HYPERTENSION AND NEUROCOGNITIVE IMPAIRMENT AS MEASURED BY THE ZAMBIA NEUROBEHAVIORAL TEST BATTERY-A PILOT STUDY.

By

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AUTHOR'S DECLARATION

I, Lumbuka Kaunda, do hereby declare that the contents of this masters dissertation represents my work, and that it has not been previously submitted for any other qualification, be it degree or diploma at this University or any other University, and that any work from others has been duly acknowledged

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ABSTRACT

Hypertension has been reported as one of the most important etiologic factors in cardiovascular disease. Hypertension has serious social, physical and health consequences.The physical consequences of hypertension have been well researched. However the effect of hypertension on neurocognitive functioning has received less attention in research. Some studies (e. g Starr, Deary, Fox & Whalley (2006) have reported deficits in some domains of cognition, while others (e. g. Huang et al., 2009) have reported no significant findings on comparisons between hypertensives and normotensives. However the larger and more consistent ones (e. g Waldstein et al., 1996) have noted deficits in learning and memory, attention, abstract reasoning and executive functions. Hypertension affects the quality of life. Research into this area has revealed different results depending on the type of medication and the instruments being used to measure quality of life. This study aims at finding out the relationship between hypertension and neurocognitive functioning.

Method: The study was cross sectional in design, the sample consisted of 50 adult Zambians aged 40-65.21 hypertensives (mean age of 52.81 SD 6.047, mean education of 10.62 SD 2.674) 29 normotensives (mean age of50.48 SD 6.260, mean education of 11.45 SD 2.910). Out of 50, 15 were male and 35 were female. The recruitment was done in the clinics with the help of clinic staff. The neuropsychological domains measured in the present study were executive functioning, fluency, verbal episodic memory, visual episodic memory, motor dexterity, working memory, and speed of information processing. The measures used included: Blood pressure, neuromedical evaluation, neurocognitive assessment using the Zambia Neurobehavioral Test Battery, SF12 Health Survey ,Hypertension questionnaire.

Data analysis: Independent sample t-test was used to determine if there were any statistically significant differences in neuropsychological test performance between hypertensives and normotensives on the seven ability domains of neuropsychological functioning measured. Chi square was calculated to see if there was a significant difference in the impairment index (Global Deficit Scores) between the two groups. Pearson's correlation test was used to investigate the relationship between the side effect variable and quality of life.

Results: There was no significant difference in neuropsychological test performance on all the seven ability domains measured. On Global Deficit Scores impairment index, Chi square showed more impairment in the hypertensive group; however this was not statistically significant. Pearson's correlations test showed that at 0.05 sig. side effects correlated negatively with Physical functioning (r=0.593) and mental health (r=0.598) and at 0.01 sig. with vitality scale (r=0.6340 and social functioning (r=0.618) of the SF12 health survey domains. **Conclusion:** Quality of life seems to be more affected than neurocognitive functioning in the hypertensives in this study.

DEDICATION

This masters dissertation is dedicated to the most important woman in my life-my mother-Agness Peggy Muzongwe Kaunda.

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My sisters Belinda, Busiku, Chanda and Jacqueline, thank you, I love you all.

Dad and Peo, may your souls rest in peace, wish you were here to celebrate the many achievements with us. I love you.

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CHAPTER ONE

1.1. INTRODUCTION

Hypertension is an important etiologic factor in cardiovascular disease (Rose & Kaye, 1983). Hypertension can also affect neurocognitive functioning, and has been shown to cause changes in the domains of: executive functioning, memory, and psychomotor speed (Hannesdottir, Nitkunan, Charrlton, Barrick, MacGregor & Markus, 2009 ; Raz, Rodrique & Acter, 2003; Waldstein et al., 1996; 2003).These cognitive effects, combined with side effects of medication, can negatively affect the quality of life (Cote, Gregoire, Muisan & Charlot, 2004).

Cardiovascular disease (CVD), including hypertension has emerged in recent years as the number one cause of death globally (Matthews et al., 2006; Murray and Lopez 1996; Word Health Organization (WHO) 2002b as cited by Gaziano, Reddy, Paccaud, Horton & Chaturvedi, 2006). By 2001, it was reported to have become the leading cause of death in the developing world too (Mathers et. al., 2006; WHO 2002a as cited by Gaziano, Reddy, Paccaud, Horpton & Chaturvedi, 2006).

1.1.1. Classification of Hypertension

Blood pressure refers to the pressure the body maintains in order to effectively pump blood from the heart to the tissues via the arteries and back to the heart (Onwubere, 2005). Systolic pressure is the pressure that results from contractile phase of this process while diastolic pressure is the result of the relaxation phase and this is produced by the elastic recoil of the large arteries (Onwubere, 2005). High blood pressure therefore, denotes an elevated blood pressure above a normal range of pressure while hypertension is a chronically elevated blood pressure that denotes a "disease entity that must, of a necessity, be accorded relevant attention" (Onwubere, 2005).

The World Health Organisation criteria for hypertension is a blood pressure (BP) greater than or equal to 160/95 mmHg or the JNC 7 (Joint National Committee on Prevention, Evaluation, and Treatment report, 1997) criteria of blood pressure (BP) greater than or equal to 140/90 mmHg or self-reported use of antihypertensive drugs (Addo, Smeeth & Leon as cited in BeLue et al, 2009). However the key organisations that regulate and issue recommended cut offs are the WHO and the International Society of Hypertension and these two bodies recommend to regional and national bodies on what they should adapt (Onwubere,2005).The Nigerian Hypertension Society is among Africa's most noted. (Onwubere, 2005). In Zambia the WHO/ISH criteria has been adopted for use as the standard criteria. The table below shows the WHO/ISH classification (1999),

Table 1 WHO/ISH Classifications of Hypertension.(1999)

Category	Systolic BP(mmHg)	Diastolic BP(mmHg)
Optimal BP	<120	<80
Normal BP	<130	<85
High normal BP	130-139	85-89
Grade 1 Hypertension (mild)	140-159	90-99
Subgroup: borderline	140-149	90-94
Grade 2 Hypertension (moderate)	160-179	100-109
Grade 3 Hypertension (Severe)	=180	=110
Isolated systolic Hypertension	=140	<90

 *When the SBP and DBP fall into different categories, higher category should apply.

Source: (J. Hypertension 1999,17: 151-183 as cited by Onwubere,2005)

Hypertension is, generally, classified into basically two categories;

I) Primary or essential hypertension that is of an unknown pathology. Primary or essential hypertension accounts for more clinical cases even in Zambia.

II) Secondary hypertension is elevated blood pressure of known origin i. e renal pathology, endocrine system disorders and neurologic disorders, many other causes are yet to be discovered (Rose & Kaye, 1983).

1.1.2. Measurement of Blood Pressure

The mercury sphygmomanometer has remained a standard instrument used to measure blood pressure for over 100 years. However, in the recent years, electronic devices have been widely adopted despite the fact that they still remain poorly available in most developing countries (Onwubere, 2005).

The sphygmomanometer is calibrated in units of 2 and the reading indicates both the systolic and diastolic pressure indicating that readin   should be in multiples of 2. The average of at least 3 readings with a minimum of 2 minutes interval should be used. In the elderly it is especially mandatory to carry out readings in at least 2 positions preferably standing and lying down,   is is to account for postural changes in blood pressure (Onwubere, 2005).

During the measurement of blood pressure it is important to take into account factors that are affected by blood pressure and these include posture, and biological factors (e. g temperature, pain, anxiety, nutrition, alcohol and tobacco use).

Blood pressure rises with increasing age (wwww.righthealth.com).In determining grade of hypertension, WHO has a suggested cut off. (Refer to Table 1.1)

1. Posture

It is important to indicate the posture of the patient   BP recording, this is because arm position relative to the heart can affect   ings as much as10mm Hg (Perloff D, Grim, C, Flack J,et al-Circulation1993 as cited in Onwubere,2005)

2. Biological factors

The biological factors cited above influence blood pressure to huge extent, ideally a subject should be in a relaxed position 5minutes prior to BP measurement, should not be in pain or should not have taken alcohol, tobacco or a heavy meal prior to the BP measurement and should not in anyway be in an anxious state(Onwubere,2005).

1.1.3. Risk factors and long term consequences of hypertension

Numerous studies have noted major risk factors associated with hypertension, including: physical inactivity, cigarette smoking; especially in early middle age, excessive consumption of alcohol, a high body mass index or obesity, poor diet, and an increase in urbanisation. (Mbewu & Mbanya, 2006; Onwubere, 2005).

Hypertension increases the physical stress on the arterial walls and this can result in atherosclerosis (Ralph, Tarter, Meryl, & Beers 2006). Chronic hypertension can also result in cerebrovascular accidents such as stroke, heart failure and kidney failure (Macleod, 1981). These accidents can occur when chronic hypertension is untreated (Onwubere, 2005) .Wenger (1988) in a study of quality of life issues in individuals with hypertension documented multiple domains of daily life that can be affected by chronic hypertension. These domains include side effects of the medication, fatigue, libido levels, memory deficits, mood swings, alertness, sleep disorders, performance at work, and relations with family. Cognitive defects resulting fro   hypertension can also markedly reduce the quality of life (Taichman et al, 2005).

The above studies suggest that the quality of life of individuals with hypertension is affected not only by the illness itself but also by the medication as well (Cote, Gregoire, Muisan & Charlot, 2004).

Furthermore the effect of hypertension on quality of life was demonstrated in a pilot study carried out by Williams (1993) on the caregivers of persons with cerebrovascular accidents. He found that a considerable amount of tasks and responsibilities, such as various activities of daily living, have to be done for these patients by the caregivers. In this study the physical challenges resulted from impairments due to cerebrovascular accidents such as stroke. These further result in impairments in a number of neurocognitive domains that result in emotional vulnerability (Williams, 1993).

1.1.4. Hypertension and Neurocognitive functioning

Untreated hypertension even before clinical manifestations of cerebrovascular disease has been found to affect neurocognitive functioning (Waldstein et al., 1996).These effect of hypertension is seen as subtle deficits in many domains of neuropsychological performance (Waldstein et al., 1995 as cited in Waldstein et al., 1996).

The effect of hypertension on neurocognitive functioning remains poorly understood (Sandok & Whitnak, 1983 as cited by Waldstein et al.,1991).Cherubini, et. al., (2010) reports that the mechanisms that lead to cognitive decline in hypertensives are not fully understood yet. However knowledge in this area of study is on the rise. The mechanism by which hypertension causes cerebral damage forms the basis for the study at cognitive level (Cherubini et al., 2010). Structurally, the frequency of cerebral atrophy and the increase in the number of neuro fibrillary tangles could partially explain the decline in cognition (Cherubini et al, 2010).

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Ralph, Tarter, Merilyn and Beers (2006) in their book *Medical Neuropsychology* reviewed various studies and noted poor performance by hypertensives as compared to their normotensive counterparts. Most notably they have noted domains of memory and learning attention, executive functioning and abstracting thinking, psychomotor speed, and visuospatial abilities. They reported little deficit findings on tests of language and general verbal intelligence.

A wide range of studies have shown a general poor performance in tests of memory, executive functioning, attention and psychomotor speed (Ralph et al. 2006). It should also be noted that individual variability has been noted in performance among hypertensives (Ralph et al., 2006).

Neuropsychological assessments make use of a standardised test battery to aid in the diagnosis of brain pathology and the resulting   gnitive deficits. In order to assess cognitive functioning, a number of neuropsychological tests are administered. Each of the tests measures a particular domain of cognitive functioning. The battery of tests has to be comprehensive enough to measure many ability domains that may be affected .The Zambian Neurobehavioral test battery that is used in this study consists of 21 tests that are grouped to measure seven ability domains (i.e. working memory, executive functioning, speed of information processing, motor speed, visual episodic memory, verbal episodic memory, and fluency).

1.2. STATEMENT OF THE PROBLEM

Hypertension is a common non-communicble disease among the adult population. In the recent years it has emerged as a major risk factor in the developing world too ((Disease Control Priorities Project Report, 2009). This can be attributed largely to; the increase in urbanisation, social economic stressors such as the need for higher incomes in families, dietary conditions such as obesity and being overweight, occurrence of diabetes as a co-morbid condition, and substance abuse (BeLue, 2009). This disease has posed a huge burden in Zambia as well ,yet little research is conducted in this area.

Various studies from elsewhere, (e.g., Raz et al., 2003) have noted a relationship between hypertension and neurocognitive functioning. To provide optimal health care these effects need to be known so they can be further addressed. If we know the neurocognitive problems, rehabilitative interventions can be designed that could address these problems. Further more there is need to realise the neurocognitive effects that result from this condition and how together with the side effects of the medication this leads to a reduction in the quality of life. Raz et al, (2003); and Hannesdottir et al, (2009) reported deficits in a number of neurocognitive domains, such as executive functioning, working memory, attention and psychomotor speed. Deficits have also been reported in verbal recall and motor speed (Raz et al 2003).

Hypertension is termed as a silent killer mainly because when it is uncomplicated and usually asymptomatic. It has caused serious health problems worldwide, and in Zambia, yet it has been sidelined as a public health concern. This study presumes that hypertension gives rise to neurocognitive deficits in the rural and urban population of Zambia. In this study a population aged 40-65 was sampled because of the positive correlation between age and blood pressure. The rise in the systolic blood pressure is quite considerable in adults; and the diastolic blood pressure rises between 40 and 60 years; and thereafter begins to drop (Cherubini. et al, 2009).

1.3. RATIONALE FOR THE STUDY

Globally, hypertension has emerged as a public health concern (Seedat, 2008).This rise in the prevalence rate of hypertension has posed a burden in Sub Saharan Africa too(BeLue,et al,2009) though unfortunately, it has remained ignored as a public health concern in developing countries with most researchers focusing on infectious diseases (Goma et al.,2009).

The prevalence rate of hypertension in Zambia is estimated to be at 2 026 781 cases of diagnosed hypertension in a population of 11 025 690, or 18.38% (www.wrongdiagnosis.com/h/hypertension/stats-country.htm).This is an extrapolated estimate for the entire country which was updated in 2004 (Cure research report, 2004). This report further states that this rate is expected to double by 2030. Current literature search reveals that this is the most recent available statistic on hypertension prevalence in Zamb   However it should be noted that these were only estimates; and may have limited relevance to the actual undiagnosed prevalence of hypertension (Cure research report, 2004). There is therefore need for more research on hypertension.

 In a more localised study in Lusaka district, an estimate on hypertension was put at 12.5% (12.05% of males and 13.2% females) in a total of 1928 individuals who participated in the study. The findings in this study   be generalised to the whole population because it was carried out in Lusaka District, which is an urban setting; and is not representative of the entire Zambian population. This study also noted that there is very little research going on in the area of non communicable diseases in this country. The above figures are expected to double by 2030 due to the increase in urbanisation which has lead poor lifestyle habits, these being poor diet, physical inactivity, and excessive alcohol consumption (Goma et al, 2009).

1.3.1. Hypertension and Neurocognitive functioning and Quality of life

Decline in cognitive functioning more often than not affects the quality of life. The affects are three fold. Hypertension itself leads to a change in lifestyle as patients must take steps to try and control the blood pressure (Onwubere, 2005). This usually means a change in diet (i.e. decrease salt intake), and an increase in physical activity, if it is not in the acute stage. Furthermore, even in its uncomplicated form, hypertension may still cause a dec in some cognitive deficits. Additionally, when lifestyle modifications are not adequate to control the blood pressure levels, medication is usually prescribe severity of the condition. Medications that are commonly prescribed are diuretics, adrenergic blockers, calcium blockers (Onwubere, 2005,). Wenger (1988) confirmed that the side effects from these medications negatively impact the quality of life. The study hypothesis also draws from this fact; *There will be a negative correlation between the side effects of medication for hypertension and the hypertensives' quality of life.*

The increase in urbanisation, physical inactivity, poor diet being important factors has led to a rise in prevalence rates of hypertension even in the developing world like Zambia. This has resulted in an increase in the burden of non communicable diseases such as hypertension, and yet little research is going on this area. Furthermore, it is important to note that various studies carried out in this area have found and association between hypertension and neurocognitive functioning. For example Brady, Spiro & Gaziano (2005) in their study on effect of age and hypertension on cognition found that hypertension, especially uncontrolled, produced a pattern of cognitive decline eyond those attributable to age alone. This fact links to the study hypothesis; Hypertensives reveal more neurocognitive impairment on cognitive tests compared to normotensives.

Regarding the Zambia Neurobehavioral test battery, this has been used in HIV positive but not HIV negative subjects with hypertension. The Zambian test battery used in this study is particularly sensitive to HIV induced neurocognitive impairment. Therefore the challenge in neuropsychological evaluation, like many other test batteries is co-morbidity, and "Co morbid conditions e.g. (other infections, drug abuse, head injury, chronic illnesses) are common in HIV positive subjects."(Heaton, Franklin, Clifford, Woods, Mindt, Vigil et al, 2009).

Following the findings of previous studies on hypertension and neurocognitive functioning, this research aims to explore the neurocognitive effects that result from hypertension, and how this impacts the quality of life in the study population.

1.4. STUDY OBJECTIVES

General objectives

The general objective of this study was to investigate the relationship between hypertension and neurocognitive functioning.

Specific Objectives

1. To establish if there is a significant difference in performance on neurocognitive tests between normotensives and hypertensives.
2. To assess whether the impairment index using global deficit scores is higher in hypertensives or not.
3. To determine if there is a relationship between side effects of medication for hypertension and the hypertensives' quality of life or not.

1.5. HYPOTHESES
1. Hypertensives will perform poorer than normotensives on neurocognitive tests of executive functioning, working memory, fluency, visual episodic memory, verbal episodic memory, motor dexterity and speed of information processing.

2. Hypertensives reveal more neurocognitive impairment on cognitive tests compared to normotensives.

3. There will be a negative correlation between the side effects of   ication for hypertension and the hypertensives' quality of life.

Table 2 Variables and their measurement

Variable Type	Variables
Independent	Hypertension (Categorical)
Dependent	• Demographically corrected T-scores of the seven ability domains of the NPS battery i.e. Executive functioning, Working memory, Fluency, Motor dexterity, Speed of information processing, Visual episodic memory and Verbal episodic memory. (Continuous). • Quality of life (Continuous) • Drug Side effect (Continuous)

1.6. OPERATIONAL DEFINITIONS

1.6.1 Hypertension

For the purpose of this study, hypertension is defined as a raised blood pressure above normal for age, previously diagnosed by a health practitioner; and currently on medication to control it. Such information was obtained from the medical records provided by clinic staff. The participants in the study confirmed the diagnosis during the subsequent assessment.

1.6.2 Side effect variable

The side effect variable was scored on a "side effect scale" on the Hypertension questionnaire. This questionnaire was designed specifically for this study. The side effect scale was a score on the side effect items. The highest one could score was 12 (meant yes to everything) and the lowest was 0 (meant no to all the common side effects   the medication reported by hypertensives.

1.6.3. Quality of Life

In this study, quality of life is being measured and defined by how much the participants score on the SF-12 Health survey questionnaire (Cote,
Gregoire, Muisan & Charlot, 2004), grouped into 8 domains designed to measure physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health.

CHAPTER 2

2.1 LITERATURE REVIEW

2.1.1 Introduction

Neurocognitive functioning is affected by numerous factors as outlined in the introduction section. The following literature review ims at reviewing studies that have been conducted by other researchers on hypertension and how it affects neurocognitive functioning. The key words used in the search were hypertension, neurocognitive functioning, and quality of life of hypertensives. The resources used in the search included mainly journal articles, abstracts, web pages and medical books.

2.1.2 Hypertension as Chronic illness

Hypertension can impact every aspect of one's well-being, including physical, emotional and social well-being (Deglgcoinnocenti et al., 1992). Hypertension can lead to cardiovascular complications such as left ventricular hypertrophy, myocardial infarction, and atherogenisis; cerebro vascular system-Ischemia and cerebral haemorrhage which increase the stroke incidences ((Khan, Rehman Shah & Jielani, 2006; Macleod, 1981).

The emotional consequences include the effects of the mpairment in cognitive area such as memory which leads many into depression (Taichman, et al., 2005).

The social consequences mainly result in lifestyle adjustment to control the blood pressure and these include an adjustment in reactions stressful situations especially in work and family settings. (Onwubere, 2005).

2.1.3 Hypertension and neurocognitive functioning

Various studies have investigated the effect some common non neurological illnesses on neurocognitive functioning and hypertension is one of them. A number of them have not only used standardised test batteries but have also

gone a step ahead to reveal brain structural abnormalities that result. As much as the effect of hypertension on neurocognitive functioning has been poorly understood, it is interesting to note that research in this area goes as far back as the 1950s (e. g Apter et al., 1951).

One of the earlier studies done, was by Blumenthal and Madden (1989) who studied the slowing of memory in men with mild hypertension. The sample consisted of 24 men with mild hypertension and 28 age matched normotensives. The average age of the hypertensives was 42.17years; and that of their normotensives counterparts was 43.32years. And these were free from significant medical problems apart from hypertension.   level of education ranged between 12 and 20 years. After blood pressure assessments were done, a reaction time test was administered to measure the slowing of memory. Hypertension related deficit in short term memory was ignificant in the hypertensive group on ANOVA. Though the authors stated that the sort of impairment they found in the hypertensives could not be concluded to be clinically significant (Elias et al., 1987 as cited in Blumenthal & Madden, 1989).

Later another study was done by Waldstein et al., (1996) which investigated hypertension and neuropsychological performance: Interactive effects of age. The sample comprised of 123 untreated hypertensives and 50 normotensive men. The sample was made of two groups: the young men (23-40 years) and the middle aged men (41-56years).Their results showed an interaction of age and hypertension after co-varying for education, alcohol consumption, trait anxiety and depression scores.

Results further showed that young hypertensive men performed worse on tests of executive functioning and working memory. However, there was no significant difference in performance on neuropsychological tests between middle aged men and their normotensive counterparts. Their results suggested that hypertension related neuropsychological deficits are more pronounced in young than middle aged hypertensives. However, one could argue as to whether they independently controlled for potentially confounding variables such   alcohol consumption,

anxiety traits and depression in the middle aged group, which very few studies do.

In the above study, Waldstein et al., (1996) noted that the interaction of age and neuropsychological functioning in hypertensives was more notable in tests that tap executive or frontal lobe functions, and this was   sistent with Stuss and Benson,(1984) who was cited.

Based on that concept, a study by Raz, Rodrique & Acter (2003) investigated the relationship between hypertension and the brain; specifically looking at the vulnerability of the prefrontal regions and executive functions. The sample comprised of 40 participants that had been diagnosed with essential hypertension. These were matched with 40 normotensive controls with regards to sex and ethnicity with an age range of 30-77 years. Their formal education ranged between 12-21 years. There were no sex differences with respect to age, which is (60.85± 68.09 years for women versus 62.72± 13.04 years for men). Antihypertensive drugs being taken by each participant were noted. The common one being calcium channel blockers. One of the major strengths of this study was the neuroanatomical measures that were taken in addition to cognitive tasks. In addition, the test battery was administered by technicians that blind to the subject's medication and diagnosis to reduce bias. Furthermore, the influence of illness duration and type of medication was taken into account. Duration of illness variable showed some significant differences while grouping by medication criteria did not. Their anatomical findings revealed white matter abnormalities and a reduction in brain volume limitation.

Limitations of the study included a limited statistical power. Firstly authors say for a sample as large as they had, it would be unlikely for the null hypothesis to be rejected. Secondly blood pressure measures were not taken for all participants, hence it could not be ascertained whether the normoten   were really not hypertensive. Thirdly, in certain cognitive measures, only one measure was used. Thus making validity assurance difficult. Hence their result indicated that

hypertensives showed more perseverative errors on tests of executive functioning.

Another similar study was by Hannesdottir et al, (2009). This study was conducted to confirm white matter damage and cognitive impairment in hypertension. The sample comprised of 40 patients diagnosed and being treated for hypertension, with an average age of 69.3 years, 10 with untreated hypertension with an average age of 57.6 and 30 controls with an average age of 68.2 years. Hannesdottir et al, (2009) noted poor performance in treated and untreated participants, on tests of executive functioning and psychomotor speed, suggesting that treated hypertension shows a decline in memory.

In another study, the discrepancy was also seen because Raz et al (2003) noted poor performance in tests of executive functions.   One thing to also note was that the latter study (Hannesdottir et al, 2009) was a pilot study; and it may not be very safe to take the results as conclusive, and this   a major limitation on to this study.

Another study which is slightly different is by Starr, Deary, Fox & Whalley, (2006) whose objective was to measure the effect of blood pressure on cognition in the later adulthood age. This study adjusted for early life mental ability. The study participants included survivors of the 1947 Scottish Mental Survey with validated IQ Scores when they were 11 years. The study consisted of 1,300 participants aged around 65 years, seen in different bands over a period of four years because it was a cohort study. Their results showed that blood pressure has various effects across cognitive functioning. Their result showed a significant effect on verbal recall, an aspect of memory. One limitation observed is that the test battery used was not comprehensive enough to asse   many other domains, such as executive functioning. However, the strength   the study was the large sample size and longitudinal in nature, which entailed a follow up over a period of four years.

A study by Grossman and Zalewski (1995) compared male veterans (n=166) hypertensives in the mild range to normotensive (n=176). A comparison of neuropsychological measures of verbal and visual memory attention and executive functions was done. The variables controlled were education and income. Their results revealed no significant relationship between mild hypertension and some combined neurocognitive domains. These findings conflict Raz et al, 2003 who found that even mild hypertension ill shows a pattern of cognitive deficits.

Interestingly however, Hestad et al., (2005) in their study with the old (80-102 years) in Norway found an association between low blood pressure and neurocognitive decline and as a risk factor for dementia. Though their study also involved an association of these factors with the apolipoprotein e4 allele in these individuals they state that this may not be so in the   population. However in Zambia this will be the first of this kind of study; and the findings will definitely be useful in neuropsychological assessments in clinica   ice in this country.

Ralph et al., (2006) in their book *Medical Neuropsychology* have reviewed various studies; and have noted poor performance by hypertensives as compared to their normotensive counterparts. Most notably have been domains of memory and learning attention, executive functioning and abstracting thinking, psychomotor speed, and visuospatial abilities. The authors have stated little support on tests of language and general verbal intelligence.

However, a wide range of studies have shown a general poor performance by hypertensives in tests of memory, executive functioning, attention and psychomotor speed. It should also be noted that individual variability has been noted in performance among hypertensives (Ralph et al., 2006).

2.1.4 Hypertension and quality of life

Cognitive defects resulting from hypertension can markedly reduce the quality of life (Taichman et al, 2005). Wenger (1988) in the study on the quality of life issues in hypertension documented the domains of daily life that are usually

affected.   These include side effects of the medication, fatigue, libido levels, memory deficits, mood swings, alertness, sleep disorders, performance at work, and relations with family.

A pilot study carried out by Williams (1993) on the caregivers of persons with stroke found that a considerable amount of tasks and responsibilities have to be done for these patients. The physical challenges result from impairments due to cerebro vascular accidents such as stroke. These further result in impairments in a number of neurocognitive domains that result in emotional vulnerability.

Clinical reports of anxiety, depression and other phys   l symptoms are usually reported by caregivers of such neurologically challenged individuals due to the stress exerted on them by these responsibilities (Williams, 1993).

Therefore, individuals with hypertension are affected in their quality of life not only by the illness itself but also by the medication as well (Cote et al., 2004).

Therefore, this study seeks to explore these findings or more with the use of the Zambia Neurobehavioral test battery on the Zambian adu   population and to establish the relationship between side effects of the medication and quality of life.

In conclusion studies on hypertension and neurocognitive function have shown a huge variability the findings. This may be due in part to different sample sizes, methodologies, populations used and different measures of neuropsychological assessments. A variation has also been noted in the f   gs due to different operational definitions of hypertension.

CHAPTER3

3.1 METHODOLOGY

3.1.1 Introduction

This chapter focuses on a number of aspects concerning the methodology, such as the research design, the nature of the sample, the   ment, and the procedure. Furthermore the measures used their reliability and validity, ethical matters, data management and analysis and finally methodological limitations.

3.1.2 Research design

This was a cross sectional study; and quantitative in nature. It was a clinic based study of adults between the age of 40-65 which included hypertensives and non hypertensives. The study involved a neuropsychological evaluation using the Zambia Neurobehavioral test battery which has been designed to be sensitive towards HIV related neurocognitive impairment.

3.1.3 Nature of sample

The sample was made of a total of 50 participants between the ages of 40-65. The first 36 participants were sampled randomly as part of a larger study; and the other 14 were sampled purposefully to make sure the two groups were matched on age and gender. Hence hypertensives were recruited after normotensives in order to match the sample by age and gender.

3.1.4 Recruitment procedure

Recruitment of the participants was done from some urban clinics in Lusaka district; and these included; Kalingalinga, UNZA, Mtendere, and Chilenje Clinics. The rural clinics were Chibombo, Chongwe, and Kafue through the ongoing voluntary counselling and HIV testing campaign. This was done in order to capture an HIV negative population. HIV negative participants who were hypertensive and falling within the stated age range were requested to take part

in the study and if they agreed they were asked to fill in consent forms. Normotensives too were recruited through the ongoing HIV voluntary test campaign by the clinics staff in the various clinics mentioned above. However, the limitation to this study was that normotensives were not medically screened for hypertension.

If they agreed to take part in the study, their blood   sure was measured with the help of a nurse; if their BP was found to be stable on the day of assessment (less than 180 systolic pressure and less than 110 dia   ic pressure refer to Table 1.1 WHO/ISH Classifications (1999),the next step was administration of the Neurobehavioral medical screen to assess for any CNS confounds.   they were found neurologically normal then the entire test battery was administered. Thereafter they were required to fill in the questionnaires that have been indicated under measures.

Participants were compensated with a food and transport allowance after the assessment.

3.1.5 Inclusion Criteria

Participants had to be:

- HIV negative

- Neurologically normal subjects (free from CNS disorders).

- Between the age 40-65.

3.1.6 Exclusion criteria

- HIV positive

- HIV negative but with CNS disorders i.e. Head injuries, learning disabilities, HIV, meningitis, encephalitis, tumours, degenerative disorders, syphilis, and stroke.

- A past history of the following

Cardiac condition, thyroid disease, renal failure and diabetes mellitus.

3.2 MEASURES

3.2.1. Blood Pressure

Blood pressure was measured using a mercury sphygmomanometer with the assistance of a nurse. This was used to obtain systolic and diastolic blood pressure before each cognitive testing session begins. However, blood pressure measurements were only used for screening; and were not recorded for analysis. This is because for this study, blood pressure was defined by a previous diagnosis and on anti hypertensive medication.

3.2.2. Neuromedical Evaluation

The neuromedical examination included a review of past medical and neurological histories, history of any current or past medications and their side effects as well as a brief medical and neurological exam. All neuromedical instruments were adapted from ongoing HNRC and AIDS Clinical Trials Group (ACTG) studies.

3.2.3. Neurocognitive Assessment.

The neurocognitive assessment comprised tests of visual episodic memory, verbal episodic memory, fluency, abstraction/executive functions, attention/working memory, speed of information processing, and motor function. Specific tests are listed in Table3. These are well known Neuropsychological tools and have been widely used in neurobehavioral studies of HIV/AIDS (Carey, et al., in press; Woods, et al., in press).

Table 3. Zambia Neuropsychological Test Battery

Speed of Information Processing	*Attention/Working Memory*
• WAIS-III Digit Symbol • WAIS-III Symbol Search • Trail Making Test Part A *Abstraction/Executive Functioning* • Wisconsin Card Sorting Test (64-item version) • Colour Trails • Stroop Colour Word Test • Category Tests – computer version *Learning and Delayed Recall (2 domains)* • Hopkins Verbal Learning Test, Revised-II • Brief Visuospatial Memory Test – Revised	• Paced Auditory Serial Addition Test • WMS-III Spatial Span *Language* • Word Sound Fluency • Category Fluency (Animals, Action) *Motor* • Grooved Pegboard (Dominant and Nondominant) *Screening for Effort* • Hiscock Memory Test **Medical Screening Interview** **Behavioural Notes Summary** **Academic Skills Questionnaire**

3.3.1. A brief outline of the Reliability and Validity of the Neuropsychological Test battery measures.

The Zambia neurobehavioral test battery consists of 21 neuropsychological tests that are designed to measure different domains of cogn   functioning. This section aims at briefly describing each test, the developer and a brief study that was done to test the validity and reliability of the test.

Hopkins Verbal Learning Test-Revised

The Hopkins Verbal Learning Test-Revised (HVLT-R) is a test of learning ability and immediate recall on verbal information across multiple trials. It also measures an individual's capacity to retain, reproduce and recognise information after delay (Strauss, Sherman & Spreen,2006).The test was developed by Brandt and Benedict (2001).

Reliability and Validity of the Hopkins Verbal Learning Test-Revised

The original English version HVLT-R normative sample consisted of 1,179 adults, with 75% women, between 15-92 years (mean 59.0 SD=18.6) and formal education ranging between 2 and 20 years (mean 13.4years and SD=2.9). Of the four primary variables. which were age, education, gender, when indexed with total recall, delayed recall, percent retained and recognition discrimination, age had the largest effect on the variance (19%) (Shapiro, Benedict, Shretlen & Brandt, 1999).

Shapiro, et al., (1999) found that HVLT-R also correlated more strongly with other tests of   verbal memory and quite weakly with tests of general intelligence. Thus concluding that HVLT-R is a valid test of verbal learning and memory.

Woods et al., (2005) further supports the reliability, convergent, construct, predictive and discriminant validity of the learning and recall measures on the HVLT.

Brief Visual Memory Test-BVMT

The Brief Visual memory test (BVMT) measures "visual learning and memory using a multiple trial list learning paradigm. It is a figural learning test developed by Benedict (1997); Benedict and Groninger (1995) and   t et al., (1996)" (Strauss, Sherman & Spreen, 2006; 701).

Cherner et al.,(2009) says the current BVMT-R was standardised with 588 English language speaking adults between the age of 18-79 years(M=38.6

SD=18.0) with an average formal education of 13.4years(SD=1.8). The sample comprised 65% female, mostly Caucasian (82%) with 14.5% African mericans and 3.6% other ethnic groups.

Hierarchical regression showed that formal education and gender did not influence test results and as such T scores generated   only corrected for age. Caution however should be taken because the low s   by those with low levels of formal education may over estimate the impairment. BVMT-R users should therefore, realise this limitation of scoring and normative data. However, further research is being recommended to ascertain whether there would be an improvement in the diagnostic accuracy if the spatial location and ac   are separated and whether this will still maintain the validity and reliability of the BVMT-R.

Hiscock Dgit Memory Test (HDMT)

This test has been designed to measure visual memory and deliberate responding or malingering. It was developed by Merill Hiscock and Cheyl Hiscock from the University of Saskatchewan in 1989. It was initially known as the Hiscock Digit Memory Test named after its developers.   ically, it is used to detect factious sensory or perceptual impairment and also applied to cases claimed memory loss.

Reliability and Validity of the Hiscock Digit Memory Test

A study to substantiate the validity and reliability of the HDMT was carried out by Hiscock and Hiscock in 1989. They administered the HDMT ,Weschler adult Scale, T rails A and B, Wisconsin Card Sorting Test and other tests to a 45 year old male patient who claimed to have had a memory loss after a head injury and was referred by the provincial worker's compensation board in Canada.

Additionally two control subjects: a severely demented 53 year old woman with dementia of the Alzheimer's type and a normal 5year old girl were recruited. On test administration, it was found that the scores of the patient progressively

declined across the second and the third blocks having an overall score of 21 out of 72(29%) which was significantly below the chance(50%) level. The severely demented 53 year old woman scored at the 51% chance level (not significantly different from chance) and the normal 5 year old girl score was 82% which is significantly above chance .

Therefore, the above findings by Hiscock and Hiscock (1989); Prigatano and Amin (1993); Franzen and Martin,(1996) suggest the validity and reliability of the Hiscock Digit Memory Test(HDMT) as a reliable and valid test of factious sensory or perceptual impairment and claimed memory loss.

Spatial Span

The Wechsler memory scale II -Spatial span is a component of the Weschler memory scale 3rd ed which is a neuropsychological test battery used to assess learning and memory in adolescents and adults of age range 16-89 years of age. The WMSII spatial span has been adopted into various batteries for its testing properties.

It is a visual test of attention and memory and a derivative of the Corsi blocks test which was first developed by Corsi in the 1970s to compliment the verbal memory span task.

Validity and Reliability of the Spatial span

The spatial span is a recent revision (last 15 years)   Corsi blocks test (over 35 years) and thus has very little research done on it than the Corsi blocks test (Berch, Krikorian & Huha,1998),hence it has not been translated and validated for non English language speaking populations (Kessels, Berg, Ruisan &Brands,2008).

The testing of the validity of the spatial span is a more complex measure because it is based on three assumptions of which several studies have questioned. For example, a study was done to assess performance of a clinical population on the WMS spatial span subtest in comparison to the Digit span

(Wilde& Strauss,2008).The sample comprised 44 participants referred for assessment after injury, seizure disorder, surgery. The study reviews records of clients referred for neuropsychological assessment for medical reasons as mentioned and with a Glasgow coma scale of 14 and no history of unconsciousness greater than 1hour. It consisted of 26 males and 18 females of average educational level of 12.4 years and average age of 37.1 years.

Results showed that the raw scores for the forward digit span were higher than those for the forward spatial span while backward digit span results were lower than those of the backward spatial span questioning as   mption 1.There were also generally similar raw scores for both the forward and backward spatial span results which are in contrast to assumption 2. Hence questions have been raised as to whether the spatial span is a valid measure of visual-spatial memory or perhaps its validity would be a more complex measure.

Wilde and Strauss (2008) have concluded by cautioning the interpretation of the spatial span backward scores for clinical purposes though generally those that performed poorly on the forward spatial span test also did poorly on the backward span test.

With regards to reliability, the spatial span is a good test of recurrent assessment of degeneration (dementia) because it has a negligible practice effect (Nuechterlein et al, 2008) and yet shows reliable change indices when there's deterioration in cognition. This conclusion is based on studies done in epileptic patients in whom subtests were administered before and after surgery in order to identify tests that can be used to monitor responses to treatment. The spatial span test showed test-retest reliability and little practice effect (Martin et al 2002).

Similar results were obtained in a study on schizophrenic patients that was done to develop a valid and reliable test battery for diagnostic and prognostic purposes. The spatial span was one of the 10 out of 36 tests that were selected to test for 5 critical areas of cognitive impairment in schizophrenia based on the

results of the study. The study was made of a mixed population of Caucasians, Asians, and Africans making a total of 176 (Nuechterlein et al 2008).

Stroop Test

Stroop colour and word test was developed by John Ridley Stroop in 1935. It measures…."the ability to shift cognitive set by requiring the active inhibition of previously learned responses that are highly automatic" (Sacks,Clark,Pols & Geffen,1991,pp220).The interest is in selective attention, habitual response, automatic response suppression ability and goal oriented and is used for executive functioning.

Reliabilty and Validity of the Stroop Test

The most reliable studies done on the stroop have been test-retest reliability (TRR) studies. This so because of the importance placed on practice effect and its impact on neuropsychological tests both in researc   linical populations.

Levines et al, (2004) sampled 37 adults between 52 and 80 years. They were then tested at three time interval; "with an inter assessment interval of 14 days. They found that only the colour task did not produce decrease in completion time between the 2nd and 3rd sessions" (Levine et al. 2004, pp .292). In short, completion time was found to be of greater sensitivity than error scores were to practice effect.

Trenerry (1989) as cited in Cave (2008)found TRR correlation of the Stroop to be at r=0.90 similar to findings as cited in Lemay, Be'dard, Rouleaw, & Temblay (2004). The findings of these authors range from 0.74 to 0.88 for reading (W card),0.74 to 0.90 for naming (C card) and 0.67 to 0.91 on interference (WC).

According to McCrea and Barr (2005), one method of finding validity is to show that the test is sensitive to deficits among clinical   ients with an already established diagnosis of impairment.

An example of a study that showed validity of the stroop test is by King, Collaa, Bras, Henser & Cramon (2007).The sample included 22adults that had a diagnosis of ADHD in childhood and 22 healthy controls. The subjects were administered a block explicitly cued task switching paradigm and a stroop colour word test. The results showed that the ADHD group performed worse, had errors, and had an inability to control interference. The limitation of the study was the small sample size.

In conclusion, the above studies and numerous others have shown a fair reliability and validity of the stroop test. However there are some factors that have been noted that affect the reliability and validity of this test.

Digit Symbol and Symbol Search

The digit symbol and symbol search tests are tests that make up the Processing speed index of the Weschler Adult Intelligence Scale III. "WAIS-III is a revision of WAIS-R" (Weschler, 1991 as cited in Strauss et al., (2006 pp.283). Strauss et al, (2006) have argued that "measures such as letter number sequencing, Symbol *Search* were developed to assess working memory and processing speed." (Strauss et al.,2006 pp.283).The authors have stated the reasons for this revision among them being an extended range for age, removing or adding   items and changing some items all together. Therefore, the WAIS-III, a four factor model measures "Verbal comprehension, Perceptual organisation, Working memory, and processing speed" (pp283).The digit symbol and symbol search are therefore, designed to measure the processing speed index. However, some studies have also argued that these two tests might have a measure   attention and working memory. (Strauss et al.,2006).

Reliability and Validity of Digit Symbol and Symbol Search

Studies on the validity and reliability of these two tests have usually been incorporated in the WAIS-III as a whole measure. However emphasis has been made on the processing speed index were necessary. Gorsuch, Saklofske & Hildebrand (2000) confirmed the four description model of the WAIS-III and

concluded that "the replication of the four–factor structure(Verbal comprehension, processing speed, working memory and perceptual organi   demonstrates the psychometric integrity of the WAIS-III and attests to its portability across cultural boundaries. Not only have studies across cultures confirmed the reliability and validity of the WAIS-III but the validity has also been confirmed in measuring cognitive decline in old age (Clay et al., 2009).This gives a better picture of the fact that these tests actually measure   they are designed to measure. This has been further supported by (Heaton et al., 2003; Rayan, Sattler, et al., 2000 as cited by Strauss et al., 2006.pp.289).The authors have argued that" those subsets that measure speed of processing show the greatest difference with increasing age." Another study by Paul and Kreiner, (2000) confirmed the reliability of the WAIS-III across cultures and across both the clinical and standardization sample. The authors specifically made mention of the 11 subsets used and among them were the digit symbol and symbol search tests. It was concluded that "none of the reliability estimates differed significantly from those reported for in the WAIS-III. Similar findings emerged when reliabilities were determined separately for Caucasian and African American". (Paul & Kreiner 2000.pp 151).Test-Retest reliability of similarities, Arithmetic, Comprehension, Block designs, *Digit symbol* has also been confirmed. (Strauss et al.,2006.pp 295).

From the above stated findings, it can be concluded that the Digit symbol and Symbol search will be important measures in the standardization sample and their index will be a significant contribution to further research and as diagnostic tests.

Paced Auditory Serial Attention Test (PASAT) and Color Trails

Paced Auditory Serial Attention Test is meant to measure attention deficits including concentration, speed of processing, mental calculation, and mental tracking. It is sensitive for diagnosing cognitive impairment in individuals 16 years old and up.

Paced Auditory Serial Addition Test was originally kno   as the Paced Auditory Serial Addition Task (PASAT). This is a challenging ta   that involves working memory, attention and arithmetic capabilities. Strauss, Sherman and Spreen, (2006) stated that the PASAT was devised by Gronwall and others (Gronwall, 1977; Gronwall & Sampson, 1974; Gronwall & Writson, 1974) to provide an estimate of speed of information processing. The PASAT is also an auditory test of attention and memory. Trail Making Tests A and B are meant to measure attention, visual searching, mental processing speed,   the ability to mentally control simultaneous stimulus patterns. These tests are sensitive to global brain status but are not too sensitive to minor brain injuries.

The Color Trails Test (CTT) has been described as a culture-fair test of visual attention, graphomotor sequencing, and effortful executive processing abilities relative to the Trail Making Test (TMT). The Color Trails Test (CTT) was developed as a culturally fair analogue of the Trail Making Test (TMT).

Reliability and Validity of Paced Auditory Serial Attention Test and Color Trails

With regard to the test-retest reliability for CTT, two-week reliability is reported as marginal (.64) for Part 1 and acceptable to be high (.79) for Part 2(D'Elia et al., 1996 in (Strauss, Sherman & Spreen, 2006). They also state   at paired t-tests indicate that the interference index is significantly greater on the second test session and that not other CTT variables are significantly different across the two tests sessions.

With regard to validity, Maj et al., (1993) as cited in Strauss, Sherman & Spreen, (2006) report moderate correlations between CCT Parts 1 and 2 with TMT A and B of .41 and .50, respectively. The internal structure of the CTT has been evaluated in the normative sample and in a sample of traumatic brain injury patients. The factor structures were somewhat divergent in the two samples, although both had four-factor solutions and factors that reflected speed of perceptual tracking and sequencing. Further, for both   mples, the error near-

miss, and prompt variables appeared to tap constructs that are dissociacible from those captured by the time variables, (Strauss, Sherman & Spreen, 2006). D'Elia et al., (1996) and Maj et al., (1994) as cited in Strauss, Sherman & Spreen, (2006) reported a significant slow performance on Parts 1 and 2 in patients with traumatic brain injuries and HIV respectively.

Controlled Oral Word Association Test (COWAT) and Category fluency Test

The controlled oral word association test is a test of verbal fluency that involves coming with words upon the instruction of the examiner.

Reliability and validity The Controlled Oral Word Association Test(COWAT) and Category Fluency Test

On internal reliability, Tombaugh et al (1999) assessed the degree of internal consistency that existed among F, A and S. Coefficient alpha was computed using the total number of words generated for each letter as individual items and was found to be high (r =0.83). The same result (r=0.83) was reported for C, F and L.

In health adults, test retest correlation tends to be high, typically above 0.70, for both letter and semantic fluency with short as well as long intervals. For example, Tombough et. Al, (1999) found a test-retest reliability coefficient of 0.74 for FAS after an interval of more than five months in elderly individuals.

As might be expected, gains are seen following short retest intervals. Wilson et al (2000) reported that fluency for the same letter or category show a small; but consistent increase across 20 successive administrations over a four week period in normals as well as those with severe head injury.

Basso et al (1999) noted no gains among 50 healthy males re-tested following a 12 month interval on FAS. However, Levine et al (2004) reported gains of about

three words for 2145 healthy men when he reassessed this group with FAS with the interval of 4 to 12 months; there was change in score despite a long retest interval.

Although test-retest reliabilities are reasonable for phonemic fluen   these findings suggest that relatively large changes in performance are required to conclude that real decline or improvement has occurred as opposed to being due to the effects of practice and random measurement error (Basso, et al 1999).

A similar picture emerges for category fluency as the   described on the FAS above. This picture has been seen in a study done by Bird et al (2004) in which he evaluated semantic (animal) fluency in 99 healthy adults.

All in all what was noticed in most of the tests done   that there was some notable practice effect on the second administration a   some studies proved otherwise.

Wilson (2000) suggested that practice effects can be reduced by changing the letter or category on each test occasion. The findings of Wilmen et al (1999) are consistent with this proposal. They gave alternate forms (FAS, BDT) in a counterbalanced manner of 81 normal controls. Reliability was adequate w only small practice noted.

For the above reason and more, it has been noticed that FAS and Category fluency tasks could be reliable but, there is great need for the examiner to control for practice effects so that correct recommendations can be made on patients.

Correlations among phonemic fluency task for example the FAS and the CFL are high. Troyer et al (2000) show that the two sets of letters are roughly comparable across different settings and groups such as the healthy, psychiatric, suspected CNS dysfunction, with correlations between forms ranging from 0.85 to 0.94.

There is high correlation even with other sets of letters such as CFL and the PRW which stand at 0.82.Correlations for written word fluency tasks and phonemic tasks is equally high standing at 0.72 and 0.81 respectively of the FAS and the CFL/PRW.

Correlations between forms using different semantic categories are also moderately high at 0.66 to 0.71 for such groups as (animals and clothing) and (animals and food).

Wisconsin Card Sorting Test and Category Test

The Wisconsin Card Sorting (WCST) test was originally   as a test of "abstract behaviour and shift of set". (Lezak, 2004). The Wisconsin Card Sorting Test has for a long time been used as a test that measures abstract behaviour or executive functioning,

Validity and Reliability of The Wisconsin Card Sorting Test and Category Test

The validity of the Wisconsin Card Sorting Test has been used tested by several researchers. Paolo, Troster, Axelrod & Koller (1995) loo   at the construct validity of the Wisconsin Card Sorting Test and the relationship between WCST test scores and memory and attention. In their study,   recruited 187 normal elderly and 181 persons with Parkinson's disease who were recruited from the community and retirement homes. An exclusion criterion was used by excluding all normals that scored below 130 on the Dementia Rating Scale as they were not supposed to show any signs of dementia and a score of less than 130 was associated with early dementia.

The results were analysed on both number of categories and the number of preservative errors, these indicated that there was an increased number of preservative errors among the subjects with Parkinson's disease than the normals. The results thus indicated that an increase in preservative errors

increases among individuals with frontal lobe dysfunction supporting the validity of the test as a measure of frontal lobe functions.

In trying to understand the reliability of the WCST, Bowden, Fowler, Bell, Whelan, Clifford, Ritter and Long (1998), evaluated the reliability and internal validity of the WCST. In their work they had a sample of 75 university students to assess the reliability of the test and were given two forms of the test one after the other. In the administration process, the first set was given in the standard form while in the second form the administration was changed. The results were significant on the errors and the number of categories completed. However, there were no practice effects that were observed in this study. The results also showed low retest reliability and alternate form reliability with an average of .43 on Pearson's r which showed that almost of 80% of the results could be attributed to error variance. The authors argue that the test cannot be used in a clinical sample until the reliability of the test is fully tested. However, it is important to take note that the administration of the test was altered in this study and this is likely to affect results as standard rules of test administration were   followed. The WCST in conclusion, can be argued to be a valid test of executive functioning and the studies outlined above give some guidance on what to consider in further research as well as when making clinical decisions. It is also important to take note that the reliability of the test is not optimum and caution should be used especially in the administration of alternate forms of the test. It has also been argued that due to its' low reliability the test does not have very good specificity although it reports high sensitivity to frontal brain lesions (Bowden, et al, 1998).

Category Test

The test was developed by Halsted (1947) to assess the ability to conceptualise qualities such as size, shape, number, position and colour. It is a test of executive functioning.

Reliability and Validity of the Category Test

In a study to look at test-retest reliability, Dikmen, Heaton, Grant & Timken (1999), recruited 354 normal or neurologically stable participants. The participants were all of at least 15years of age and of these 138 had no recent head trauma but were friends of those with head injuries and were tested after 11 months, 121 had recent head injury and has their baseline testing a month after the trauma and 11 months after the baseline testing. A variety of tests were used and these included the Halsted Reitan Test Battery, Wechsler's Adult Intelligence Scale (WAIS) and other memory test. The results obtain   found reliability coefficient of between Pearson's r of .40 to .85 over   median interval of 11 months.

In this study, it is argued that there are two types of reliability. These are the concept of clinical reliability versus psychometric reliability which is cited in this study. The authors argue that "clinical reliability is used to consistently classify individuals' performances as normal *versus* impaired on the basis of cut-off scores" (p.353); and the results obtained on the neuropsychological mea used including the category test had better clinical than p   metric reliability. However, the clinical reliability is easily affected by practice effects especially if the testing interval is very short. Goldstein & Watson, (1989) and Matarazzo, et al, (1974) argue that with severely impaired neurological patients, the reliability coefficients tend to be as high as .90 even two years   the baseline testing (Cited in Strauss, Sherman & Spreen, 2006). Considering that rel   lity is concerned with getting consistent results and a reduction of measurement error, it can be argued based on these results that the current test retest results may not be very high but they do seem to show some consistency in the way they are reported at different times.

3.4.0. Questionnaires

3.4.1.SF 12 Health survey

The SF12 Health survey is a 12 item questionnaire that measures the quality of life in hypertensives.SF12 stands for Short-form 12-item. This is the form that has been shortened from original SF-36 which was developed in the United States to measure the quality of life specifically for hypertensive patients. The SF-36 initially consisted of 36 items, one item was used to   easure health transition and the other 35 items were grouped into 8 domains designed to measure physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health. The eight domains were narrowed down to measure two components i. e physical component and the mental component. Thereafter, a shorter form with 12 items was constructed using 12 items from the SF 36. These adopted the same 8 domains (Core et al., 2004).

Core et al. (2004) carried out a stidy to determine the validity of the SF-12. The objective of the study was to determine the extent to which SF-12 gave similar results on measurement of the quality of life as compared to the SF-36 when administered to the same population of individuals on hypertensive drugs. The sample comprised of patients between the age of 18 and 80 years and on at least one anti-hypertensive drug. Their results suggested that the SF-12 is a valid measure of health related quality of life and can be used as an alternative to the SF-36. Furthermore, it also has the advantage of less time to complete because it is 10 minutes less than the SF-36 as it only takes 2 minutes to complete (Core et al., 2004). See appendix 3.

3.4.2. Hypertension questionnaire

In addition, participants filled in a questionnaire that was specifically designed for this study to capture information on the hypertension condition. The questions included information on the duration since diagnosed,   edication, and its side effects; and hence the "side effect variable" in the data management which is a

continuous variable that includes responses on the questionnaire. See appendix4.

3.4.3. Ethical Considerations

Approval was obtained from The University of Zambia Biomedical Research Ethics prior to the commencement of the research. An informed consent was obtained from each participant after explaining to them the purpose of the study prior to participation in the study. All pieces of information were entirely confidential and participants were free to withdraw from the study at any time. All the questionnaires and assessment tools were coded thereby ensuring confidentiality. See appendix 1 and 2.

3.4.4. Data management and analysis

The data was analysed using SPSS computer software (version 15). The following is an outline of the variables and the analysis outline that was employed.

1) Descriptive statistics were carried out to give a clear picture   the sample in terms of the mean age and standard deviation, mean   ion, frequency of males versus females, rural versus urban status.

2) Hypertension status versus the seven ability domains of the neuropsychological test battery; mean Global Deficit Score (GDS) used (Carey et al.2010). A t test was carried out to measure any discrepancy in performance between hypertensives and normotensives on the seven ability domains of the NPS battery and that is visual episodic memory, verbal episodic memory, fluency, abstraction/executive functions, attention/working memory, speed of information processing, motor function.

3) Hypertension status versus GDS impairment: Chi-square test was used to determine if there was any significant difference in the impairment index of hypertensives compared to normotensives or not. Individuals were considered impaired if they had a GDS of 0.5 or higher. In order to arrive at Global deficit scores, T scores were converted (which are demographically corrected for age, education, rural urban status and Zambia Achievement Test) using the conversion method shown in the Table 5.

Table 5 Conversion table for transforming T Score into Deficit Scores.

T scores	Deficit score	Impairment descriptor
=40	0	Normal
39–35	1	Mild
34–30	2	Mild-to-Moderate
29–25	3	Moderate
24–20	4	Moderate-to-Severe
=19	5	Severe

*source Carey et al, 2010, Vol 26, no .3,pp 308.

4) Pearson's correlation test was carried out to determine if there was any correlation between side effects variable and SF12 domains.

5) It should be noted that the scores used in the data management were T scores; these were generated by demographically correcting for background variables such as education, age, rural urban status and ZAT (Zambia Achievement test).

3.4.5. Methodological limitations

Due to the non availability of CT and MRI scans in Zam   this study did not have brain structure evidence in these participants. Screening for a history and/or presence of co morbid conditions that occur with hypertension were not done therefore the study relied on participant's clinic record.

4.0.RESULTS

Response rate

Table 6. Showing the Response rate

Expected number of participants	Actual number recruited	Response rate
25 normotensives 25 hypertensives Total=50	29 normotensives 21 hypertensives Total=50	100%

Table 7. Characteristics of the sample by age and education

Demographics		Hypertensives	Normotensives	P	t
Age	Mean SD	52.81 6.047	50.48 6.260	0.195	1.316
Education	Mean SD	10.62 2.674	11.45 2.910	0.309	-1.028

Hypertensives were slightly older than normotensives, P=0.195, while normotensives had a slightly higher mean education at   9, however this was not statistically significant. Equal variances were assumed.

Figure   1.

Hypertension
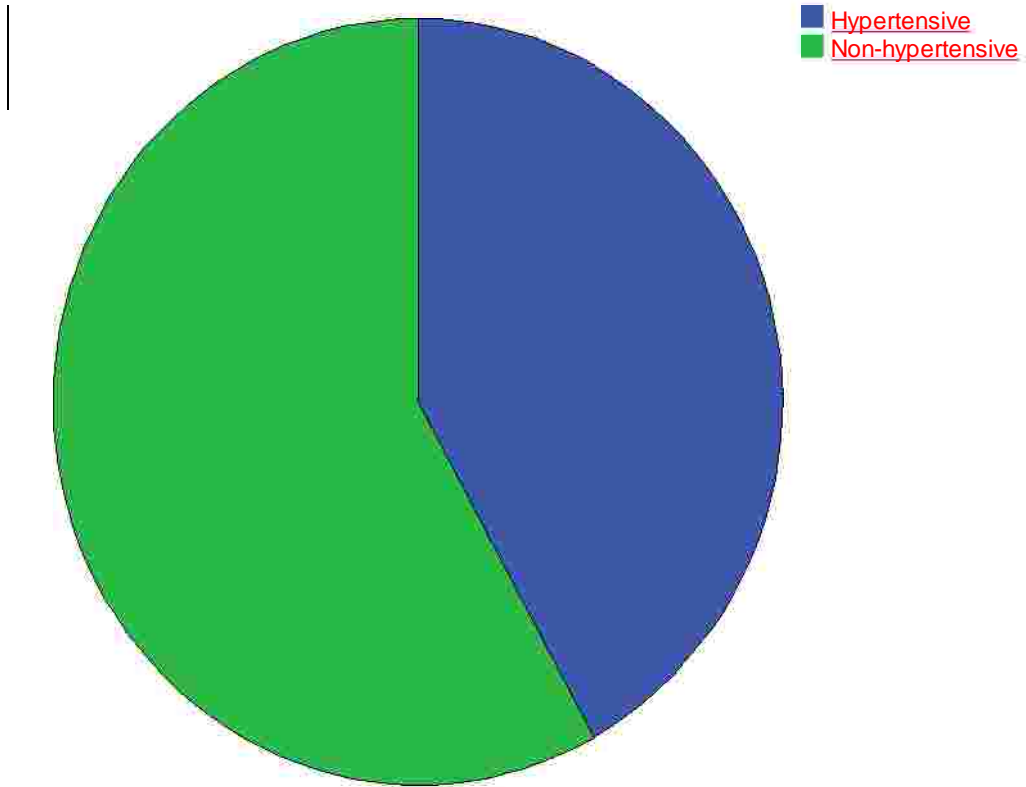
The above pie chart represents the ratio between hypertensives and normotensives in the sampled population.

Figure 2.
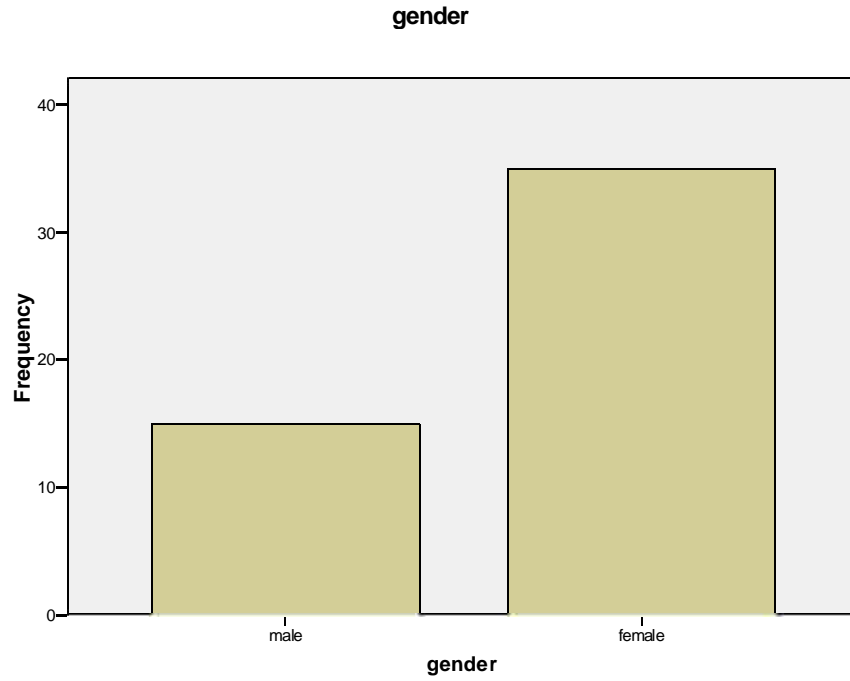
gender

The above figure shows the sample by gender. There were more females than males in this sample.

Figure 3.

education

The above figure shows the sample by education ,most of the participants had 10 years of education.

Figure 4.

age

The above figure shows the sample by age. The sampled   tion ranged
between the age of 40-65.

Table 8. Hypertension versus the seven ability domains of the neuropsychological test battery.

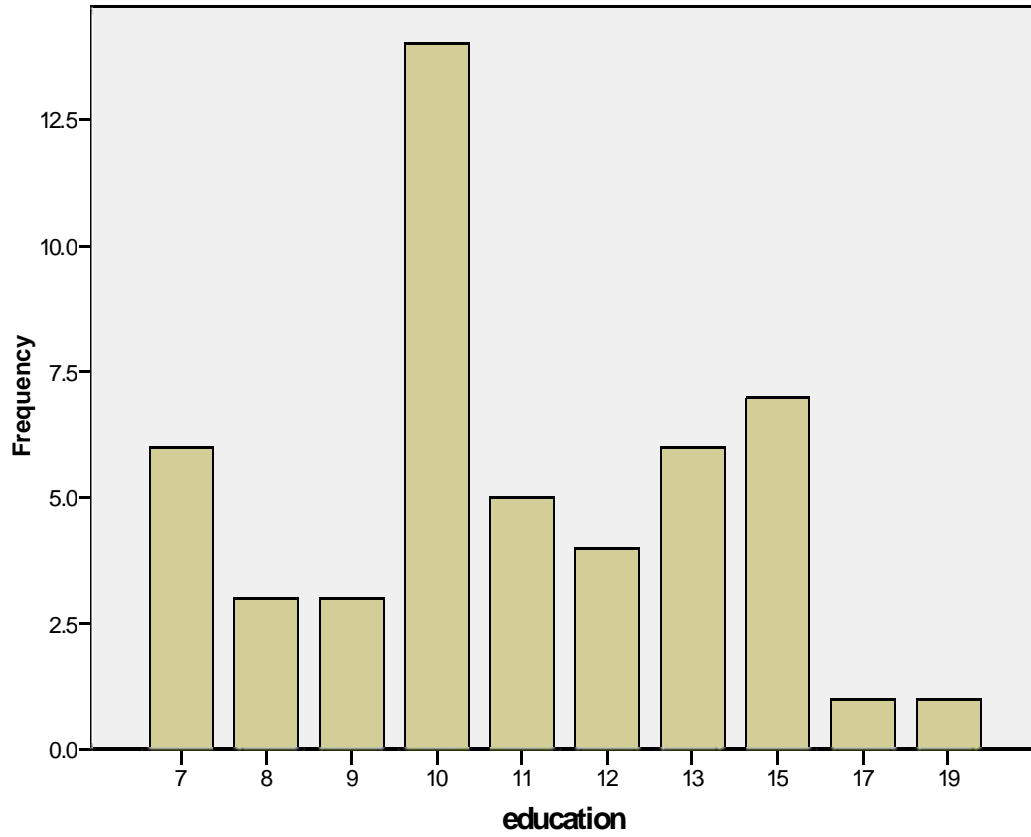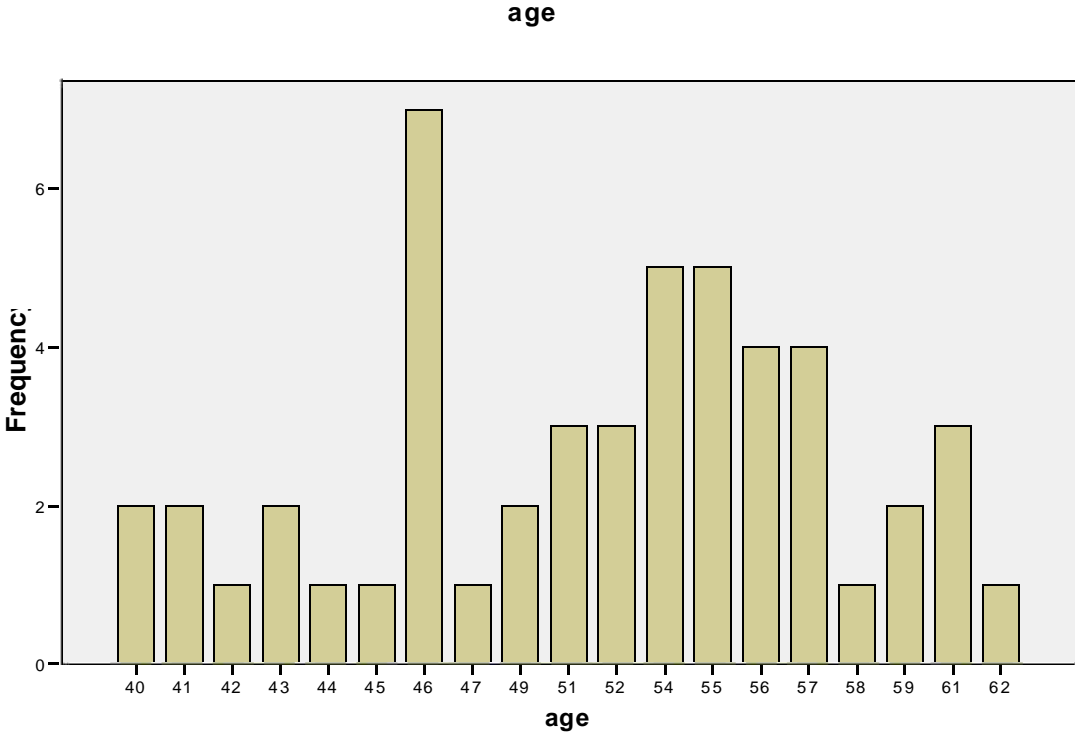| Neuropsychological domain T-score means		Hypertensive	Normotensive	t value	P value	Cohen's d
Executive functioning	Mean SD	48.42 6.928	48.21 5.553	0.125	0.901	0.00032 54
Fluency	Mean SD	48.48 6.928	48.67 5.651	-0.110	0.913	0.00025 20
Working memory	Mean SD	49.93 7.374	50.40 7.122	-0.226	0.822	0.001
Visual episodic memory	Mean SD	47.98 9.822	50.59 9.750	-0.931	0.356	0.018
Verbal episodic memory	Mean SD	48.67 11.581	49.71 7.847	-0.379	0.706	0.003
Motor	Mean SD	47.90 6.895	50.26 10.839	-0.874	0.386	0.008
Speed of information processing	Mean SD	48.90 7.608	50.09 6.035	0.619	0.539	0.004

As shown by the average scores, there were no statistically significant differences in performance between hypertensives and normotensives on the seven neuropsychological domains ps= 0.356).

Table 9. Differences in impairment as per Global Deficit Scores

	hypertensive	Normotensive	Total
Not impaired count % within hypertension	18 85.7%	27 93.1%	45 90%
Impaired count % within hypertension	3 14.3%	2 6.9%	5 10%
Total count % within hypertension	21 100%	29 100%	50 100%

Further analysis done to determine whether there was any significant difference in impairment between the hypertensives and normotensives, and this revealed that there was a higher percentage (14.3%) of impairment within the hypertensive group as compared to the normotensives group (6.9%). However this finding was not significant ($?^2$ = 0.74, p=0.390).

Table 10. Correlation table between side effects and Quality of life

	r	Sig.(2 tailed
General functioning	-0.383	0.129
Physical functioning	-0.593*	0.012
Role physical scale	-0.260	0.313
Bodily pain	0.039	0.882
Vitality scale	-0.634**	0.006
Social functioning	-0.618**	0.008
Role emotional scale	-0.345	0.175
Mental health	-0.598*	0.011

*Correlation is significant at 0.05 level (2 tailed)

**Correlation is significant at 0.01 level (2 tailed)

At a 0.05 (2 tailed) significance level our side effect variable correlated negatively with the physical functioning(r=0.593) and mental health (r=0.598) of the SF12. At a 0.01 significance level, side effects correlate negatively with the vitality scale(r=0.634) and the social functioning(r=0.618) of the SF12.

CHAPTER 5

5.1.DISCUSSION

This chapter discusses the results of each hypothesis   this study whose main objectives were: To establish if   there is a significant difference in performance on neurocognitive tests between normotensives and hypertensives or not; secondly to assess whether the impairment index using   bal deficit scores is higher in hypertensives and to determine if there is a relationship between side effects of medication for hypertension and the hypertensives' quality of life or not.

5.1.1.Hypothesis 1- *Hypertensives will perform poorer than normotensives on neurocognitive tests of executive functioning, working memory, fluency, visual episodic memory, verbal episodic memory, motor dexterity and speed of information processing.*

From the results obtained there was no statistically significant differences in performance be between hypertensives and normotensives on the tests of attention, fluency, motor dexterity, visual episodic memory, verbal episodic memory, executive functioning P>/0.356. This could be attributed to;

Sample size-this which could have been small hence, reducing the statistical power (Zalewski & Grossman, 2005) who argued that in studies with a small sample, that do not find significant differences in performance on neuropsychological tests, more often than not it is due to a reduction in the statistical power.

Furthermore, Blumenthal and Madden (1989) argued that various forms of neuropsychological test batteries have revealed neuropsychological hypertension related deficits on some measures and it was not clear why such deficits could appear on some tests and not on others. The present study was the first of its kind on this particular test battery; hence it could have been quite different from

other test batteries used by other researchers. This is confirmed by Birns and Kalrd (2009).

Additionally, the methodological control over confounding variables such as age, education, rural urban status, alcohol abuse, and concurrent medical condition could have been done differently from what other researchers in the past have done.

Lastly, and important to note is that the study sampled well controlled hypertension and this could suggest that the condition might be in its mild and medication could be acting as a neuroprotector on drastic cognitive decline. Consistent with the findings in this study, there are   that have found no significant differences in performance between medicated hypertensives and normontensives (Zawelski& Grossman,2005; Huang et al.,2009). Variations have been noted in the stage of the condition, differences in medication ,as these form a separate entity on cognitive impairment (Birns& Kalrd,2009; Zawelski& Grossman,2005). Variations in results have been noted with mild, moderate and severe hypertension. There are studies that have found no significant differences in performance between medicated hypertensives and normotensives. Paran, Anson, Reuveni (2003) further confirm this in their study of blood pressure among the elderly. They found that mild hypertension actually appeared to enhance cognitive functioning in their sampled population.

Further variations have been noted in studies that have sampled participants on different antihypertensive drugs as this forms a separate entity on cognitive impairment (Birns& Kalrd, 2009; Zawelski& Grossman, 2005).

5.1.2. Hypothesis 2- *Hypertensives reveal more neurocognitive impairment on cognitive tests compared to normotensives.***-**

On global deficit scores impairment, more impairment was noted in the hypertensive group than the normotensives group by 7.9%,however this was not significant,$x2=0.74$,$P=0.390$. The scores were arrived at after converting T scores to global deficit scores. Refer to table 3.2 under data management.

The use of global deficit scores to predict impairment has been widely adopted by researchers to report impairment in different conditions. Norman et al., (2007) used GDS in their study on caffeine intake being independently associated with neuropsychological performance in patients with obstructive sleep apnea. Carey et al.(2010) carried out a study to explore the predictive validity of the Global deficit score approach in summarising neuropsychological test results. But their study was specifically in detecting HIV-related cognitive impairment. Their results supported the validity of the GDS as a clinically useful way of summarising Neuropsychological test results.

5.1.3. Hypothesis 3- *There will be a negative correlation between the side effects of medication for hypertension and the hypertensives' quality of life.*

Pearson's correlation test revealed that at 0.05 significant level correlated side effects correlated negatively with physical functioning (r=59.3%) and mental health (r=59.8%). At 0.01 significant level, side effects correlated negatively with vitality scale (r=63.4%) and social functioning (r=61.8%). of the SF12 health survey which measures quality of life in hypertensives. This is a strong correlation as it is above 50%.

In many cases treatment of chronic illnesses is not curative. Therefore, it becomes imperative to improve functioning and quality of life (Deglgcoinnocenti et al, 1992).Nearly all anti hypertensive medication has been associated with some side effects (Dimsdale, 1992). In the present study, most participants were on diuretics and Dimsdale (1992) confirms that even patients treated on diuretics commonly report side effects.

From the results obtained on Pearson's correlation test of side effects and quality of life (SF12 domains),it shows that there is a relationship between a hypertension and quality of life, and this is consistent with Wenger (1988) who documented the domains of daily life that are usually   among them was the side effects of the medication. Wenger (1988) in the study on the quality of life issues in hypertension documented the domains of   ily life that are usually

affected. These include *side effects of the medication*, fatigue, libido levels, memory deficits, mood swings, alertness, sleep disorders, performance at work, and relations with family.

CHAPTER SIX

6.1.0. CONCLUSION

According to our literature review, some studies have   differences in performance on neuropsychological tests between hypertensives and normotensives while others have not. However, based on the results of study, there are no statistically significant differences in the domains of the neuropsychological test battery that were measured bet   hypertensives and normotensives.

Hypertension affects the quality of life (Taichman et al, 2005). As seen in the results of this study, hypertensives are affected not only by the disease its   but also by the side effects of the medication thereby markedly reducing their quality of life. Therefore, we can conclude that quality of life is more affected than neurocognitive functioning in our study population. This is shown by high Pearson's r values of; 59.3% (side effect and physical functioning); 59.8%(side effect and mental health); 63.4%(side effect and vitality scale); 61.8% (side effect and social functioning).These findings are important in order to design intervention programs that go beyond medication alone.

Intervention programs that improve the quality of life   these individuals with such conditions are very cardinal. These are mainly life style modifications as supported by Smith et al., (2010) who found that increased aerobic fitness and weight loss appeared to improve neurocognitive functioning.

6.1.1. Implications of the findings in a Zambian Context

The findings in this study in the Zambian context should be able to raise an awareness about the importance of prioritising research of the non-communicable diseases specifically in the area of hypertension. It is clear from the results by Global deficit scores that there is some impairment in cognition and this has been shown to affect the quality of life. Only when these findings are

taken as significant, will the need to design intervention programs be effected. Some of these would include intervention programs that improve memory, executive functioning and many other areas of cognitive functioning.

6.1.2. Implication to health practice

The findings in this study have an implication to health practice. This should be able to alert health practioners as they deal with their hypertensive patients that it is not only lowering of the blood pressure that matters most but treatment should also include making the patient aware that their quality of life might be affected by the medication. There is need to also make them aware about neurocognitive effects that could result. This would help them handle the effects better, and in some cases they may seek intervention programs that could improve their quality of life.

6.1.3.Recommendations

1. Due to methodological limitations of this study, we recommended a larger study to be done in future with a bigger sample size and incorporating brain structural scans that could help reveal more information.

2. We would also recommend that in future studies, the effects of confounding variables, specifically alcohol consumption, anxiety and depressive scales be taken cared of methodologically as these have been documented to affect results (Waldstein & et al,1996).

6.1.4. Strengths of the Study

The present study has a number of strengths. Firstly, the neuropsychological test battery that was used is comprehensive enough to cover a number of neurocognitive domains as outlined in the results section. And the reliability and validity of these instruments has been tested and documented. Secondly, the scores used in the analysis(T scores) were corrected for the background variables such as age, education, rural-urban status and ZAT(Zambia

Achievement Test).Thirdly, the recruitment of the participants was done by clinic staff and these are well trained people in the medical fraternity.

6.1.5.1 Limitations of the study

This study like any other study had limitations too. Firstly the sample size could have been sample hence this could have reduced the statistical power. This concept is supported by Zalewski & Grossman (2005). Secondly, we did not couple the investigation with brain structural scans. These are important because if the part of the brain affected is known, this could give insight about what sort of impairment will be seen.

Thirdly the study did not control for confounding variables of alcohol consumption, trait anxiety and depression. These have   reported to affect hypertension related cognitive studies (Waldstein et al., 1996).

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