5	60	85
14	10	10	0	0	0	0	0	5	10	10	10	10	0	5	5	10	5	10	5	5	45	65
15	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	10	85	100
16	10	10	5	5	5	5	5	5	10	10	10	10	10	10	15	15	10	15	10	10	90	95
17	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	5	85	95
18	10	10	5	5	5	5	5	10	10	10	10	10	5	10	10	15	5	10	5	5	70	90
19	10	10	5	5	0	0	5	5	10	10	10	10	5	10	5	10	5	10	5	5	60	75
20	10	10	0	0	0	0	0	5	10	10	10	10	0	5	10	15	10	10	5	5	55	70
21	5	5	0	0	0	0	0	0	5	5	5	5	0	0	5	10	0	5	0	0	20	30
22	10	10	5	5	5	5	5	5	10	10	10	10	5	5	5	10	5	10	5	5	65	75
23	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	5	85	95
24	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	5	85	95
25	10	10	5	5	5	5	10	10	10	10	10	10	10	10	10	15	10	15	5	5	85	95

Appendix 22: Percentage changes between pre-test and post-test BI scores for the control group

Participants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	33.3	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	25	0
8	0	0	0	0	0	0	0	0	0	33.3
9	0	0	0	0	0	0	0	0	0	33.3
10	0	0	0	0	0	0	0	25	0	0
11	0	0	0	0	0	0	0	25	0	0
12	0	0	0	0	0	0	0	0	0	33.3
13	0	0	0	0	0	0	0	0	25	0
14	0	0	0	0	0	0	0	0	25	0
15	0	0	0	0	0	0	0	0	25	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	33.3	0	0	0	0	0	0
18	0	0	0	0	0	0	0	25	0	0
19	0	0	0	0	0	0	0	0	0	33.3
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	33.3
23	0	0	0	0	0	0	0	0	0	33.3
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
MEAN	0	0	0	1.33	0	0	1.33	3.0	4.0	7.99

Overall mean of all items= 1.77

Appendix 23: Percentage changes between pre-test and post-test BI scores for the experimental group

Participants	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item10
1	0	0	0	0	0	0	0	25	25	33.3
2	0	0	50	33.3	0	0	0	25	25	33.3
3	0	0	50	0	0	0	0	25	25	0
4	0	0	50	33.3	0	0	0	25	0	0
5	0	0	0	0	0	0	0	25	25	0
6	0	0	0	0	0	0	0	25	25	33.3
7	0	0	0	33.3	0	0	33.3	0	25	0
8	0	0	0	0	0	0	0	25	25	0
9	0	0	0	0	0	0	33.3	25	25	0
10	0	0	0	33.3	0	0	33.3	25	25	33.3
11	0	0	0	33.3	0	0	33.3	25	25	33.3
12	0	0	0	0	0	0	33.3	25	25	0
13	0	50	50	33.3	0	0	0	25	25	0
14	0	0	0	33.3	0	0	33.3	25	25	0
15	0	0	0	0	0	0	0	25	25	33.3
16	0	0	0	0	0	0	0	0	25	0
17	0	0	0	0	0	0	0	25	25	0
18	0	0	0	33.3	0	0	33.3	25	25	0
19	0	0	0	0	0	0	33.3	25	25	0
20	0	0	0	33.3	0	0	33.3	25	0	0
21	0	0	0	0	0	0	0	25	25	0
22	0	0	0	0	0	0	0	25	25	0
23	0	0	0	0	0	0	0	25	25	0
24	0	0	0	0	0	0	0	25	25	0
25	0	0	0	0	0	0	0	25	25	0
Mean	0	2.0	8.0	11.99	0	0	11.99	23.0	23.0	7.99

Overall mean of all items= 8.79

Appendix 24 : Questionnaire-English

1. Can you sit without support? If no, what support do you require?
2. Can you stand without support? If no, what support do you require?
3. Can you do daily activities like bathing, eating and dressing on your own or do you need assistance?
4. Do you walk using a walking aid? If yes, what type of aid?
5. How is your balance when you walk/stand?
6. How is your balance when you do your daily activities?
7. Do you think your balance can improve?
8. What problems do you experience that prevent you from doing daily activities?

Appendix 25: Questionnnaire-isiZulu

Imibuzo

1. Ungakwazi ukuhlala ngokwakho? Uma ungakwazi sizo luni ongaludinga?
2. Ungakwazi ukuma ngokwakho? Uma ungakwazi sizo luni ongaludinga?
3. Uyaludinga yini usizo uma wenza imisebenzi yosuku, njengokugeza, ukudla, ukugqoka?
4. Ingabe uhamba ngokokusiza? Uma kungalo, ingabe ikuphi?
5. Uma uhamba noma umile awuntengantengi?
6. Awuntengantengi uma wenza imisebenzi yosuku?
7. Ucabanga ukuthi ukuntengantenga kwakho kungaba ngcono?
8. Iziphi izinkinga ohlangabezana nazo ezikuvimbela ukuthi wenze imisebenzi yakho yosuku?

Appendix 26: Stability and Balance intervention Program

1. Sitting upright with 2 feet on the ground and reaching for objects with upper limbs that are objectively placed.

2. Kneeling to a half kneeling position and hold for 10 seconds. Alternate both lower limbs.

3. Standing erect, flexion of both hips and knees (as if into squatting), hold for 10 seconds.

4. Standing on 1 lower limb, hold for 10 seconds. Alternate both lower limbs.

5. Standing on 1 lower limb and raising other limb to a stair. Alternate both lower limbs.

6. Standing on 1 lower limb and tapping points on the ground that is equally and objectively placed with other limb. Alternate both lower limbs.

7. Standing on 1 leg and kicking a ball with the other lower limb. Alternate both lower limbs.

8. Standing with 2 feet on the ground and reaching for objects with upper limbs that are objectively placed.

9. Walking on 2 straight lines that are 10 centimetres apart on the ground.

Appendix 27: Normal physiotherapy exercise sessions at the Phoenix Assessment and Therapy Centre

1. Auto-assisted upper limb exercise for shoulder flexion and extension

2. Auto-assisted upper limb exercise for shoulder abduction and adduction

3. Using momentum to roll to affected and unaffected sides

4. Bridging with both lower limbs

5. Bridging with affected lower limb

6. Trunk rotations to affected and unaffected sides

7. Joint approximation exercises in sitting

8. Joint approximation exercises in standing

9. Ball therapy for scapular movements using a medium sized ball

10. Ball therapy for trunk dissociation using a big ball

11. Hand activities

12. Gait re-education in parallel bars or with an aid