

**NEUROPSYCHOLOGICAL FUNCTIONING AND QUALITY OF LIFE AMONG
TYPE 2 DIABETIC PATIENTS IN GHANA**

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BY

JACOB OWUSU SARFO

(10230891)



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DECLARATION

This is to certify that this thesis is the result of research undertaken by Jacob Owusu Sarfo under supervision towards the award of Master of Philosophy in Clinical Psychology Degree in the University of Ghana, Legon.

.....
Jacob Owusu Sarfo
(Student)

Date.....



.....
Prof. C. C. Mate-Kole
(Principal Supervisor)

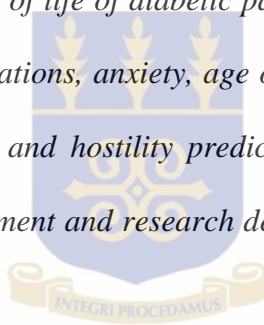
Date.....

.....
Prof. J. Y. Opoku
(Co-Supervisor)

Date.....

ABSTRACT

Diabetes as a metabolic disorder predisposes patients to both biomedical and psychological dysfunctions. The aim of the study was to determine the pattern of neuropsychological deficits and quality of life among individuals living with Type 2 diabetes mellitus in Ghana. One hundred (100) participants comprising 50 patients with Type 2 diabetes and 50 healthy controls matched on age and education were recruited. Using a battery of neuropsychological tests and behavioural measures, data was collected at the Diabetic Clinic, Korle-Bu Teaching Hospital. The results showed that individuals with Type 2 diabetes obtained significantly lower scores than the healthy controls on executive functions, memory, visuospatial and visuoconstructional functioning tests. In addition, Type 2 diabetes also affected the quality of life of diabetic patients who were sampled for the study. Specifically, depression, complications, anxiety, age of respondents, health beliefs, cognitive failure, interpersonal sensitivity and hostility predicted quality of life. These results have implications for clinical management and research design in psychological studies involving Type 2 diabetes.



DEDICATION

To all families across the globe with relatives diagnosed with diabetes mellitus.



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LIST OF ABBREVIATIONS

ADA	American Diabetic Association
APA	American Psychiatric Association
CDC	Centers for Disease Control and Prevention
CT	Computer Tomography
DG	Diabetic Group
DSM IV-TR	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision.
HCG	Healthy Control Group
IDF	International Diabetes Federation
GHS	Ghana Health Service
MOH	Ministry of Health
MRI	Magnetic Resonance Imaging
NDMRC	National Diabetes Management and Research Centre
NMIMR	Noguchi Memorial Institute for Medical Research
WHO	World Health Organization

CHAPTER ONE-INTRODUCTION

Background to the Study

Diabetes mellitus is described as a metabolic disorder, which is evident by a chronic state of hyperglycaemia (increased blood glucose), accompanied by a disorder of food nutrients' (carbohydrate, protein and fat) metabolism as a result of associated problems in insulin secretion, insulin action, or both (American Diabetes Association [ADA], 2003a). The cardinal clinical manifestations used as indications for diagnosis include polyuria, polydipsia, polyphagia and unexplained weight loss. These indications, although they may vary in intensity and frequency among patients with diabetes mellitus, they still serve as one of the clinical measures through which diagnosis may be reached (World Health Organisation [WHO] & International Diabetes Federation [IDF], 2006).

For over three decades, diabetes mellitus has been on the increase in Ghana (IDF, 2012). Although, Ghana's Ministry of Health tries to provide some medical treatment opportunities for individuals diagnosed with this disorder, very little is known about their neuropsychological functioning. Notwithstanding this, diabetes mellitus is one of the incapacitating chronic disorders globally, that poses several public health issues across a broad age range (ADA, 2003c). According to the World Health Organization's format for the diagnosis of diabetes, the range of blood glucose symptomatic of diabetes mellitus is either by: a Fasting Venous Plasma Glucose (FPG) ≥ 7.0 mmol/l or Venous Plasma Glucose ≥ 11.1 mmol/l at two hours after a 75g oral glucose load [Oral Glucose Tolerance Test (OGTT)] (WHO & IDF, 2006).

In addition, the classification of diabetes mellitus may vary across scope; it is predominantly classified into several different types based on its cause, pathophysiology, and management. The major classifications of diabetes are Type 1 diabetes (formerly called Insulin-Dependent Diabetes Mellitus), Type 2 diabetes (formerly called Non-Insulin

Dependent Diabetes Mellitus), and Gestational Diabetes Mellitus (which occurs as a result of pregnancy). The use of numbers (1 and 2) rather than Roman numerals (I and II) is to avoid any confusion when differentiating between the types (ADA, 2003a). Type 1 diabetes mellitus is noted to account for about 5% to 10% diabetic cases. It affects the pancreatic beta cells, which produces insulin in the human gastrointestinal system for the metabolism of ingested food as digestion ensues. These beta cells are mainly destroyed by an autoimmune reaction which occurs in the body of the affected individuals. Hence, such patients physiologically elicit limited or no insulin; thus, requiring a continual insulin therapy to manage their blood glucose levels.

In effect, Type 1 diabetes has an acute onset and predominantly occurs before 30 years of age [Centers for Disease Control and Prevention (CDC), 2002]. On the other hand, about 90% to 95% diabetic cases are Type 2 diabetes mellitus (CDC, 2002). This mostly occurs as an effect of diminished sensitivity to insulin and damaged pancreatic beta cell which lead to a low level of insulin (Quinn, 2001).

Due to its pathophysiology and its late occurrence (usually above 30 years), Type 2 diabetes is managed with diet, exercise, oral agents and insulin injection therapy (ADA, 2003a). Statistical projection estimating people across the world living with diabetes was proposed to increase from 171 to 366 million, between the years 2000 and 2030 (Wild, Roglic, Green, Sicree, & King, 2004). Thus, it becomes very important to identify all the possible threats associated with this disorder and their best possible management.

A well-noted aspect of both Type 1 and Type 2 diabetes is that both can result in serious complications if the right precautions in care are not adhered to. These complications are broadly classified into retinopathy, nephropathy, and neuropathy, for which a careful glucose control is needed (ADA, 2003b). In addition to these complications, common systemic disorders have been noted to arise from these

complications. A common clinical manifestation arising from retinopathy may increase from a subtle vision problem to potential and/or complete vision loss.

Moreso, neuropathic complications are also manifested in the forms of foot ulcers, poor healing which may later lead to amputations. In some neuropathic cases too, sexual problems like erectile dysfunctions are evident. Nephropathic disorders leading to various types of renal disorders like kidney failure are also possible. Owing to the devastating nature of diabetes mellitus, the central goal of treatment has been focused on reducing the risk of patients clinically diagnosed with diabetes from developing any of these main vascular and neuropathic complications (ADA, 2003b).

Neuropsychological Functioning and Diabetes Mellitus

Diabetes mellitus was first indicated in a study by Miles and Root (1922) to show certain neuropsychological deficits. In their study, individuals diagnosed with Type 1 diabetes sampled were identified to show some classical cognitive deficits. Recent studies have reported on some distinctive neuropsychological deficits among individuals diagnosed with diabetes in general. Among individuals with Type 1 diabetes, the neuropsychological deficits include; psychomotor skills, general intelligence and motor speed difficulties (Northam et al., 2001; Weinger et al., 2008; Wessels et al., 2007). Patients with Type 2 diabetes however display profound neuropsychological deficits which may be accounted for by a combination of old age and other comorbidities (National Institute of Diabetes and Digestive and Kidney Diseases, 2004). Notable among these comorbidities are cardiovascular disorders (Ferguson et al., 2003; Knopman et al., 2001) and dementia (Stewart & Liolitsa, 1999).

Studies by Nguyena, Evans and Zonderman (2007) indicated that the influence of chronic conditions including diabetes mellitus, cardiovascular conditions and

musculoskeletal conditions had a significant effect on cognitive performance. They also found that age was significantly associated with chronic medical conditions and cognitive performance. Other studies in the area of chronic medical illness in addition to diabetes mellitus found individuals with hypertension, and other respiratory disorders like obstructive sleep apnoea to often exhibit some significant neuropsychological functioning (Annweiler et al., 2011; Boeka, & Lokken, 2008; Ostrosky-Solis, Mendoza, & Ardila, 2001; Salorio et al., 2000).

Another area worth noting is the effect of Type 2 diabetes on patients' brain. One important neuroanatomical region which is usually affected is the cerebral cortex (Garde, Mortensoen, Krabbe, Rostrup & Larsson, 2002). Garde et al. (2002) identified that neuropsychological deficits associated with Type 2 diabetes, are normally observed in abnormalities like infarcts and atrophy on Magnetic Resonance Imaging (MRI). Van Harten et al. (2006) in their reviews on MRI studies identified a significant relationship between Type 2 diabetes and brain anomalies like cerebral atrophy and lacunar infarcts which may arise from the occlusion of an artery. Nonetheless, conditions like hypertension and stroke which are common comorbid states in Type 2 diabetes were also noted to increase the likelihood of patients developing brain disorders.

General Quality of Life Issues and Diabetes Mellitus

Besides the reported neuropsychological deficits, quality of life is also affected in patients with diabetes (Munshi et al., 2006). Quality of life issues as denoted by Maatouk et al. (2012) indicate the state of loss and decline in a person's perception of life's goodness with influences from past and/or present life events. They expanded these perceptions that the quality of life of adult patients with diabetes was affected by some factors like mood, physical and other problems. Significant among these factors were

depression, diabetes related complications and other negative lifestyle behaviours which served as a way of adjusting to their perceived loss. Munshi (2006) claimed that diabetes coupled with these factors often affect the cognitive abilities of the patients negatively. These cognitive deficits were seen in aspects like the executive function, attention, psychomotor speed and memory (Alexopoulos et al., 2002).

Substantial to the effects of quality of life are the individual's health beliefs. These beliefs have been noted to affect the lifestyle choices of many human populations by predisposing them to high risks for many disorders (Ebbeling, Pawlak & Ludwig, 2002). According to Gaston and Porter (2003), some of these sociocultural norms lead to the toleration of certain lifestyle disorders like obesity and excessive weight of both relatives and friends. Interesting to this finding was the fact that excessive weight tolerant beliefs among some overweight African Americans were noted to share close resemblance with the beliefs of some West African countries (their supposed original ancestry). They assumed that such standard of physique which was accepted as beauty models was an inherited belief from their ancestral place of origin. Furthermore, cultural norms tend to transform an individual's standards towards living especially when it relates to health (Cutler, Whitaker, & Kodish, 2003). According to Baskin, Ahluwalia, and Resnicow (2001), it is difficult to address some lifestyle issues among black families without impairing their sociocultural perceptions like their body images, eating and food habits.

Statement of the Problem

This thesis seeks to determine the level of neuropsychological functioning and quality of life among Type 2 diabetic patients in Ghana. According to the International Diabetes Federation (IDF) (2012), about 354,020 Ghanaians are now living with diagnosed diabetes mellitus at the end of 2012. Also, an additional number of 292,450 Ghanaians

have been projected as the number of undiagnosed cases in 2012 alone. In effect, this places a huge socioeconomic burden of about USD \$ 114.76 management cost per person (IDF, 2012). Thus, the need for a more holistic care in the management protocols of both the Ghana Health Service (GHS) and the Ministry of Health (MOH) to include neuropsychological care is imperative.

Additionally, Type 2 diabetes mellitus which is the most prevalent and also correlates highly with neuropsychological deficits and dementia (Luchsinger et al., 2007; Luchsinger et al., 2001) has to be studied using Ghanaian samples to address the above problems. Unfortunately, these neuropsychological impairments are not identified early in most patients even in the developed countries (CDC, 2008). Hence, a study on the neuropsychological functioning and quality of life among individuals diagnosed with diabetes is needful to report a better clinical picture.

Relevance of study

This study seeks to provide the Ministry of Health and other stakeholders in the management of Type 2 diabetes mellitus like the Ghana Health Service, with a clinical neuropsychological functioning and quality of life perception. These findings will inform these practitioners of screening, diagnostics, management, and referral services when working on individuals diagnosed with diabetes in Ghana. Also, this effort will also serve as a step in complementing the expensive cost of MRI and other radiologic imaging techniques that are scarce in Ghana as used in some studies (Van Harten, de Leeuw, Weinstein, Scheltens & Biessels, 2006; Garde et al., 2000) to show brain infarcts and other damages. As a result, secondary and tertiary prevention within the scope of diabetes

mellitus can be identified and managed earlier to decrease or prevent some of or all arising complications.

Results from this study will also inform practicing Clinical Neuropsychologists in sub-Saharan Africa to identify adequate test batteries from the study needed not only to screen individuals diagnosed with diabetes but to identify distinct deficits and also measure progress in management. This is needed in the current practice of clinical neuropsychology in Ghana, as it stands as an emerging field in the management of diabetes across the globe (CDC, 2008). In addition, findings from this study will also make recommendations that will be valuable for future researches on the neuropsychological functioning and quality of life of individuals with diabetes. This will be a valuable enhancement to literature since this study will provide additional data on Ghanaian patients with Type 2 diabetes mellitus.

Aims of the Study

The main aim of this thesis is to investigate the neuropsychological functioning and perceived quality of life of individuals clinically diagnosed with Type 2 diabetes mellitus.

Specific objectives for this study are

- To examine the effect of Type 2 diabetes on neuropsychological functioning.
- To explore the perceived quality of life among diabetic patients.
- To explore the predictors of perceived quality of life.
- To identify the relationship between the neuropsychological functioning and quality of life of individuals diagnosed with Type 2 diabetes.
- To explore the predictors of health beliefs.
- To examine the effect of Type 2 diabetes on other psychological functioning.

CHAPTER TWO-LITERATURE REVIEW

Overview of Literature Review

Over a century, diabetes mellitus has been identified as one of the causal factors of some cognitive dysfunctions (Miles, & Root, 1922). Subsequently, various studies to measure the levels of functioning have been done with different research methods and samples. Generally, the neurological consequences of blood glucose levels on cerebral functioning among diabetic patients had consistently shown some poor neuropsychological functioning like attention, processing speed, memory, and executive functioning (Boeka, & Lokken, 2008).

Anatomically, the human brain, which lies in the skull of the head, is a small regional organ, which forms only 2% of the body weight. Nonetheless, it consumes nearly $\frac{1}{4}$ of the total body glucose as its main source of energy. Thus, to the brain, inadequate supply can even be fatal or might lead to permanent impairment (Magistretti, & Pellerin, 1996). To support this claim, some brain imaging studies have shown photographic portions of brain cellular deaths, which were associated with diabetes mellitus (Garde et al., 2002; Van Harten et al., 2006). In addition to these anatomical and neuropsychological issues related to diabetes, especially the Type 2, studies have shown some declines in the quality of life of individuals diagnosed with diabetes (Munshi et al., 2001). This is partly due to neurotransmitter imbalances in acetylcholine, glutamate and Gama Acetyl Butyric Acid, which occur with poor glucose supply (Schulingkamp, Pagano, Hung, & Raffa, 2000).

Other factors like poor medical management, comorbid states and psychosocial factors, which are usually seen in most chronic illnesses, also affect their general quality of life of individuals diagnosed with diabetes. Significant among them is depression, which is

found mostly among the individuals diagnosed with Type 2 diabetes (Anderson, Freedland, Clouse, & Lustman, 2001). Notwithstanding these studies so far, some gaps relating to unexplored aspects, conflicting results, research method and/or sampling techniques have been identified.

Neuropsychopathology of Diabetes Mellitus

The goal of treatment for diabetes mellitus in both Type 1 and Type 2 is to control the amount of circulating glucose in the blood after digestion. Following the outcome of two studies, first done by the Diabetes Control and Complications Trial [DCCT] (1993) and later by the United Kingdom Prospective Diabetes Study [UKPDS] (1998), an increased blood sugar indicator called glycaemia (HbA1c) was found to be the cause of diabetic complications. In essence, this indicator is observed as an important marker for possible determination of prognosis. As described in both researches, individuals diagnosed with diabetes who were able to regulate a strict glycaemic control were observed to have lesser complications than their comparative cohort even after a decade.

This enables glycaemic management protocol to provide a basis to regulate either a higher (hyper) or lower (hypo) blood glucose (glycaemia) level into normal ranges. Cardinal among the signs and symptoms of hypoglycaemia and hyperglycaemia are their ability to affect the normal body functioning. In a review on the cognitive performance in Type 1 and Type 2 diabetes by Brands and Kessels (2009), circulating blood glucose was noted as an important fuel for cerebral function. Consequently, hyperglycaemia led to symptoms like nervousness, perspirations, dizziness, hunger, confusion, difficulty to produce spoken speech, headache, lack of energy, loss of concentration and attention. However, hypoglycaemia led to depressive mood, thirst, frequent urination, vomiting, poor cognitive function, lethargy, drowsiness, abdominal and leg pains.

Although both hypoglycaemia and hyperglycaemia have been noted in the decline of systemic functioning, some studies have implied contrary findings to their effect. Hyperglycaemia, for example, has been connected to diabetic ketoacidosis [DKA] and hyperosmolar hyperglycaemic state [HHS] (Kitabchi, Umpierrez, Murphy & Kreisberg, 2006). Kitabchi et al. (2006) however outlined these complications as having some uncommon neurological declines among clinical diabetic samples. This may result in cerebral oedema, a lethal problem of prolonged hyperglycaemia complication mostly occurring in 0.7–1.0% of newly diagnosed children and 72-74% of young adults in their twenties. In such cases of DKA and HHS, all the signs and symptoms of hyperglycaemia are manifested clinically with central nervous system dysfunctions that are characterised with episodes of seizures, pupillary changes, incontinence, bradycardia (slow heart rate) and respiratory arrest.

In addition, this systemic defect in circulatory blood sugar, whether low or high, highly impacts negatively on the brain's structure and function. Weinger and Jacobson (1998) described the burden of hypoglycaemia and hyperglycaemia on cognitive functioning of individuals diagnosed with diabetes as dysfunctional. Due to the central nervous system's dependence on glucose for its energy, an acute glycaemic imbalance (hypo or hyper) may be destructive (Brands & Kessels, 2009). Describing the distinct route of pathophysiology entailed in diabetic brain damage, not much has been reported about it. In a rare histological study done some decades ago by Reske-Nielsen et al. (1965) using 16 patients, diabetes mellitus was implicated as a possible cause for severe brain damage. In this study, the mean diabetic onset among participants was 7 years with a mean duration of 24 years. This histological study revealed a justification for their introduction of the pathological term 'diabetic encephalopathy'. Noteworthy in this study is the analysis of brain autopsies, which showed significant brain tissue death and atrophies in areas such as

the leptomeninges, optic chiasm, macroscopical softening and large hemorrhages within the region of the brain stem.

Although Reske-Nielsen et al. (1965) could not outline the pathway of the diabetic brain damage irrespective of the neurological impairments, their reports served as a valuable basis for conceptual studies. There have been validations of their findings by recent Magnetic Resonance Imaging (MRI) and Computer Tomography (CT) scan studies showing areas of brain damage (Garde et al., 2002; Van Harten et al., 2006). Notwithstanding the small sample sizes used in these clinical studies, their results to some degree are able to link neuropsychological challenges associated with individuals diagnosed with diabetes to both hyperglycaemic and hypoglycaemic complications.

Nonetheless, some studies have also aligned themselves specifically with either hyperglycaemic or hypoglycaemic complication alone. To this end, hyperglycaemia had frequently been identified by most studies as rather the cause of neuropsychological deficits than hypoglycaemia. In a study conducted on a recent large sample of 1144 individuals diagnosed with diabetes Type 1 diabetes, hyperglycaemia was identified as having a significant effect in causing diabetic neuropsychological dysfunctions. Participants with a mean age of 27 years were administered a collection of cognitive batteries to measure these deficits.

This study was done in two phases, first as the Diabetes Control and Complication Trial [DCCT] (1996), and continued later as the Epidemiology of Diabetes Interventions and Complications [EDIC] study (2006). In their findings, both studies attributed neuropsychological deficits to poor management of diabetes, which resulted in hyperglycaemia. Evidently, these had led to a further discovery of significant cortical and subcortical brain damages in the forms of atrophy and cerebral infarcts. Pathologically,

individuals diagnosed with Type 2 diabetes showed a combination of tissue deaths with or without visible symptoms of functional deficits when compared to controls (den Heijer et al., 2003). These atrophy and infarcts as explained have been outlined to be associated with cognitive deficits in individuals diagnosed with Type 2 diabetes (Garde et al., 2002; Van Harten et al., 2006).

In addition, Convit, Wolf, Tarshish, and De Leon (2003) show in their study, a systemic perspective of impaired glucose circulation especially on the central nervous system. Their study outlined that poorly regulated peripheral glucose is significantly associated with the volume of hippocampus and performance of verbal memory. As a result, the study sought to compare the hippocampal volumes and memory functions of a group of non-diabetic adults (middle and older aged) with a measure of peripheral glucose control by the body. Findings in the study noted that those with a poorly regulated peripheral glucose regulation correlated significantly with diminished volumes of hippocampus and showed memory dysfunctions.

Unlike some studies that related neuropsychological dysfunctions to cerebral atrophy and infarcts (Garde et al., 2002; Van Harten et al., 2006; Convit et al., 2003) rather associated hippocampal function to cause memory problems in poor glucose regulation. Although the specific location of the brain has been conflicted, the critical role of diabetes mellitus cannot be ruled out of neuropsychological dysfunctions and poor quality of life with its mood disorders.

Theoretical Framework

Executive Function Theory

Executive function has been an area of interest to many neuropsychologists and neuroscientists. As a result, several theories and models have been used to explain this broad concept of functioning although each is not fully comprehensive in itself (Packwood, Hodgetts, & Tremblay, 2011). In a review on executive functions, these tasks were proposed to be maintained mainly by the brain's frontal lobe. In effect, these capabilities in humans have been noted to assist them in planning, execution, evaluation and meeting the demands of varying situations over different periods of time. In effect, any impairment in functioning related to executive functions is classified into a group called 'dysexecutive syndrome' (Burgess, & Alderman, 2004).

In early perspectives on executive functions, the working memory served as one of the most relevant theoretical models. However, the working memory model was revised later to indicate the executive component as a dominant constituent for the co-ordination of all types of memory functions (Baddley, 2000). In addition, it has however been argued that executive function may have an extensive association even in long term memory task (Parkin, 1997). Nonetheless, majority of diabetic neuropsychological functioning and affect are explained by Stuss and Benson's Model on executive functions (Stuss & Alexander, 2000; Stuss & Benson, 1984, 1986) and Shallice's Supervisory Attentional / Contention Scheduling Model (Norman, & Shallice, 1980; Shallice, & Burgess, 1998).

Stuss and Benson's Model on Executive Functions (Stuss and Alexander, 2000; Stuss & Benson, 1984, 1986)

This model attributes executive functions to the prefrontal cortex, its cortical and sub-cortical networks in the human brain. It further describes executive functions as mental

activities, which are refined like anticipation, planning, goal selection, organization, initiation, execution and self-regulation of goal-directed activity (Stuss & Benson, 1986). Stuss and Benson's (1984) work defined four extensive categories of dysfunctions. These four operational levels include arousal-attention; perceptual-motor; executive mediation and self-awareness. Based on these categories, Burgess et al. (1996) developed a dysexecutive questionnaire that defined dysexecutive set of symptoms to include a combination of emotional, behavioural, motivational and cognitive changes.

A further review on executive functions showed that the frontal lobes play a significant role in memory processing. Anatomically, the frontal lobe is divided into two; right and left lobes. The right frontal lobe enables the recovery of stored memory while the left frontal lobe assists in the encoding and formation of memory. In effect, it serves as the fundamental location for more strategic memory activities (Evans, 2004). Stuss and Alexander (2000) supported the fact that the frontal lobe is strongly connected to the human limbic system and affect. From their analysis, the frontal lobe is much likely to primarily regulate affective receptiveness, personality changes, and self-alertness rather than executive cognitive activities.

From their examination of patients with frontal lobe lesions, the complexity of the task or activity was not able to differentiate frontal lobe functions from other brain regions. This was quite impossible because complex tasks may demand a more multifaceted brain processing other than the frontal lobe alone. Thus, even the local frontal lobe regions function homogeneously, as subjects were tested progressively on more complex tasks (Stuss & Alexander, 2000).

Shallice's Supervisory Attentional / Contention Scheduling Model (Norman & Shallice, 1980; Shallice & Burgess, 1998)

This model seeks to define the operation of the frontal lobe to support a type of cognitive processing system termed as the Supervisory Attentional System (SAS). According to this model, SAS assists an individual to engage in not less than eight functional tasks. This processing system in daily life may be affected individually once the executive functions are impaired. These functions include spontaneous schema creation, monitoring, working memory, rejection of schema, adoption of processing mode, delayed intention marker realization, goal setting, and episodic memory retrieval (Shallice & Burgess, 1998).

This model provides a systemic approach for looking at executive function in a more practical way. SAS is believed to have a contention scheduler, which serves a regulatory factor in an individual's daily actions, whether in routine or non-routine situations. In routine activities, it controls the shared competition that may arise from the environmental triggering effects on the choice of involuntary actions. In most cases, its role is to regulate and help the person choose the best action while inhibiting the rest as there may be several competing actions activated at the same time. However, the supervisory attentional system regulates non-routine or voluntary conditions mostly when these schedules have to be transformed or controlled as a result of a new judgement or choice (Norman & Shallice, 1980).

Theories on executive functions and memory had been noted to be more explanatory in providing much understanding of how neurobiochemical changes and brain tissue death due to diabetes affects neuropsychological functioning. However, their relationship with diabetic quality of life and illness beliefs have not been conceptualised in most studies.

The Health-Related Quality of Life (HRQOL) Theory (Wilson & Cleary, 1995)

The Health-Related Quality of Life (HRQOL) Theory according to Wilson and Cleary (1995) explains and measures the quality of patient care in an illness situation. Quality of life (QOL) is described as the general attitudes, feelings, or the capacity of individuals to perceive an ultimate contentment in a specific aspect of health. This aspect of health life (physical, mental or social), which is recognised by the individual as highly significant to their well-being, in an illness situation, is threatened by the development of disease or health-related dysfunctions.

In this model, five domains were identified as fluctuating on a continuum. Health-Related Quality of Life's continuum ranges from biological factors and social factors up to psychological complexity of an individual's health life. In addition to these factors, the individual's personal characteristics and environmental factors seem to affect one's placement on the continuum (Wilson, & Cleary, 1995). According to Wilson and Cleary (1995), these personal domains consist of physiological factors, symptom status, functional status, general health perceptions, and overall quality of life. These factors are very important as they do alter greatly an individual's perception of life and the general effect of the illness.

As evident in Bonomi, Patrick, Bushnell and Martin's (2000) study to validate the World Health Organization Quality of Life (WHOQOL) instrument, individuals who were chronically ill had significantly lower mean score on various quality of life domains just as healthy adults or reproductive women. Hence, the study noted changes in life situations like chronic illness, aging and pregnant states as negative to a person's perceived quality of life. In this study, Type 2 diabetes mellitus is noted as the chronic medical illness, which is likely to affect the quality of life of patients.

Review of Related Studies

Diabetes Mellitus and Neuropsychological Functioning

Type 2 diabetes mellitus has been noted to affect some neuropsychological functioning in most studies. These studies in some instances noted some specific functional problems like executive function while others identified more global functional impairments. Luchsinger et al. (2011) in their study to identify the role diabetes plays on global cognitive function recruited 2169 people (less than 55 years of age) in a randomised control trial. Findings showed that diabetes had much influence on global cognitive decline using the Comprehensive Assessment and Referral Evaluation (CARE) test. However, findings showed that individuals diagnosed with diabetes with good diabetic control had better performance rating than the rest when their diabetic glycaemic management index (Hemoglobin A1c [HbA1c]) was assessed ($p = 0.03$). Thus, though diabetes affects cognitive functioning, an improved control may aid in reducing rapid decline.

Among an extremely obese sample who were prone to chronic medical disorders like diabetes, hypertension and sleep apnoea (N= 68), cognitive tests showed several deficits. Domains of neuropsychology that were assessed focused mainly on intellectual and academic achievement, verbal fluency, executive functioning, processing speed, and memory. As illustrated by previous studies, executive functioning tests (Rey Complex Figure Test, Wisconsin Card Sorting Test and Trail Making Test) and the Controlled Oral Word Association Test showed poor functioning (both with $p < .001$), however, the duo showed no challenges when measured on the California Verbal Learning Test-II, Animal Naming Test, or Logical memory subtest of the Wechsler memory scale-III. Thus, the declining role chronic disorders, including diabetes, play in executive functioning and verbal learning/ memory was clearly supported (Boeka, & Lokken, 2008).

On the account of neurocognitive speed and inconsistency, the significant role of normal aging is significant. Notwithstanding this role, a comparative study of older adults with Type 2 diabetes (T2D) showed a significant difference between their performances on speed processing tests. Results showed neurocognitive speed (mean rate) among Type 2 with ages between 55 and 81 years to be slower as compared to the control (ages between 53–91 years). Thus, it was observed that Type 2 diabetes places individuals in a hypothetical position of vulnerability on an adjusted neural continuum (Whitehead, Dixon, Hultsch, & MacDonald, 2011). This study had much strength with its ability to combine both longitudinal and cross sectional study methods. However, the ages of both diabetic and control groups could as well be tested in a younger group to validate this decline much clearly.

Quality of life and Diabetes Mellitus

Quality of life issues have been discussed as a critical concept in most chronic illness. As a result, several studies have been able to indicate a significant relationship between a person's quality of life and respective glycaemic control. Consequently, a poor diabetic management had been identified to affect quality of life (Pibernik-Okanovi, 2001). Based on the paucity of evidence on the predictors of quality of life (QoL), Imayama, Plotnikoff, Courneya and Johnson (2011) sought to determine the predictors of quality of life in adults with Type 1 diabetes and how it varies from those with Type 2 diabetes.

Results showed that adults with Type 1 diabetes had higher health related quality of life (HRQL), was predicted by a higher score in activity trait (personality) ($\beta = 0.28, \rho < 0.01$), less number of comorbidities ($\beta = -0.27, \rho < 0.01$), low body mass index ($\beta = -0.12, \rho < 0.01$), less likelihood of being a non-smoker ($\beta = -0.14, \rho < 0.01$), and a much higher physical activity rates ($\beta = 0.16, \rho < 0.01$). In addition, satisfaction of life was predicted by

individuals diagnosed with diabetes having a partner ($\beta = 0.11, \rho < 0.05$), earning a high amount of annual salary ($\beta = 0.16, \rho < 0.01$), and a higher score in activity trait [personality] ($\beta = 0.27, \rho < .01$). Significantly, the Type 2 diabetic group showed that aging affected a person's health related quality of life but not with life satisfaction (Imayama et al., 2011). Although this study measured quality of life with life satisfaction and personality of both Type 1 and 2 individuals with diabetes, its limitation is observed in the secondary data used.

In a more comprehensive meta-analysis among 1,892 subjects with diabetes, a significant improvement of quality of life was noted after adequate self-management training. Random effect size analysis showed a significant difference between treatment and control groups after their interventions. Consequently, the control sample did not show any improvement as compared to the treatment group who had the intervention. Thus, when individuals diagnosed with diabetes have control over their condition through self-management interventions, their quality of life is consequently improved (Cochran & Conn, 2008). Nonetheless, some studies on the other hand indicated no such associations between diabetes and quality of life (Kleefstra et al., 2005; Pitale et al., 2005) or even with drug adherence (Billups, Malone, & Carter, 2000).

Type 2 Diabetes Mellitus and Depression

Quality of life is predominantly affected by mood disorders and poor psychological well-being. Significant among these disorders is depression, although diabetes has been shown to play a very distinct role in causing them. In a review done on diabetes and depression by Sargin, Çakin and Sargin (2002), 30% of all patients with diabetes suffer some degree of depression. Their review seems to link the depression in individuals with diabetes to hyperglycaemic complication rather than hypoglycaemia. Although the actual

pathological pathway was not outlined in this study, the role of cognitive appraisal as defined in the normal process of grieving as a result of their perceived loss in health was noted to be affected by the effect of hyperglycaemia.

The relationship between diabetes and depression has been reported as significant in several studies. For example, a study conducted on 301 elderly Hispanics to determine the associations between depression, diabetes and metabolic-nutritional factors, revealed some pulsating results. Using a cross-sectional design, 53 clinically depressed, with memory decline were compared with 33 healthy controls. The study combined several measures, which ranged from laboratory fasting blood glucose examinations, functional and nutritional measures, neuropsychological testing to MRI/CT scans to ensure the validity of the results. Majority of the clinically depressed group were noted to be individuals diagnosed with diabetes compared to the control group. In addition, the individuals diagnosed with diabetes in the depressed group had a case of poorly managed diabetes and dietary habits (Fitten et al., 2008).

Also, aging and sex of humans have been implicated as enabling factors in depression development and prognosis. In a study to determine how urban settings, sedentariness and unhealthy eating lifestyles affect depression, aging and sex played significant roles. Among a sample of 553 men and 637 women (both above 65 years), a random multistage sampling technique was used. Using Geriatric Depression Scale (GDS), majority (35%) of women as compared to (25%) men were classified as having intense depressive symptoms. Again, most (70%) women showed a range of (mild-to-severe) depressive symptoms as compared to men (54%). Thus, females were more likely to show more depressive symptoms as they aged than men. The phase of older adulthood encouraged a gradual decline in activities of daily living making them more sedentary,

develop poor dietary habits, and stay in less interactive social environments (Mamplekou et al., 2010).

Diabetes, Depression and Neuropsychological Functioning

A significant relationship has been observed to exist between depression and neuropsychological function. Several studies have been able to explain some of these dysfunctions using batteries of neuropsychological test. The relationship between diabetes, depression and cognitive impairments is shown in most studies as significant. Among the older population in Hong Kong with diabetes (N= 66,813) receiving care between 1998 and 2001, Chau et al. (2011) identified that they were 1.3 times more likely to have neurocognitive dysfunctions and 1.3 times more likely to have depressive disorders, compared to older non-diabetics, when age, sex and educational level were controlled. These differences were linked with management practices as the younger individuals diagnosed with diabetes had a decreased risk of both physical, functional, affect and cognitive impairments.

Notwithstanding this study's strength of using a large sample size and confirmations of undiagnosed diabetic cases by blood glucose tests, the study used secondary data of hospital's service records which may have possible confounding effects variables like the sample not being representative. In a similar trend, Watari et al. (2006) used a battery of tests to assess the nature of neuropsychological functioning between depressed and non-depressed adults diagnosed with Type 2 diabetes. In the study, 20 adults with Type 2 diabetes with major depression showed more significant cognitive dysfunctions than the 20 non-depressed adults with Type 2 diabetes and 34 controls (without diabetes and depression). Comparatively, depressed individuals diagnosed with diabetes showed neuropsychological declines in attention or information processing speed

than the non-depressed diabetic group. In addition, individuals with both diabetes and depression performed poorly on attention, information processing speed and executive function tests when compared with the control group. This suggested a negative effect of depression especially among the diabetic group on neuropsychological functioning. This confirms that the biochemical changes described in Schulingkamp et al. (2000) has implications for both impairment of quality of life and neurocognitive function. Observing from this study also, participant age range was relatively skewed towards older adults, thus making it more difficult to delineate the effect of normal aging process and pure depressive symptoms.

Diabetes Mellitus and Health Belief

An important factor that affects health choices of a group of people is the health belief of a particular group of people. According to the Explanatory Model of Illness or Illness Representation, the health belief model seeks to explain the cultural beliefs of people regarding a particular disease. Thus, this model expresses the unique nature of cultural differences in explaining disease prevention, their causality and management (Fisher et al., 2000). In a specific cultural frame, members who share in the same values and belief systems are noted to possess their own personalised explanatory model of illness. As noted in some studies, these health beliefs usually vary or take account of some biomedical perspective for describing a particular condition (Arcury et al., 2004; Jezewski, & Poss, 2002).

Health belief and illness perception in Ghana is culturally defined. In a study by de-Graft Aikins (2003), 'health' in one of the largely spoken Ghanaian Akan languages, 'Twi', is '*apomudini*' which literally means 'strong body'. Thus, health is appreciated by both rural and urban Ghanaians as consistent to general absence of weakness and

unhindered daily activities. Another important value of health was the unity of life seen among all aspects of human life; psychosocial, economical, spirituality and self. Hence, it is defined as a balance of unity among the mind, spirit and body of an individual in relation to his environment.

Just as the Latinos defined diabetes mellitus by two main sets of illness beliefs, biomedical and sociocultural causes (Coronado, Thompson, & Godina, 2004), Ghanaians also identified five causal theories which could be grouped under these two major causal beliefs. Based on a qualitative design, the study was able to describe these causal belief theories as sugar, hereditary, physiology, poor quality foods and sorcery. Noteworthy is the name given to diabetes in Twi, which is 'esikyere yare'. This literally interprets as 'sugar disease' and thus respondents mainly focused on abstaining or reducing all sugar containing foods. In addition, the definition of diabetes to affect a group of socioeconomic class was conflicting although both rural and urban respondents called it '*esikafoo yare*'. 'Disease of the wealthy', as it may be literally translated, was seen by rural respondents to affect more of the rich who had luxurious lifestyles and poor dieting habits [high sugary and fatty foods] (de-Graft Aikins, 2003).

This was however disagreed among the high-income urban respondents who believed physiology and heredity might be the cause. This view about diabetes, coupled with its related cost and cultural beliefs, had influencing effects on the decision to seek or maintain self-care and general quality of life. Hence, the study showed strong association between illness, indecision and interruption to care with respect to the socioeconomic livelihood of individuals diagnosed with diabetes. In addition, the perspective of the Ghanaian culture generally shows that some homogenous cultural variables were much likely to affect their view of the prevention, causes and management of diabetes mellitus (de-Graft Aikins, 2003).

Diabetes Mellitus, Comorbidities, Neuropsychological Function, Illness Belief and Quality of Life

In most cases of Type 2 diabetes, there has been reported evidence of several chronic comorbidities. Among Ghanaian diagnosed with diabetes, de-Graft Aikins (2003) noted that they suffered several comorbidities and symptoms. Prevailing among them were general malaise, light-headedness, headaches and unhealed wounds, sexual dysfunction, visual impairment and physical disability. Hypertension, prostate cancer, asthma, and gout were also noted among them. Renal disorders like chronic kidney failure (Kurella, et al., 2005), cardiovascular and musculoskeletal conditions (Nguyena et al., 2007) were also identified as common comorbidities of diabetes mellitus.

In a study to access the relationship of age, sex and quality of life of individuals diagnosed with diabetes, findings showed that younger patients (18–44 years) had poorer quality care than the older. This also was seen in their poorer cholesterol and glycaemia profile even though the older individuals diagnosed with diabetes were mostly comorbid with hypertension (Gray, Millett, O’Sullivan, Omar, & Majeed, 2006). These disorders do not only affect their illness perceptions and quality of life (de-Graft Aikins, 2003; Kurella, et al., 2005) but their neuropsychological functions (Annweiler et al., 2011; Boeka, & Lokken, 2008; Ostrosky-Solis, Mendoza, & Ardila, 2001; Salorio et al., 2000). Aging as a normal physiological process, may weaken the immunity of older adults with diabetes to be influenced with other disorders and symptoms. Nonetheless, the association between Type 2 diabetes, aging and increasing comorbidities have been established as significant (Nguyena et al., 2007).

Summary of the chapter

This study examined the neuropsychological functioning and quality of life among individuals diagnosed with Type 2 diabetes in Ghana. Based on a systematic thematic review of literature, theories (executive function and health-related quality of life) and related studies were analysed.

Rationale

This study is necessary based on the following research gaps identified in literature that must be filled. Generally, studies reviewed before this thesis worked on either the neuropsychological functioning (Northam et al., 2001; Northam et al., 2001; Weinger et al., 2008; Wessels et al., 2007) or the quality of life (Alexopoulos, et al., 2002; Maatouk et al., 2012; Munshi, 2006) among individuals diagnosed with diabetes without looking at the linkage between both concepts. Thus, a critical look at the interaction effect of these two variables on Type 2 diabetes mellitus with illness perception is critically examined in this study.

Unlike studies (Chau et al., 2011; Imayama et al., 2011) which looked at secondary data with few measures, this study works on primary data from all respondents. In effect, this thesis compares clinical diabetic samples with healthy controls which some reviewed studies failed to report on. Accordingly, this thesis sets out clearly specific deficits that have not been adequately researched in other studies. Hence, it did not only report the neuropsychological and quality of life aspect of diabetes mellitus but also offered a comparison picture for future studies.

Finally, this study serves as a bridge to link other researches globally with that of Ghanaian samples. Hence, this offers a data on Ghanaian samples and serves as a beginning point for other future researches.

Statement of Hypotheses

Based on the literature reviewed, the following hypotheses were tested:

1. The diabetic group will perform poorer on executive function skills compared to the healthy control group. [This hypothesis is derived from studies that have observed that Type 2 diabetes places individuals in a high risk for executive dysfunctions when measured on executive functioning (Boeka, & Lokken, 2008; Whitehead et al., 2011)].
2. The diabetic group will perform poorer on memory function compared to the healthy control group. [This hypothesis is also derived from literature that diabetes affects the memory function of patients (Boeka, & Lokken, 2008)].
3. The diabetic group will perform poorer on visuoconstructional and visuospatial abilities compared to the healthy control group. [This hypothesis is derived from studies that show that psychomotor function and other visuospatial abilities have been linked to the cognitive losses cause by diabetes (Alexopoulos et al., 2002)].
4. The diabetic group will perform poorer on quality of life assessment than the healthy control group. [This hypothesis is also derived from literature that with respect to the burden of chronic illness and complications, it is expected that diabetes will affect the quality of life of patients more than controls (Imayama et al., 2011; Pibernik-Okanovi, 2001)].
5. Depression, complications, anxiety, age of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and hostility will significantly predict level of

quality of life (QoL). [This hypothesis is based on the observation that these symptoms and comorbidities tend to affect a person's quality of life (Kurella et al., 2005; Nguyena et al., 2007)].

6. Age, education and number of complications will predict health belief of respondents. [This hypothesis is based on the fact that demographic characteristics like level of education which is linked with income may affect how an individual perceive health and illness (Mamplekou et al., 2010)].
7. The diabetic group will have higher scores on the BSI subscales than the healthy control group. [This hypothesis is derived from studies that show that Type 2 diabetes increases the risk for comorbidities (Gray et al., 2006) and quality of life issues (de-Graft Aikins, 2003; Kurella et al., 2005), thus, may place some amount of psychological dysfunctions upon diagnosed individuals].

Proposed Conceptual Framework

Figure 1 shows the proposed conceptual framework of the study's hypothesised findings. The figure indicates expected significant relationships between the variables used in this study. Type 2 diabetes is expected to affect the neuropsychological functioning and the quality of life of patients. Type 2 diabetes mellitus is also proposed to affect the psychological functioning of individuals based on the Brief Symptom Inventory subscales. Similarly, variables like depression, complications, anxiety, ages of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and level of hostility are expected to predict quality of life levels. Finally, the study also proposes that age, education and number of complications will predict the health belief of a person.

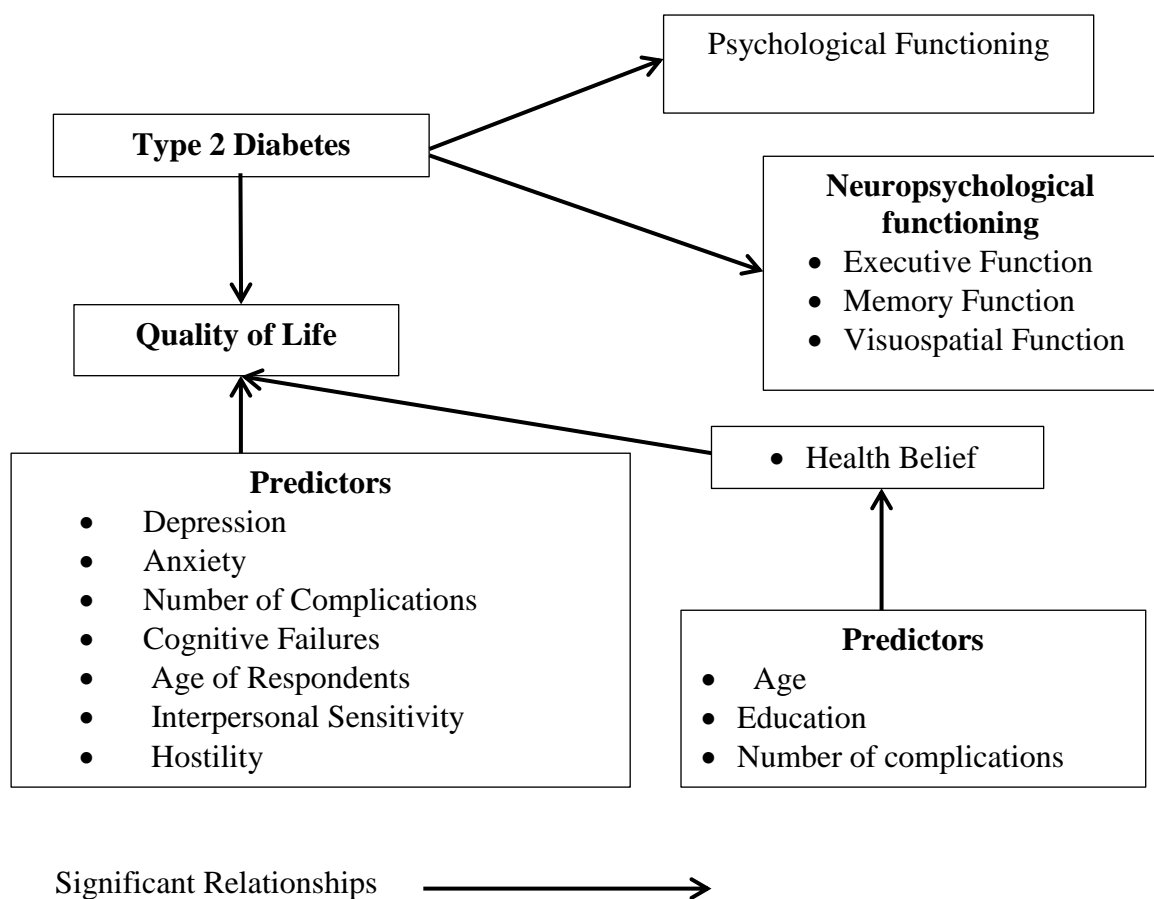


Figure 1

Proposed Conceptual Framework

Operational Definitions

Adult: A person above 18 years of age.

Diabetes Mellitus: Individuals diagnosed clinically with Type 2 diabetes mellitus by the use of standard blood glucose levels.

Health Belief: Individual's perception about health, which is culturally or medically influenced.

Neuropsychological functioning: Skills associated with memory, executive functions, attention, visuospatial skills, visuomotor coordination and mood.

Quality of Life: It is the general and specific views a person holds about how good their life is.

CHAPTER THREE-METHODOLOGY

Population

The primary population comprised both male and female diabetic patients with their families at the Diabetic clinic of the Korle-Bu Teaching Hospital. This population was chosen due to the fact that it covered individuals with various socioeconomic and disorder characteristics across Ghana. Since this was a maiden study in the country, a varied level of demographic qualities was easier and possible at a tertiary-level health provider like Korle-Bu Teaching Hospital.

Sample Size Determination

A sample size of one hundred (100) respondents comprising fifty (50) diabetic patients and fifty (50) healthy controls were sampled. This sample size was arrived at by using Epi-infoTM sample size calculation for unmatched Case-Control Studies Version 3.03.17 (Centers for Disease Control and Prevention, 2012). Using the Kelsey formula, an alpha of 0.05 and a power of 80 gave a calculated sample size forty-four (44) case group and forty-four (44) control group. In order to decrease the chances of non-response case effects on the test outcomes, an additional six (6) respondents were added to each of the groups to add up to a total of hundred (100) respondents.

Sampling Technique

The purposive sampling method was used to select case samples. This is due to the specialized nature of the study and the selective nature of samples to suit the study. Healthy controls were selected using convenience sampling technique to identify available

family members who accompanied them to the clinic or people who shared similar demographic characteristics with respondents.

Participants

The study sample was made up of diabetic patients with healthy controls who were matched only on age and educational levels. The inclusion criteria for participation in this study incorporated participants with at least a basic level of education and aged above 18 years who were willing to participate. Some potential participants were excluded on grounds of cognitive contra-indications like dementia, central nervous system disease, and unstable medical illness. Other Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision [DSM-IV-TR] Axes I and II disorders, drug or alcohol dependence, head trauma (American Psychiatric Association [APA], 2000) and/or refusal to wilfully participate.

Participants' selection criteria were based on the following criteria:

Diabetic Group (DG)

Inclusion Criteria:

1. Met the clinical medical diagnosis for Type 2 diabetes.
2. Had started biomedical therapy for diabetes.
3. Could read and write in order to complete the tests

Exclusion Criteria:

1. Had a history of cognitive contra-indications like dementia, central nervous system disease, and unstable medical illness.
2. Had a history of DSM-IV-TR axes I and II disorders.
3. Had a history of drug or alcohol dependence.
4. Had a history of head trauma.

5. Refusal to wilfully participate or offer consent.

Healthy Control Group (HCG)

Inclusion Criteria:

1. Not diagnosed with diabetes mellitus.
2. Had matched demographic qualities with the diabetic patients.
3. Could read and write in order to complete the tests.

Exclusion Criteria:

1. Had a history of cognitive contra-indications like dementia, central nervous system disease, and unstable medical illness.
2. Had a history of DSM-IV-TR axes I and II disorders.
3. Had a history of drug or alcohol dependence.
4. Had a history of head trauma.
5. Refusal to wilfully participate or offer consent.

Demographic Data

The demographic characteristics are shown in two different tables. Table 1 shows the frequencies and percentages of the variables while Table 2 depicts the means and standard deviations of variables measured in years.

Table 1

Frequency and Percentages of Diabetic and Healthy Control Groups

Variables	Category	Diabetic Group	Healthy Control Group
		(n = 50)	(n = 50)
		Frequency (%)	Frequency (%)
Sex	Male	21 (42.0%)	24 (48.0%)
	Female	29 (58.0%)	26 (52.0%)
Marital Status	Married	33 (66.0%)	41 (82.0%)
	Single	5 (10.0%)	4 (8.0%)
	Divorced	4 (8.0%)	2 (4.0%)
	Cohabit	3 (6.0%)	2 (4.0%)
	Widowed	5 (10.0%)	1 (2.0%)
	Type of	Hypoglycaemia	5 (10.0%)
Complication	Hyperglycaemia	5 (10.0%)	0 (0.0%)
	Loss of Feeling	3 (6.0%)	1 (2.0%)
	Eye Problems	13 (26.0%)	4 (8.0%)
	Hypertension	2 (4.0%)	2 (4.0%)
	Body Pains	0 (0.0%)	2 (4.0%)
	Multiple Complications	13 (26.0%)	0 (0.0%)
	None	9 (18.0%)	41 (82.0%)
Diabetic Treatment Option	Insulin and Diet	12 (24.0%)	
	Tablet and Diet	38 (76.0%)	

Table 2

Means and Standard Deviations of Diabetic and Healthy Control Groups on Some Demographic Variables

Variables	Diabetic Group	Healthy Control Group
	(n = 50)	(n = 50)
	Mean (SD)	Mean (SD)
Age in Years	46.6 (10.4)	45.9 (10.1)
Education in Years	14.0 (2.6)	14.0 (2.6)
Years of Diagnosis	4.8 (3.8)	

Research Design

The study employed a Case-Control Study design as its research design. This design was selected because it enables researchers to establish relationships between two different existing groups. In this study, the two populations selected varied in their existing type of case exposure. Thus, the case group had an existing exposure to Type 2 diabetes mellitus while the control group were non-diabetics. In addition, this design allows the groups selected to be compared on neuropsychological functioning and some behavioural measures.

The use of Case-Control Study design in diabetes studies have been supported and used in several studies including sexuality (Jiménez-Garcia et al., 2012), drug-induced Parkinsonism (Ma et al., 2009), alexithymia and depression (Chatzi et al., 2009) to outline significant differences between individuals diagnosed with diabetes and controls.

Instruments

The study adopted and adapted the following set of tests (neuropsychological and behaviour measures) as tools for data collection.

Mini Mental State Examination [MMSE] (Folstein, Folstein, & McHugh, 1975)

The Mini Mental State Examination (MMSE) was intended as a screening tool for identifying global cognitive dysfunction and particular areas of cognitive dysfunction. This screening test assesses orientation, attention, calculation, memory, recall, language, and spatial ability. MMSE is based on a global scoring system and is significantly reported to differentiate between two groups of patients with a Cronbach's alphas of 0.75 and 0.70 during admission and after discharge respectively in Turkey (Elhan et al., 2005).

The Trail Making Test [TMT] (Reitan & Wolfson, 1985)

The Trail Making Test (TMT) is an executive function test which measures speed processing, sequence alternation, cognitive flexibility, visual search, motor performance and complex attention (Lezak, Howieson & Loring, 2004). TMT consist of a two part test, A and B. To administer this test, the subject is asked to draw lines to join successively numbered circles on Part A work sheet and join the same number of successively numbered and lettered circles on Part B worksheet by alternating between the two different successions. This executive function test measures areas of visuomotor skill and speed, attention and cognitive flexibility. Scoring is based on the total time spent on completing both part A and Part B, including the time used to identify mistakes and corrections by the participants. TMT has a moderately high reliability coefficient of 0.60 (Spren & Strauss (1998).

Modified Card Sorting Test [MCST] (Nelson, 1976)

This is a test used for assessing abstract concepts and a shorter version of the Wisconsin Card Sorting Test (WCST), which was developed by Nelson (1976). This neuropsychological test is extensively used for clinical examination of executive functions in patients. Sixty four cards are used in two consecutive trials with four different colours [red, green, blue and yellow], form [circles, stars, squares and crosses] and number [1, 2, 3, and 4] (Bujoreanu & Willis, 2008).

During the test administration, the subject chooses the cards that are to be matched by colour, form or number. A study done by Caffarra et al. (2004) used a normative data of 248 healthy subjects ranging from 20 to 90 years of age and equal distribution of educational level and sex (124 males and 124 females). The study used a multiple regression analyses and showed a significant effect of age and education on the amount of types and perseverative errors but none by sex. A good interrater reliability (0.87, $p = 0.001$) was identified by Dubois, Slachevsky, Litvan and Pillon (2000).

National Adult Reading Test [NART] (Nelson, 1982)

National Adult Reading Test (NART) is made up of 50 irregular phonetic words and is used to assess the premorbid mental ability of subjects developed by Hezel Nelson. Accurate pronunciation of the words shows prior knowledge of them (Lezak et al., 2004). A high correlation of 0.73 was observed between the older adults without dementia and intelligence test taken at 11 years (Crawford et al., 2001). The NART has split-half reliability of 0.90 to 0.93 (Nelson, 1982). The responses of NART are individually scored as either correct or incorrect, according to their pronunciation.

California Verbal Learning Test-Second Edition [CVLT-II] (Delis, Kramer, Kaplan & Ober, 2000)

This is a verbal memory test, intended to measure the use of semantic associations as a means of learning words. The CVLT-II does include two category lists of words, “List-A” and “List-B”. List-A contains names of vegetables, animals, ways of travelling, and furniture. List-B also contains vegetables, animals, musical instruments and parts of buildings. Presentations of items are done in a randomised fashion with instructions to recall the words in any sequence. This is done in order to assess the subject’s use of spontaneous semantic associations (Lezak et al., 2004). Reliability score for CVLT-II given by the authors are high (Delis et al., 2000) with a split-half reliability of 0.87 to 0.89 and alternate form reliability of 0.72 to 0.79 for all the measures.

Wechsler Adult intelligent Scale [WAIS] (Wechsler, 1981; Wechsler, 2008)

This is an intelligence test developed by David Wechsler to measure the intelligence among older adolescents and adults. The current revised edition comprises of 10 main subtests and 5 supplemental subtests (Wechsler, 2008).

Digit Span Subtest (Wechsler, 2008)

This study selected two part of the test; Digit Forward and Digit Backward. Each test section consists of seven sets of random number sequences which enables the examiner to read out loud a number per second. It measures both auditory attention and span of immediate verbal memory recall (Lezak et al., 2004). In Digit Span, the examiner reads a series of numbers. After the full series is read, the participant repeats them in the order in which they were given (Forward) or repeats them in the reverse order of presentation (Backward). Each level (number of digits) has two trials with dissimilar series of numbers. If the subject fails both trials at a given level, the test is discontinued. The

subject receives one point for each trial he/she passes. The maximum score on each subtask (Digit Forward and Digit Backward) is 14 (two trials for each of seven levels).

Digit Symbol Subtest (Wechsler, 1981)

This is a psychomotor performance test that is comparatively unaffected by an individual's leaning or intellectual achievements. It is made up of rows that contain small black squares, each paired with a number that is randomly assigned between one and nine. A sample of corresponding key which are made up of nonsense symbols are printed to each number. Test-retest reliability has a high correlation coefficient of between 0.82 and 0.88 (Wechsler, 1981).

Rey-Osterrieth Complex Figure Test [ROCF] (Rey & Osterrieth, 1944)

This test was constructed by Rey in 1941 as test for visuospatial abilities and memory. This test was further developed and enhanced by Osterrieth in 1944. This test also involves planning, organizational abilities, and problem-solving schemes (Strauss, Sherman & Spreen, 2006). The patient is told to copy the design on a plain drawing paper of 8 ½ x 11-inch size. Time limit needed for the patient to draw a complete figure is within five minutes. After a 30 minute interval, the patient is called upon to construct the same figure from memory. The subject's overall score is based on the precision of eighteen constituents of the figure. Scoring of each constituent score ranges from 0 to 2 with the highest possible score of 36 (Strauss, Sherman, & Spreen, 2006).

Judgment of Line Orientation test [JLO] (Benton, Varney, & Hamsher, 1978)

The Judgment of Line Orientation (JLO) test is extensively used to measure visuospatial abilities of individuals. This was originally conceptualised and developed by

Dr Arthur L. Benton and colleagues in 1978 (Benton et al., 1978). This test examines the accurateness of a person's angular judgements based on line orientations about a pair of angled lines that visually match with an identical pair immersed within a semi-circular collection of 11 lines.

Individuals are asked to specify which two lines from the collection on the bottom page of the spiral-bound stimulus book are precisely in the same position and thus, indicate the same direction as the two lines on the top page. Participants are allowed 5 practice trials prior to commencing test items. Actual lines in the test items have portions of the line erased to increase task difficulty although there is no time limit for response. A score is given to a response as correct when both lines are rightly identified (Benton et al., 1978).

The Cognitive Failures Questionnaire [CFQ] (Broadbent, Cooper, FitzGerald, & Parkes, 1982)

This is a 25-item questionnaire that was designed by Broadbent and colleagues in 1982 to measure an individual's likelihood of committing an error in the accomplishment of an everyday task. Items on CFQ evaluate a general factor of cognitive failure that comprises; perception, memory, and motor function. An example of questions on CFQ is "Do you drop things?" which may be rated on a 5-point Likert-type scale [0 = never, 4 = always] (Broadbent et al., 1982). The Cronbach's alpha for the CFQ was found to be 0.91, with a test-retest reliability of 0.82 over an interval of 2 months (Vom Hofe, Mainemarre, & Vannier, 1998).

Brief Symptom Inventory [BSI] (Derogatis, & Melisaratos, 1983)

This is a 53-item self-report inventory designed to reveal the clinical psychological manifestations of psychiatric, medical and healthy subjects alike. It was developed from the Symptom Check List-90-R. It measures nine profiles of primary symptom areas and

three global dimensions of psychological distress. The answers are on a 5-point likert scale, from 0 = “not at all”, to 4 = “extremely”. Sample questions for example includes... “Nervousness or shakiness inside...” BSI’s component subscales measure several dimensions of psychological dysfunctions. The Global severity index (the total score on the scale) is obtained by adding up all the items under all the subscales and dividing it by 53 (the total number of items on the scale). These subscales include the following item summations [Somatization (Items 2, 7, 23, 29, 30, 33, 37), Obsession-Compulsion (Items 5, 15, 26, 27, 32, 36), Interpersonal Sensitivity (Items 20, 21, 22, 42), Depression (Items 9, 16, 17, 18, 35, 50), Anxiety (Items 1, 12, 19, 38, 45, 49), Hostility (Items 6, 13, 40, 41, 46), Phobic Anxiety (Items 8, 28, 31, 43, 47), Paranoid Ideation (Items 4, 10, 24, 48, 51) and Psychoticism (Items 3, 14, 34, 44, 53). The BSI has a high Cronbach's α that ranges from 0.71 to 0.85 (Derogatis, & Melisaratos, 1983).

Spitzer Quality of Life Index [SQLI] (Spitzer, Dobson & Hall, 1981)

The Spitzer Quality of Life Index is a universal Quality Of Life index that covers five dimensions of quality of life (activity, daily living, health, support of family and friends, and outlook). It was intended for use by medical practitioners to help them assess the comparative benefits and hazards of a variety of treatments and management. The psychometric properties of SQLI were identified in a series of validation tests by over 150 physicians to assess 879 patients with an average completion time of one minute. Fifty-nine percent of physicians claimed that they were at least ‘very confident’ of the validity of their scores. An evaluation of internal consistency established a significantly high coefficient (Cronbach’s $\alpha = 0.775$).

Compensatory Health Belief Index [CHBI] (Knäuper, Rabiau, Cohen, & Patriciu, 2004)

Compensatory Health Belief was developed from the traditional health belief model and it is a 17-item questionnaire. It primarily identifies the health beliefs of people and their associative cognitive dissonance. Individuals frequently counterbalance undesirable behaviour with healthy ones. The scale ranges from 1 to 5 depending on the rate at which an individual agreed with a definite compensatory health belief (for example “Having a juice before exercising can make up for the decrease in blood glucose caused by the exercising”). The CHBI has an overall significantly high reliability coefficient of 0.820.

Procedure

Ethical clearance to carry out the research was obtained from both the Ethical Research Board of Noguchi Memorial Research Institute in the University of Ghana and the National Diabetes Research Center, Diabetic Clinic in the Korle Bu Teaching Hospital. After approval was obtained, an introductory letter from the Psychology Department was sent to the clinic unit heads to permit data collection within a three month period. A pilot study was first conducted to ascertain the appropriateness, and reliability of the adopted tests on Ghanaian clinical samples with 10 samples. Details of reliability for the various tests are as follows; MMSE = 0.70, TMT = 0.70, MCST = 0.83, NART = 0.95, CVLT-II = 0.64, Digit Span Subtest = 0.85, Digit Symbol Subtest = 0.87, ROCF = 0.93, JLO = 0.64, CFQ = 0.88, BSI = 0.98, SQLI = 0.81, and CHBI = 0.89.

After a thorough initial screening using the Mini Mental State Examination [MMSE] (Folstein, Folstein, & McHugh, 1975), all participants were offered a battery of neuropsychological tests which lasted for an average of two hours in a session. Individuals within the inclusion criteria were sampled and allowed to sign informed consent forms to

indicate their willingness to join the study before administration of questionnaires. The assessment process entailed an administration of a demographic questionnaire, neuropsychological tests and behavioural measures to all selected participants. During the testing period, boredom and tiredness risks were concurrently checked by frequently asking if participants needed a break or wanted to discontinue.

The testing was done in a special testing room created for data collection in the Diabetic Clinic to ensure that all testing biases like noise and lighting challenges were controlled to a higher degree. After testing was completed, participants were thanked as a sign of appreciation for their time. Completed tests were then collected at the end of each session, scored and packed into sealed envelopes to ensure confidentiality and safety of responses.

CHAPTER FOUR-RESULTS

Preliminary Analysis

The hypotheses formulated in this study were tested using the Statistical Package for the Social Sciences (SPSS) version 20.0 for windows (IBM Corporation, 2011). Following all the assumptions required for parametric test selection and usage, the hypotheses were tested with Independent t Test, One-Way Multivariate Analysis of Variance, Pearson Product-Moment Correlation Coefficient and Hierarchical Linear Regression analysis.

The Independent t Test was used to access the differences between the diabetic group and the healthy control group on quality of life levels. One-Way Multivariate Analysis of Variance was used to establish the difference between the diabetic group and the healthy control group on executive function, memory, visuospatial, visuoconstructional and Brief Symptom Inventory (BSI) subscales. Pearson Product-Moment Correlation Coefficient was used to establish the relationships between behaviour measures and some neuropsychological tests. The Hierarchical Linear Regression analysis was used to identify the predictors of quality of life among the respondents.

The data was further screened for possible missing data and outliers in the data. In addition, other data transformations which included calculation of grand and subscale scores of the behaviour measures were done before continuing with the hypothesis testing.

Test of Hypothesis 1

Hypothesis 1 stated that the diabetic group will perform poorer on executive function skills compared to the healthy control group. To test this hypothesis, the One-Way Multivariate Analysis of Variance (MANOVA) was used to access the effect of Type 2 diabetes mellitus on specific executive function tests. Since the covariance and

homogeneity assumptions underlying the MANOVA were violated, Pillai's Trace was selected [$F_{(4, 95)} = 6.633, \rho = .000$, Pillai's Trace = .218, Partial Eta Squared = .218]. The result of the One-Way MANOVA is summarised in Table 3.

Table 3

Summary Table of the One-Way MANOVA Comparing Executive functions among the Diabetic Group with the Healthy Control Group

Variables	Diabetic Group	Healthy Control	<i>F</i>	<i>Df</i>	<i>P</i>	η^2
	(n = 50)	Group (n = 50)				
	Mean (SD)	Mean (SD)				
TMT A	89.30 (24.28)	66.46 (22.59)	23.722	1,98	.000	.195
TMT B	181.80 (43.16)	142.78 (51.73)	16.771		.000	.146
TMT (B-A)	92.50 (33.82)	76.32 (35.63)	5.424		.022	.052
MCST CAT	3.56 (1.51)	4.44 (1.57)	8.155		.005	.077
MCST P E	10.92 (8.95)	7.48 (8.17)	4.028		.048	0.39

Notes: TMT A= Trail Making Test A, TMT B= Trail Making Test B, TMT (B-A) = Trail Making Test B-A, MCST CAT = Modified Card Sorting Test Correct Categories, MCST P E = Modified Card Sorting Test Correct Categories

From the table, a significant difference existed between the diabetic group and the healthy control group on all the components of the Trail Making Test (TMT); TMT A [$F_{(1, 98)} = 23.722, \rho = .000$ with an effect size of $\eta^2 = .195$], TMT B [$F_{(1, 98)} = 16.771, \rho = .000$ with an effect size of $\eta^2 = .146$] and TMT B-A [$F_{(1, 98)} = 5.424, \rho = .022$ with an effect size of $\eta^2 = .052$] respectively. In effect, the diabetic group performed poorer on all the Trail Making Test subtests by taking a longer average time in seconds as shown in Table 3 when compared with the healthy control group respectively; TMT A [($M_D = 89.30$

seconds) > ($M_C = 66.46$ seconds)], TMT B [$(M_D = 181.80$ seconds) > ($M_C = 52.65$ seconds)], TMT B-A, [$(M_D = 92.50$ seconds) > ($M_C = 76.32$ seconds)].

Comparison on the Modified Card Sorting Test (MCST) also indicated significant differences between the two groups on both the number of correct categories (MCSTCAT) arranged and the number of perseverative errors (MCST P E) committed respectively; MCST CAT [$F_{(1, 98)} = 8.155, \rho = .005$ with an effect size of $\eta^2 = .077$] and MCST P E [$F_{(1, 98)} = 8.155, \rho = .048$ with an effect size of $\eta^2 = 0.39$]. In effect, the diabetic group performed poorer than the healthy control group by scoring low on both the number of correct categories (MCST CAT) [$(M_D = 3.56) < (M_C = 4.44)$]. In addition, the diabetic group performed poorer again than the control group by scoring a higher number of perseverative errors (MCST PE) [$(M_D = 10.92) > (M_C = 7.48,)$]. Hence, the hypothesis that ‘the diabetic group will perform poorer on executive function skills compared to the healthy control group’ was supported by the data.

Test of Hypothesis 2

Hypothesis 2 stated that the diabetic group will perform poorer on memory function compared to the healthy control group. To test this hypothesis, the One-Way Multivariate Analysis of Variance (MANOVA) was used to test the effect of Type 2 diabetes mellitus on specific memory tests. With respect to the violation of the covariance and homogeneity assumptions underlying the MANOVA, Pillai’s Trace was selected [$F_{(9, 90)} = 4.201, \rho = .000$, Pillai’s Trace = .296 with a Partial Eta Squared = .296]. The One-Way MANOVA result is summarised in Table 4.

Table 4

Summary Table of One-Way MANOVA Comparing Memory among the Diabetic Group with the Healthy Control Group

Variables	Diabetic Group	Healthy	<i>F</i>	<i>df</i>	<i>P</i>	η^2
	(n = 50)	Control Group				
	Mean (SD)	Mean (SD)				
Rey IR	11.51 (6.48)	15.69 (6.10)	11.031	1, 98	.001	.101
Rey D R	5.64 (5.37)	9.45 (6.57)	10.087		.002	.093
Digit Sym R	10.42 (5.79)	13.90 (6.89)	7.480		.007	.071
Digit Span T	11.68 (2.89)	14.62 (3.44)	21.507		.000	.180
CVLT I R	18.36 (4.45)	21.88 (4.65)	14.963		.000	.132
CVLT D R	3.24 (1.02)	4.30 (1.52)	16.621		.000	.145
CVLT D C	2.66 (.96)	3.98 (1.92)	18.872		.000	.161
CVLT A %	88.25 (10.83)	93.80 (8.40)	8.206		.005	.077

Notes: Rey IR = Rey-Osterrieth Complex Figure Test Immediate Recall, Rey D R= Rey-Osterrieth Complex Figure Test Delayed Recall, Digit Sym R= Digit Symbol Recall, Digit Span T = Digit Span Total Score, CVLT I R= California Verbal Learning Test Immediate Recall, CVLT D R= California Verbal Learning Test Long Delayed Recall, CVLT D C= California Verbal Learning Test Long Delayed Cued Recall, CVLT A % = California Verbal Learning Test Total Long-Delay Forced-Choice Recognition Accuracy in Percentages

From the table, a significant difference existed among all the various memory tests when the diabetic group was compared with the healthy control group. With respect to the Rey-Osterrieth Complex Figure Test, a significant difference exists between the two groups on both the accuracy of figure drawn at both Immediate Recall (Rey I R) and Delayed Recall (Rey D R) in memory. The differences between them were indicated as

follows; Rey I R [$F_{(1, 98)} = 11.031, \rho = .001$ with an effect size of $\eta^2 = .101$] and Rey D R [$F_{(1, 98)} = 10.087, \rho = .002$ with an effect size of $\eta^2 = .093$]. As evident from Table 4, the diabetic group performed poorer by recalling and drawing less accurate figures compared with the healthy control group respectively; Rey I R [($M_D = 11.51$) < ($M_C = 15.69$)] and Rey D R [($M_D = 5.64$) < ($M_C = 9.45$)].

In addition, a significant difference existed between the two groups on the Digit Symbol Recall subtest (Digit Sym R) [$F_{(1, 98)} = 7.480, \rho = .007$, an effect size of $\eta^2 = .071$]. In effect, Table 4 showed that the diabetic group when compared with the healthy control group performed poorer by writing fewer number of recalled symbols [($M_D = 34.24$) < ($M_C = 42.66$)]. In addition, the diabetic group again recalled fewer number of digit symbols compared with the healthy control group [($M_D = 10.42$) < ($M_C = 13.90$)].

Table 4 also showed that a significant difference existed between the two groups with regards to their performance on Digit Span (Digit Span T) [$F_{(1, 98)} = 21.507, \rho = .000$ with an effect size of $\eta^2 = .180$]. The table showed that the diabetic group when compared with the healthy control group on the Digit Span test performed poorer by recalling fewer numbers of digits; Digit Span T [($M_D = 11.68$) < ($M_C = 14.62$)].

On the assessment of verbal memory, a significant difference existed between the two groups with regards to their performance on the California Verbal Learning Test (CVLT). These differences were measured respectively on the following aspects of CVLT as follows; Correct Immediate Free Recall (CVLT D R) [$F_{(1, 98)} = 14.963, \rho = .000$ with an effect size of $\eta^2 = .132$], Correct Long-Delay Recall (CVLT D R) [$F_{(1, 98)} = 16.621, \rho = .000$, an effect size of $\eta^2 = .145$], Correct Long-Delay Cued Recall (CVLT D C) [$F_{(1, 98)} = 18.872, \rho = .000$ with an effect size of $\eta^2 = .161$], and Total Long-Delay Forced-Choice Recognition Accuracy in Percentages (CVLT A %) [$F_{(1, 98)} = 8.206, \rho = .005$ with an effect size of $\eta^2 = .077$].

These differences occurred as participants in the diabetic group recalled fewer number of words from immediate recall to various delayed time periods compared to the healthy controls as shown in Table 4 respectively; CVLT I R [(M_D = 18.36) < (M_C = 21.88)], CVLT D R [(M_D = 3.24) < (M_C = 4.30)], CVLT D C [(M_D = 2.66) < (M_C = 3.98)] and CVLT A % [(M_D = 88.25) < (M_C = 93.80)]. Thus, the hypothesis that ‘the diabetic group will perform poorer on memory function compared to the healthy control group’ was supported by the data.

Test of Hypothesis 3

Hypothesis 3 stated that the diabetic group will perform poorer on visuoconstructional and visuospatial abilities compared to the healthy control group. The One-Way Multivariate Analysis of Variance (MANOVA) was used to test the effect of Type 2 diabetes mellitus on specific visuoconstructional and visuospatial abilities. With respect to the violation of the covariance and homogeneity assumptions underlying the MANOVA, Pillai’s Trace was selected [$F_{(2, 97)} = 13.619, \rho = .000$, Pillai’s Trace = .219 with a Partial Eta Squared = .219]. The One-Way MANOVA result is summarised in Table 5.

Table 5

Summary Table of the One-Way MANOVA Comparing the Visuoconstructional and Visuospatial Abilities among the Diabetic Group with the Healthy Control Group

Variables	Diabetic Group	Healthy Control	<i>F</i>	<i>df</i>	<i>P</i>	η^2
	(n = 50)	Group (n = 50)				
	Mean (SD)	Mean (SD)				
Digit Sym C	34.24 (10.48)	42.66 (14.62)	10.954	1, 98	.001	.101
JOL	16.96 (3.51)	19.78 (2.49)	21.446		.000	.180

Notes: Digit Sym C = Digit Symbol-Coding, JOL = Judgment of Line Orientation test

The results showed that a significant difference existed among the two groups on the Digit Symbol Coding subtest (Digit Sym C) [$F_{(1, 98)} = 10.954, \rho = .001$ with an effect size of $\eta^2 = .101$]. Thus, table 5 showed that the diabetic group when compared with the healthy control group performed poorer on visuospatial and speed abilities by writing fewer number of symbols [($M_D = 34.24$) < ($M_C = 42.66$)].

In addition, a significant difference existed between the two groups on the Judgement of Line Orientation test, [$F_{(1, 98)} = 21.446, \rho = .000$ with an effect size of $\eta^2 = .180$]. In effect, the diabetic group when compared with the healthy control group as shown in Table 5 performed poorer on visuospatial ability by judging fewer number of line orientation accurately [($M_D = 16.96$) < ($M_C = 19.78$)]. Hence, the hypothesis that ‘diabetic group will perform poorer on visuoconstructional and visuospatial abilities compared to the healthy control group’ was supported by the data.

Test of Hypothesis 4

Hypothesis 4 stated that the diabetic group will perform poorer on Quality of Life assessment than the healthy control group. To test this hypothesis, the Independent t Test was used to compare these two groups on their scores of Spitzer Quality of Life test. The Independent t Test result is summarised in Table 6.

Table 6

Independent t Test Comparing the Quality of Life of the Diabetic Group with the Healthy Control Group

	Diabetic Group (n = 50)	Healthy Control Group (n = 50)	t	df	ρ
Variable	Mean (SD)	Mean (SD)			
Quality of Life	7.22 (1.93)	9.18 (1.78)	- 6.602	98	.000

From Table 6, a significant difference existed between the quality of life scores of the two groups [$t_{(98)} = -6.602$, $\rho = .000$]. With respect to their mean and standard deviation scores on the Spitzer Quality of Life, the diabetic group had a poorer quality of life score compared to the healthy control group respectively [($M_D = 7.22$) < ($M_C = 9.18$)]. Therefore, the hypothesis that ‘the diabetic group will perform poorer on Quality of Life assessment than the healthy control group’ was supported by the data.

Test of Hypothesis 5

Hypothesis 5 stated that Depression, Complications, Anxiety, Age of Respondents, Health Beliefs, Cognitive Failure, Interpersonal Sensitivity, and Hostility will significantly

predict level of Quality of Life (QoL). The Hierarchical Multiple Regression Analysis was used to test this hypothesis.

A hierarchical multiple regression analysis was conducted for the outcome variable, quality of life (QOL). Depression was entered in step 1 as possible predictor. The respondents' level of anxiety and complications were entered in step 2, followed by their cognitive failures, health beliefs and age in step 3. Respondents' interpersonal sensitivity and hostility were entered in step 4. In this study, decision on the hierarchical order was based on the claim by Newton and Rudestam, that *"the variables that are entered first are those that are regarded as (a) being particularly important or previously determined to relate to the dependent variable"* [p. 255]. Table 7 shows the summary of the individual predictors and the overall Hierarchical Multiple Regression Model Summary.

Table 7

Summary Table of the Hierarchical Multiple Regression Analysis Testing the Predictors of Quality of Life

Variables	Quality of Life			
	β Step 1	β Step 2	β Step 3	β Step 4
<i>Step 1</i>				
Depression	-.482**	-.092 ^{ns}	-.066 ^{ns}	-.059 ^{ns}
<i>Step 2</i>				
Anxiety		-.303*	-.125 ^{ns}	-.128 ^{ns}
Number of Complications		.374 **	.354**	.324**
<i>Step 3</i>				
Cognitive Failures			-.296**	-.295**
Health Beliefs			-.259**	-.301**
Age of Respondents			.160**	.200**
<i>Step 4</i>				
Interpersonal Sensitivity				-.395**
Hostility				.365**
<i>Model summary</i>				
Model F	29.607**	18.428**	8.321**	7.513**
(df)	(98)	(96)	(93)	(91)
$\triangle R^2$.232**	.213**	.117**	.062**
Adj R^2	.224**	.428**	.534**	.591**
R^2	.232**	.445**	.562**	.625**

Notes: β are the standardised regression coefficients. ** $\rho < 0.01$, * $\rho < 0.05$, ns = not significant

From the Hierarchical Multiple Regression Analysis in Table 7, the individual predictors were significant as follows: depression predicted QoL significantly only at step 1 [$t_{(98)} = -5.441$, $\beta = -.482$, $\rho = .000$]. Also, anxiety predicted QoL significantly only at step 2 [$t_{(96)} = -2.435$, $\beta = -.303$, $\rho = .017$]. The number of complications experienced by a

person predicted QoL significantly at step 2 [$t_{(96)} = 3.956, \beta = .374, \rho = .000$], at Step 3 [$t_{(93)} = 4.116, \beta = .354, \rho = .000$] and at Step 4 [$t_{(91)} = 3.958, \beta = .324, \rho = .000$].

The cognitive failures experienced by a person predicted QoL significantly at both Step 3 [$t_{(93)} = -3.578, \beta = -.296, \rho = .001$] and Step 4 [$t_{(91)} = -3.803, \beta = -.295, \rho = .000$]. Furthermore, health beliefs (illness perception) experienced by a person predicted QoL significantly at both Step 3 [$t_{(93)} = -3.285, \beta = -.259, \rho = .001$] and Step 4 [$t_{(91)} = -4.027, \beta = -.301, \rho = .000$]. In addition, the ages of respondents (years) predicted QoL significantly at both Step 3 [$t_{(93)} = 2.040, \beta = .160, \rho = .044$] and Step 4 [$t_{(91)} = 2.662, \beta = .200, \rho = .009$]. Lastly, interpersonal sensitivity [$t_{(91)} = -3.199, \beta = -.395, \rho = .002$] and hostility [$t_{(91)} = 2.703, \beta = .365, \rho = .008$] both predicted QoL significantly at Step 4 respectively.

Findings from Table 7 showed that the model in step 1, which consisted of depression accounted for approximately 23% of the total variance in QoL [$F_{(1, 98)} = 29.607, \rho = .000, R^2 = .232$]. Also, step 2 (anxiety and number of complications) accounted for approximately 21% of the total variance in the model [$F_{(3, 96)} = 25.665, \rho = .000, R^2 = .213$]. In addition, approximately 12% of the variance was predicted in the model at step 3 (cognitive failures, health beliefs and age of respondents) [$F_{(6, 93)} = 19.928, \rho = .000, R^2 = .117$]. Finally, step 4 (interpersonal sensitivity and hostility) accounted for approximately 6% of the total variance in QoL [$F_{(8, 91)} = 18.918, \rho = .000, R^2 = .062$].

Hence, the hypothesis which stated that ‘depression, complications, anxiety, age of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and hostility will significantly predict level of quality of life (QoL).’ was supported by the data.

Test of Hypothesis 6

Hypothesis 6 stated that age, education and number of complications will predict health belief of respondents. To test this relationship, a Linear Multiple Regression was

needed to determine the predictive variance explained by these variables. In order to test for these predictors, a preliminary analysis using a Pearson Product-Moment Correlation Coefficient showed that there was no significant relationship between the health beliefs of the respondents and their level of education in years [$r_{(98)} = -.057, \rho = .287$]. Nonetheless, there was a significant relationship between health beliefs and number of complications of respondents [$r_{(98)} = -.245, \rho = .007$]. In addition, the ages of respondents in years had a significant relationship with their level of health belief [$r_{(98)} = .424, \rho = .000$].

Owing to these associations, there was no need for further prediction analysis. Consequently, instead of a Linear Multiple Regression, a classified correlational analysis based on the two groups was done to identify the specific role Type 2 diabetes mellitus played. Table 8 shows a summary of these relationships among the two classified groups.

Table 8

Pearson Product-Moment Correlation Coefficient showing the relationship among Health Belief, Age, Education and Number of Complications.

Variables	Diabetic Group	Healthy Control Group
	(n = 50)	(n = 50)
	Health Belief	Health Belief
Age in Years	.460**	.404**
Education in Years	-.089 ^{ns}	-.030 ^{ns}
Number of Complications	-.047 ^{ns}	-.180 ^{ns}

** $\rho < 0.01$, ns = not significant

With respect to Table 8, the ages of respondents in years had a significant relationship with the health beliefs of both the diabetic group [$r_{(48)} = .460, \rho = .000$] and the healthy control group [$r_{(48)} = .404, \rho = .000$]. However, there was no significant

relationship between health beliefs and education either among the diabetic group [$r_{(48)} = -.089, \rho = .269$] or the healthy control group [$r_{(48)} = -.030, \rho = .419$]. Also, there was no significant relationship between health beliefs and number of complications either among the diabetic group [$r_{(48)} = -.047, \rho = .373$] or the healthy control group [$r_{(48)} = -.180, \rho = .105$]. Thus, Hypothesis 6 which stated that ‘age, education and number of complications will predict health belief of respondents’ was not supported by the data.

Test of Hypothesis 7

Hypothesis 7 stated that the diabetic group will have higher scores on the BSI subscales than the healthy control group. In order to test this hypothesis, the One-Way Multivariate Analysis of Variance (MANOVA) was used to test the effect of diabetes on these various Brief Symptom Inventory (BSI) subscales. Following the violation of the covariance and homogeneity assumptions underlying the MANOVA, Pillai’s Trace was selected [$F_{(10, 89)} = 8.066, \rho = .000$, Pillai’s Trace = .475 with a Partial Eta Squared = .475]. The One-Way MANOVA result is summarised in Table 9.

Table 9

Summary Table of the One-Way MANOVA Comparing BSI subscales among the Diabetic Group with the Healthy Control Group

	Diabetic G (n = 50)	Healthy Control Group (n = 50)	<i>F</i>	<i>df</i>	ρ	η^2
Variables	Mean (SD)	Mean (SD)				
Somatization	1.39 (.66)	.59 (.36)	56.46	1, 98	.000	.366
Obsession Compulsion	1.30 (.71)	.57 (.48)	36.20		.000	.270
Interpersonal Sensitivity	1.60 (.86)	.64 (.47)	45.91		.000	.319
Depression	1.27 (.63)	.82 (.62)	12.89		.001	.116
Anxiety	1.46 (.80)	.50 (.43)	54.88		.000	.359
Hostility	1.45 (.55)	.78 (.58)	42.96		.000	.305
Phobic Anxiety	1.40 (.88)	.61 (.51)	29.51		.000	.231
Paranoid Ideation	1.46 (.78)	.56 (.46)	49.98		.000	.338
Psychoticism	1.27 (.65)	.61 (.45)	35.28		.000	.265
Global Severity Index	1.37 (.68)	.48 (.42)	61.46		.000	.385

From Table 9, a significant difference existed among all the various BSI subscales when the diabetic group was compared the healthy control group. Scores on somatization showed significant difference among the two groups [$F_{(1, 98)} = 56.46$, $\rho = .000$ with an effect size of $\eta^2 = .366$]. The diabetic group had a higher score than the healthy control group [($M_D = 1.39$) > ($M_C = .59$)].

In addition, scores on obsession compulsion showed significant difference among both groups [$F_{(1, 98)} = 36.20$, $\rho = .000$ with an effect size of $\eta^2 = .270$]. The diabetic group had a higher score than the healthy control group [($M_D = 1.30$) > ($M_C = .57$)].

A significant difference existed between the two groups on their scores on interpersonal sensitivity [$F_{(1, 98)} = 45.91, p = .000$ with an effect size of $\eta^2 = .319$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.60) > (M_C = .64)$].

Scores on depression showed significant difference between the diabetic and healthy control groups [$F_{(1, 98)} = 12.89, p = .001$ with an effect size of $\eta^2 = .116$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.27) > (M_C = .82)$].

A significant difference existed between the two groups on their scores on anxiety [$F_{(1, 98)} = 54.88, p = .000$ with an effect size of $\eta^2 = .359$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.46) > (M_C = .50)$].

With respect to the scores on hostility, a significant difference existed among the two groups [$F_{(1, 98)} = 42.96, p = .000$ with an effect size of $\eta^2 = .305$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.45) > (M_C = .78)$].

Scores on phobic anxiety showed that a significant difference existed between the two groups [$F_{(1, 98)} = 29.51, p = .000$ with an effect size of $\eta^2 = .231$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.40) > (M_C = .61)$].

Concerning paranoid ideation, a significant difference existed between the two groups [$F_{(1, 98)} = 49.98, p = .000$ with an effect size of $\eta^2 = .338$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.46) > (M_C = .56)$].

Scores on psychoticism showed a significant difference between the diabetic and healthy control groups [$F_{(1, 98)} = 35.28, p = .000$ with an effect size of $\eta^2 = .265$]. The diabetic group had a higher score than the healthy control group [$(M_D = 1.27) > (M_C = .61)$].

Finally, a significant difference existed between the two groups on their scores on the global severity index [$F_{(1, 98)} = 61.46, \rho = .000$ with an effect size of $\eta^2 = .385$]. The diabetic group had a higher score than the healthy control group [($M_D = 1.37$) > ($M_C = .48$)].

Thus, the hypothesis which stated that the ‘the diabetic group will have higher scores on the BSI subscales than the healthy control group’ was supported by the data.

Summary of findings

This study tested four main hypotheses to assess the neuropsychological functioning and quality of life among Type 2 diabetes mellitus patients in Ghana. The summary of findings is presented below:

- Type 2 diabetes mellitus negatively affects the memory (verbal and non-verbal) function of study participants.
- Type 2 diabetes mellitus negatively affects the executive functions of study participants.
- Type 2 diabetes mellitus negatively affects the visuospatial abilities of study participants.
- Type 2 diabetes mellitus negatively influences the quality of life of study participants.
- Depression, complications, anxiety, ages of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and level of hostility significantly predicts quality of life of study participants.
- Type 2 diabetes mellitus significantly increases the level of psychological problems among the study participants.

CHAPTER FIVE-DISCUSSION

Findings from Hypothesis 1 supported the claim that the diabetic group will perform poorer on executive function skills compared to the healthy control group. The executive functioning tests significantly discriminated Type 2 diabetic patients from the healthy control group. These findings are in line with previous studies which claimed that Type 2 diabetes mellitus diagnosis places a burden of hypothetical state of ‘executive dysfunction vulnerability’ (Boeka, & Lokken, 2008; Whitehead et al., 2011).

Based on this study’s results on executive function tests like the Trail Making Test [TMT] (Reitan, & Wolfson, 1985) and Modified Card Sorting Test [MCST] (Nelson, 1976), participants with Type 2 diabetes mellitus performed significantly poorer than controls. Thus, since the TMT, for example, measures speed processing, sequence alternation, cognitive flexibility, visual search, motor performance and complex attention (Lezak, Howieson, & Loring, 2004), any increase in the examinees’ test results (time in seconds) are more likely to show deficits in any of these areas.

These findings however can further be explained by the distinct role frontal lobes play in executive processing (Evans, 2004). Considering the notable events of brain cellular deaths that are associated with empirical diabetes mellitus brain scan studies (Garde et al., 2002; Van Harten et al., 2006), such possible brain deaths in this important region of the human brain’s executive functioning might be as a result of inadequate glucose supply in diabetic psychopathology (Kessels, 2009).

Findings from Hypothesis 2 supported the claim that the diabetic group will perform poorer on memory function compared to the healthy control group. Memory function has a strong relationship with the almost all the other cognitive functions and thus, quite difficult to separate distinctively. Since this study incorporated a comprehensive

battery of verbal and non-verbal tests, the role of Type 2 diabetes on memory function cannot be underestimated. Notwithstanding the fact that some diabetic researches have focused on local (Boeka, & Lokken, 2008; Convit et al., 2003) and global dysfunctions (Luchsinger et al., 2011) resulting from diabetes mellitus, the distinct impact of memory has been supported by both past and current studies with regards to both verbal and non-verbal memory functions.

Although several arguments have been built around these findings, the study's results indicated that Type 2 diabetes mellitus may affect the memory functions of affected persons negatively. Although Fitten et al. (2008) supported this assertion, they attributed it to factors like depression, poorly managed case of diabetes and dietary habits. Luchsinger et al. (2011) also supported these findings, illustrating the effect of Type 2 diabetes mellitus with a more global cognitive burden. Considerably, these negative defects were supported with an emphasis on general intelligence rather than specific memory problems (Northam et al., 2001). It is noteworthy that some functional losses have been measured with respect to specific activities of daily living (Alexopoulos et al., 2002).

In effect, the memory deficit burden placed by Type 2 diabetes mellitus has been noted as correlating highly with the neuropsychological deficits experienced in dementia if not managed adequately (Luchsinger et al., 2001; Luchsinger et al., 2007). With other confounding variables like normal aging and other comorbidities like cardiovascular disorders and dementia, diabetic patients are more likely to be predisposed to higher risks of memory problems (Ferguson et al., 2003; Knopman et al., 2001; National Institute of Diabetes and Digestive and Kidney Diseases, 2004; Stewart & Liolitsa, 1999).

Findings from Hypothesis 3 supported the claim that the diabetic group will perform poorer on visuoconstructional and visuospatial abilities compared to the healthy control group. On the account of visuospatial abilities, the results from the Judgement of

Line Orientation test (Benton et al., 1978) indicated that diabetic patients performed poorer than the control group. This finding is supported by some recent studies as one of the neuropsychological challenges diabetes places on patients' functioning (Weinger et al., 2008; Wessels et al., 2007).

Just as indicated in the preceding findings, some physiopathological and psychopathological explanations may be offered as explanations for this finding. Convit et al.'s (2003) brain studies discovered that poorly regulated peripheral glucose in diabetic cases was significantly associated with the volume of the brain's hippocampus anatomy and physiology. Since this component of the brain is associated with the limbic system which in turns affects the spatial navigation and other memory functions, diabetic patients may have challenges in some visuospatial activities.

As indicated from the study's results, the Judgment of Line Orientation test (Benton et al., 1978) was not only able discriminate the diabetic group from the healthy control group on visuospatial judgments like planning, organizational abilities but problem-solving schemes also (Strauss, Sherman & Spreen, 2006).

In addition, some relational explanation of effects could be drawn as there were an indication that, challenges in other cognitive functions like memory and executive dysfunctions might have placed some burden on the visuospatial functioning. Moreso, Stuss and Alexander (2000) supported the fact that the frontal lobe is strongly connected to the human limbic system and affect. Thus, challenges in other areas like executive functions and memory are more likely to have also influenced these results too.

The findings from the study supported the hypothesis that the diabetic group will perform poorer on quality of life assessment than the healthy control group. This view is supported by studies that look at the impact of chronic illnesses like Type 2 diabetes

mellitus on the general appraisal of patients' quality of life. Although a general acceptance of a significant effect of diabetes on perceived quality of life, poorly managed cases were noted to be most influenced (Pibernik-Okanovi, 2001). Thus, those who have adequate management skills with respect to their diabetic condition were more likely to improve their general quality of life.

Other biochemical explanations offered by Schulingkamp et al. (2000) can be observed as noteworthy. According to them, chemical fluctuations of neurotransmitters like acetylcholine, glutamate and Gama Acetyl Butyric Acid, which rely mainly on glucose for their adequate secretion and supply into the human system, are highly profound as risk factor diabetic cases. Hence, poor quality of life may be declined further by chemical irregularities in a poor glycaemic control. In addition, other quality of life factors like poor medical management, comorbid states and psychosocial factors are confirmed to cause depressive symptoms which may affect quality of life of patients (Anderson et al., 2001).

Nonetheless, the significant relationship between diabetes mellitus and quality of life had been denied on the basis of no reported significant associations between the two variables (Kleefstra et al., 2005; Pitale et al., 2005). Interestingly, proper management or good drug adherence behaviour pattern had been rejected by Billups, Malone and Carter (2000) to affect quality of life of patients.

Findings from the study confirmed the hypothesis that depression, complications, anxiety, age of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and hostility significantly predict level of quality of life (QoL). Imayama et al. (2011) supported the claim that a significant difference exists between the quality of life among Type 1 and Type 2 diabetic patients. The role of behavioural pathologies and challenges associated with normal aging process like increasing risks of morbidity rates are central to

Type 2 diabetes mellitus. Depression and other mood disorders confirmed in this study have been reported by Sargin et al. (2002) to affect approximately 30% of all patients with diabetes. Generally, their study confirmed number of comorbidities, body mass index (BMI), physical activity rates, individuals diagnosed with diabetes having a partner, amount of annual salary, and personality to be among individuals diagnosed with Type 1 diabetes. Contrasting these with persons with Type 2 diabetes who are often older than the Type 1 patients, aging affected their health-related quality of life but not with their general life satisfaction.

Another significant predictor relevant to the sociocultural definition of health is the health belief of people. This model expresses the unique nature of cultural differences in explaining disease prevention, their causality and management (Fisher et al., 2000). In a specific cultural frame, members who share in the same values and belief systems are noted to possess their own personalised explanatory model of illness. As noted in some studies, these health beliefs usually vary or take account of some biomedical perspective for describing a particular condition (Arcury et al., 2004; Jezewski & Poss, 2002). Studies have linked the sociocultural perception of people to their health, especially in relation to chronic disorders.

Interestingly, according to de-Graft Aikins (2003), 'health' to Ghanaians goes beyond just having physical illness to include 'psychosocial, economical, spirituality and self' challenges. In addition, cultural norms were noted to transform individuals' standards towards living especially when it relates to health (Cutler et al., 2003). Thus, health belief is able to predict quality of life in this study.

Age as it progresses is noted as a predictor in this study. In most cases, human aging have been implicated as an enabling factor in depression development and prognosis. This may also influence chronic disorders as the older adulthood phase predisposes a person to negative lifestyle habits like gradual decline in activities of daily living, increase in sedentary lifestyles, poor dietary habits, and living in less interactive social environment (Mamplekou et al., 2010).

Findings from this study rejected Hypothesis 6 which stated that age, education and number of complications of respondents will predict health belief of respondents. The findings showed that there was no significant relationship between the health beliefs of the respondents and their level of education in years. However, health beliefs related with the number of complications and the ages of respondents in years.

Although a further specific comparison analysis of these relationships among both groups only supported the relationship between respondents' health beliefs and ages, de-Graft Aikins' (2003) model on the intricate nature of the Ghanaian health belief system might have accounted for the lack of significance. In effect, the health or illness perception among Ghanaians may not easily be predicted by some specific personal achievements like job or educational level when the confounding holistic intricate perspective of the role of the body, soul and spirit are ignored.

Considerably, this result is contradictory to findings of studies like that of Mamplekou et al. (2010) who reported that demographic factors like education affect an individual's view about his or her health. In addition, the data confirmed the hypothesis that the diabetic patients will have higher scores on the BSI subscales than the healthy controls. As noted from the results, the Brief Symptom Inventory [BSI] (Derogatis & Melisaratos, 1983) was able to discriminate the two groups on somatization, obsession

compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism and global severity index. In all cases, the diabetic group scored higher on the various subscales than the healthy control group.

Even though most studies have confirmed the role depression plays in diabetic pathology and vice versa (Maatouk et al., 2012; Sargin et al., 2002), there have been some silence with respect to the other psychopathologies noted in this study. Nonetheless, some meanings could be drawn from the respective neuropsychological deficits found in the study. As suggested by Munshi et al. (2006), the incidence of neuropsychological deficits in diabetes could be linked with depression incidence. In addition, Maatouk et al. (2012) confirmed the influence of depression by linking it with diabetic-related complications. In addition, current Magnetic Resonance Imaging and Computer Tomography studies among diabetic patients have been reported by Fitten et al. (2008) to confirm the validity of depression to be associated with memory decline when compared with healthy controls.

Observing from previous discussed supporting studies on diabetes, these related psychological problems could have been accounted by the poorly managed cases of diabetes which could be inferred from the increasing number of multiple complications noted among the diabetic group. In addition to the neuropsychological and biochemical explanations, the significantly higher levels of psychological problems among the diabetic group might have been accounted for by the complementary effects from various predisposing variables like increased risks of comorbidities (Gray et al., 2006), poor quality of life (de-Graft Aikins, 2003; Kurella, et al., 2005; Pibernik-Okanovi, 2001), cognitive deficits (Munshi, 2006) and poor glucose circulation (Brands, & Kessels, 2009; Kitabchi et al., 2006).

Observed Conceptual Framework

Figure 2 shows the revised conceptual framework presenting the significant relationships between the variables measured in this study. The results depicted that Type 2 diabetes mellitus affected significantly the neuropsychological functioning and the quality of life of patients in the study. Also, diabetes was noted to affect the global severity index of psychological disorders of respondents. Moreover, quality of life was significantly predicted by depression, complications, anxiety, age of respondents, health beliefs, cognitive failure, interpersonal sensitivity, and level of hostility. Finally, depression, cognitive failure and level of complications predicted the global neuropsychological functioning of a person.

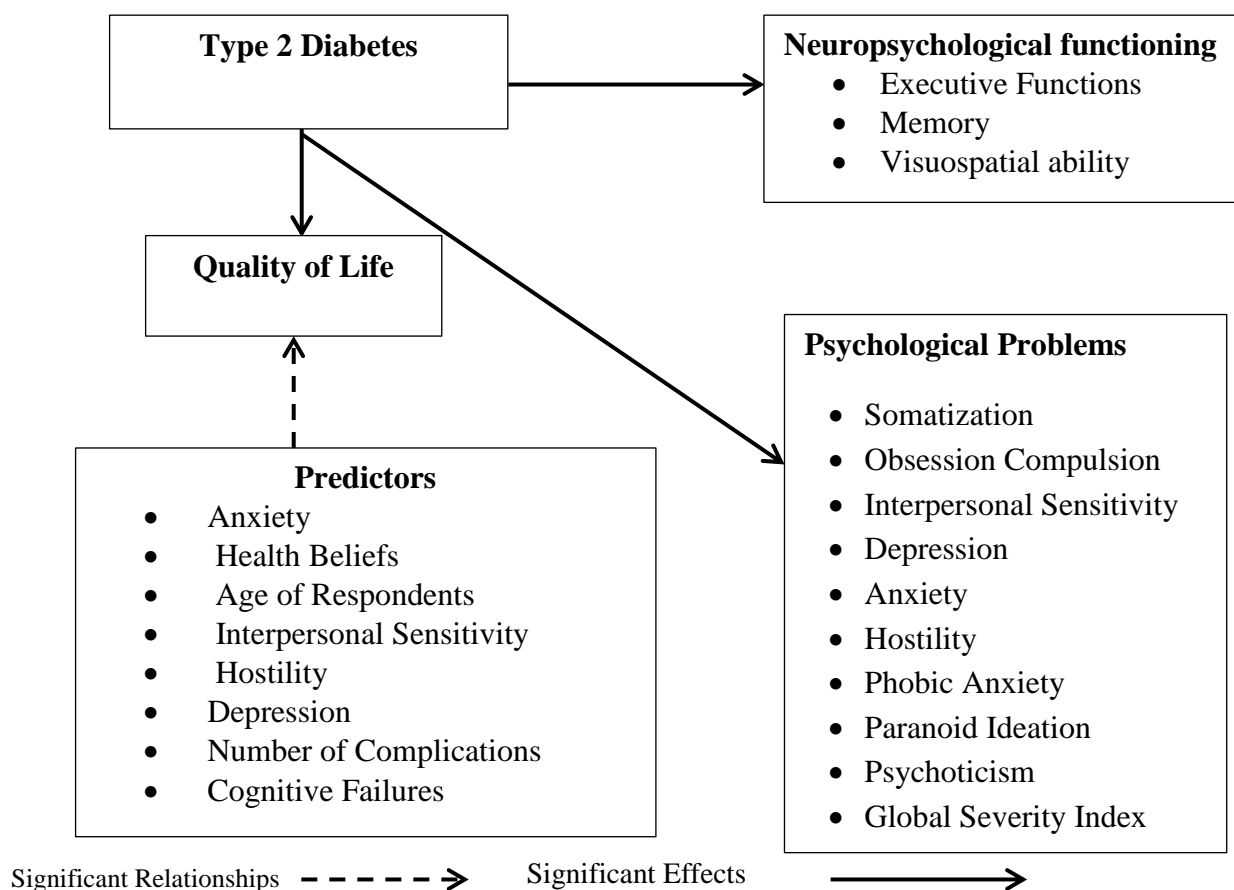


Figure 2

Revised Conceptual Framework

Implications of Findings for Clinical Practice

The main findings from this study confirm that Type 2 diabetes mellitus may affect the neuropsychological functioning and quality of life of patients. Central to these findings are predictors like number of complications/comorbidities, aging, health beliefs and other mood pathologies like anxiety and depression. Owing to these challenges, the clinical management skills of professionals have to be upgraded to include skills required to screen subtle deficits to control these dysfunctions.

In effect, neuropsychological screening tests and other quality of life measures must be added to the routine care of individuals living with diabetes. This integration between medical and neuropsychological care will call for an intensive training and upgrading of technical knowledge among clinicians. Additionally the results of this study offers evidence for the need of the Ministry of Health to employ qualified Clinical Psychologists into the various health care institutions to assist with the psychological management of diabetes.

In the same vein, professional bodies and training institutions offering psychology at all levels as well can incorporate and train their students and researchers on the psychological burden that chronic illness imparts on the general wellbeing of people. This to a greater degree will afford future of clinicians to be well grounded in the scope of handling all aspects of psychological challenges faced by patients.

In line with the behavioural burden that diabetes places on people, clinicians will have to draw comprehensive management programmes that will include the families of patients. This will not only improve the quality of life of patients but will also help their caregivers to better understand the disorder.

Limitations of the Current Study

The most significant limitation of the study was the use of non-probability sampling techniques during in the data collection. The convenience and purposive sampling techniques served as a form of limitation factor in generalising the study results.

Another important limitation worth noting is the fact that the study used only the quantitative approach to research. Concepts like quality of life and health beliefs are better understood when patients are allowed to express themselves. Future researches should use the mixed method approach to be able to handle these concepts adequately.

Finally, the sample size of hundred although may be justified in the scope of clinical studies reduces the generalisation of findings.

Notwithstanding all these limitations, this study fills some research gaps in diabetic studies and may serve as a good basis for future studies.

Direction for future research

There is a need for further studies to look at the following areas:

- The neuropsychological functioning and other behaviour measures can be taken with blood samples to identify specific glucose levels and other blood related complications.
- Brain scans in the form of MRI and/or CT scans can be added as part of the data collection process to identify the specific area of brain damage.
- Functional and nutritional measures may be added as part of data collection instruments.
- An additional number of controls with other chronic medical conditions and/or clinical neurological dysfunctions can be added.
- A critical look at the role spirituality plays in affecting both quality of life and other psychological functioning of people living with diabetes can be looked at.
- Studies can take a qualitative approach to look at the role quality of life, health belief and spirituality play in the lives of individuals diagnosed with Type 2 diabetes.

Conclusions

Diabetes mellitus is one of the incapacitating chronic disorders globally, that poses several public health issues across a broad age range (ADA, 2003c). Although, diabetes mellitus has shown a consistent increase over three decades in Ghana (IDF, 2012), little is known about their neuropsychological and quality of life functioning. Considering the efforts by Ghana's Ministry of Health to provide some medical treatment opportunities for individuals diagnosed with diabetes, an additional research on their neuropsychological functioning will increase the effectiveness of diabetic care in Ghana and other sub-Saharan African countries.

This study sought to identify the neuropsychological functioning and quality of life among diabetic patients in Ghana. Using the systematic thematic review of literature, theories and other related studies were analysed.

Results from the study showed that Type 2 diabetes mellitus affected significantly the neuropsychological functioning of humans. These negative effects were observed in areas such as executive functioning, memory and visuospatial functioning. In addition, Type 2 diabetes also affected the quality of life of diabetic patients who were sampled in the study. Specifically, quality of life was predicted by the number of complications, depression, cognitive failure, aging, health belief, anxiety, interpersonal sensitivity, and hostility. Furthermore, individuals diagnosed with Type 2 Diabetes also scored higher on other psychological dysfunctions when measured on the Brief Symptom Inventory subscales.

Despite the fact that this study has some significant limitations, results of the study have implications for clinical management and future Type 2 diabetes research.

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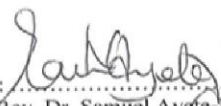
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Available from url:

http://www.who.int/diabetes/publications/Definition%20and%20diagnosis%20of%20diabetes_new.pdf. Date retrieved: 22/03/2013.

Appendix I

Ethical Clearance by NMIMR


NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH		
<i>Established 1979</i> <i>A Constituent of the College of Health Sciences</i> University of Ghana		
Phone: +233-302-916438 (Direct) +233-289-522574 Fax: +233-302-502182/513202 E-mail: nirb@noguchi.mimcom.org Telex No: 2556 UGL GH	INSTITUTIONAL REVIEW BOARD 	Post Office Box LG 581 Legon, Accra Ghana
My Ref. No: DF.22 Your Ref. No:	14 th March, 2013	
ETHICAL CLEARANCE		
FEDERALWIDE ASSURANCE FWA 00001824 NMIMR-IRB CPN 069/12-13	IRB 00001276 IORG 0000908	
On 14 th March 2013, the Noguchi Memorial Institute for Medical Research (NMIMR) Institutional Review Board (IRB) at a full board meeting reviewed and approved your protocol titled:		
TITLE OF PROTOCOL	: Neuropsychological Functioning and Quality of Life among Type-2 Diabetic Patients in Ghana	
PRINCIPAL INVESTIGATOR	: Jacob Owusu Sarfo, Mphil Cand	
<p>Please note that a final review report must be submitted to the Board at the completion of the study. Your research records may be audited at any time during or after the implementation.</p> <p>Any modification of this research project must be submitted to the IRB for review and approval prior to implementation.</p> <p>Please report all serious adverse events related to this study to NMIMR-IRB within seven days verbally and fourteen days in writing.</p> <p>This certificate is valid till 13th March, 2014. You are to submit annual reports for continuing review.</p>		
Signature of Chairman:	 Rev. Dr. Samuel Ayete-Nyampong (NMIMR – IRB, Chairman)	
cc:	Professor Kwadwo Koram Director, Noguchi Memorial Institute for Medical Research, University of Ghana, Legon	

Appendix II

Ethical Clearance by NDMRC

NATIONAL DIABETES MANAGEMENT AND RESEARCH CENTRE

FAX: 021 671047
 TEL: 021 671047
 Email:



Korle-Bu Teaching Hospital,
 P.O. Box 77, Korle-Bu,
 Accra . Ghana.

REPUBLIC OF GHANA

My Ref No
 Your Ref No.

VISITING STUDENT RESEARCH PROJECT/ATTACHMENT FORM (To be completed in duplicate)

Please note: Students wishing to undertake research at the NDMRC are expected to submit a proposal and consent form relating to their work along with this form before they will be allowed to start their project at our Centre

Full Name of Student JACOB OWUSU SARFO Age 26 Male Female
 Tel No. 0246485735 Email Sarfo.joc@yahoo.com
 Alternative Contact Person's Name (Parent/Guardian/Spouse) MOTHER Tel. 0249445411

Status of Student (tick and complete): Degree Student Programme.....
 Graduate Student Programme MPHIL CLINICAL PSYCHOLOGY
 Other, please specify.....

Supervisor at NDMRC (the student is to discuss this with his/her Main Supervisor)

Purpose of Visit /Title of Student Project: NEUROPSYCHOLOGICAL FUNCTIONING AND QUALITY OF LIFE AMONG TYPE 2 DIABETICS IN GHANA.
 List all Resources and Facilities that will be needed by student at NDMRC:
 Anticipated Start date of Visit 23-04-2013 Completion date 30-06-2013

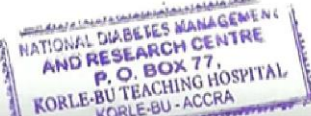
INSTITUTIONAL ENDORSEMENT
 Name of Student's Academic Institution UNIVERSITY OF GHANA Department PSYCHOLOGY
 Title and Name of Main Supervisor of student PROF. C. C. MATE-KOBE Highest Qualification PHD
 Address UNIVERSITY OF GHANA, DEPARTMENT OF PSYCHOLOGY
P.O. BOX 45693, LEGON
 Tel 0274813254 Email djabatey@iainmail.com

As the main Supervisor, I undertake to ensure that a copy of the student's examined long essay, dissertation, thesis or report of the visit will be sent to the Director, National Diabetes Management and Research Centre, Korle Bu, Accra.

[Signature] 11-04-2013
 Signature of Main Supervisor Date
 UNIVERSITY OF GHANA-LEGOA
 DEPARTMENT OF PSYCHOLOGY
 Official Stamp of Student's Department

SECTION TO BE COMPLETED AT NDMRC, KORLE BU

Inputs needed Yes No Honaria to clients Yes No Approval Given Yes No
[Signature] 19/4/13
 Signature of Director, NDMRC Date



Appendix III

Introductory Letter by the Department of Psychology, University of Ghana

UNIVERSITY OF GHANA
DEPARTMENT OF PSYCHOLOGYTel: (233-0302) 500381 Ext. 3754/3310 P. O. Box LG 84, Legon Ghana E-mail: psychology@ug.edu.gh
028 955 04 63

PSYC 2/33/01

April 25, 2013

Our Ref. No.....

TO WHOM IT MAY CONCERN
JACOB OWUSU SARFO

The above-named is an M.Phil Clinical Psychology student in the Department of Psychology, University of Ghana, Legon. His index number is 10230891.

In partial fulfillment of the requirement for the awards of the M.Phil degree, **Jacob Owusu Sarfo** has to write and submit an original thesis.

He has selected the topic: "**Neuropsychological Functioning and Quality of Life among Type 2 Diabetics in Ghana**".

To enable him collect data for his work, he would need to administer questionnaires and/or conduct interviews. He has selected your Institution as suitable for his data collection.

Any assistance you may give him would be greatly appreciated.

Thank you for your co-operation.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'C. Akotia'.

Dr. Charity S. Akotia
(Head of Department)

Appendix IV

Consent Form of the Study

CONSENT FORM

Title: Neuropsychological Functioning and Quality of Life among Type-2 Diabetic Patients in Ghana

Principal Investigator: Jacob Owusu Sarfo

Principal Supervisor: Prof. C. C. Mate-Kole

Address: Department of Psychology, University of Ghana, Legon

General Information about Research

You are invited to participate in an academic research project which is aimed at examining the challenges associated with structure and function of the brain as related to human behaviour and quality of life in patients with adult onset Diabetes. I am investigating this topic to understand the relationship that diabetes mellitus in adulthood has on the structure and function of the human brain, which may be experienced in the activities of daily living and on quality of life. It is a paper and pencil test that will require you to either remember or recall some items or do some drawings on a paper. It is estimated to take between 1- 2 hours. Feel free to ask questions if you do not understand something.

Possible Risks and Discomforts

You may experience fatigue as a result of long period of test administration. You will be given ample time in the form of periodic breaks to prevent fatigue during testing. Some of the tests may be easy, while others may be difficult. You are not required to answer all the questions correctly or to perform all the tasks perfectly.

Possible Benefits

This study was not planned to benefit you directly. Nonetheless, your participation in this research will enrich the understanding of the neuropsychological deficits in adult diabetic patients.



1

Confidentiality

Your responses will be treated with utmost confidentiality. Only the researcher and approved research assistants will have access to the individual data you will provide. The results will be reported in an aggregated format (e.g., as averages, etc.), and under no circumstances will any individual participant be unidentified in a publication or presentation describing this study.

Compensation

This study will not include any compensation apart from a verbal appreciation of your valued time and efforts.

Voluntary Participation and Right to Leave the Research

Your participation in this study is entirely voluntary and may refuse to participate in this research without any penalty. You may at any time, for any reason, discontinue your participation without any negative consequences after having begun as a participant.

Contacts for Additional Information

The following numbers can be contacted in case of any discomfort, explanation or further information.

Researcher: Jacob Owusu Sarfo (Tel: 0246485735)

Supervisor: Prof. C. C. Mate-Kole (Tel: 0274313254)



Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board of Noguchi Memorial Institute for Medical Research (NMIMR-IRB). If you have any questions about your rights as a research participant you can contact the IRB Office between the hours of 8am-5pm through the landline 0302916438 or email addresses:

nirb@noguchi.mimcom.org or HBaidoo@noguchi.mimcom.org . You may also contact the chairman, Rev. Dr. Ayete-Nyampong through mobile number 0208152360 when necessary.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title (*Neuropsychological Deficits and Quality of Life among Type 2 Diabetic Patients*) has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

Date

Name and signature or mark of volunteer

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

Date

Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

Date

Name Signature of Person Who Obtained Consent



Appendix VI

Demographic Questionnaire

QUESTIONNAIRE

Time started..... **Time ended**.....

SECTION A
BIOGRAPHIC DATA

1. Sex: a). Male _ b). Female _

2. Age

3. Years after 1st diabetes diagnosis.....

4. Marital status
a). Married _ b). Single _ c). Divorced _ d). Cohabiting _
e). Widowed _ f). Other Specify

5. Level of education
a). No formal education _ b). Primary school _ c). Middle/JSS/JHS _
d). Secondary school _ (e) Tertiary _

6. Occupation
a). Student _ b). Unemployed _ c). Self-employed _ d). Civil Servant _
e). Public Servant _ g). Other Specify

7. Diabetes treatment regimen
a). Insulin& Diet _ b). Tablet & Diet _ c). Diet Only

8. Complications of diabetes
a). Hypoglycaemia _ e). Kidney problems _ h). Other Specify.....
b). Hyperglycaemia _ f). Loss of feelings _
c). Ulcers _ g). Eye problems _

1



NB: Because permissions for copyright to copy the neuropsychological and behaviour measures used in this study were not attained, the researcher could not scan them as an attachment in this section.

Appendix VII**Table 1:****Summary of Frequencies and Percentages of Some Categorised Demography of Participants**

Demography	Category	Diabetic Group (n = 50)		Healthy Control Group (n = 50)	
		Freq.	Percent	Freq.	Percent
Age	21-30	5	10.0%	3	6.0%
	31-40	8	16.0%	12	24.0%
	41-50	15	30.0%	13	26.0%
	51-60	17	34.0%	18	36.0%
	61-70	5	10.0%	4	8.0%
Educational Level (Years in Mean)	Junior High	6	12.0%	7	14.0%
	Senior High	14	28.0%	15	30.0%
	Tertiary	30	60.0%	28	56.0%
Years of Diagnosis	1-5	34	68.0%		
	6-10	13	26.0%		
	11-15	2	4.0%		
	16-20	1	2.0%		

Appendix IV

Additional Findings

Table 1

Correlation Matrix among Brief Symptom Inventory sub scales

	1	2	3	4	6	7	8	9	10	11
1. Global	-	.839**	.832**	.773**	.622**	.871**	.813**	.772**	.839**	.757**
2. Somatization	-	-	.862**	.838**	.657**	.849**	.777**	.825**	.800**	.791**
3. Obsession Compulsion	-	-	-	.808**	.644**	.828**	.806**	.808**	.807**	.754**
4. Interpersonal Sensitivity	-	-	-	-	.633**	.836**	.779**	.821**	.805**	.780**
5. Depression	-	-	-	-	-	.734**	.643**	.698**	.726**	.695**
6. Anxiety	-	-	-	-	-	-	.873**	.869**	.903**	.851**
7. Hostility	-	-	-	-	-	-	-	.863**	.840**	.834**
8. Phobic Anxiety	-	-	-	-	-	-	-	-	.830**	.838**
9. Paranoid Ideation	-	-	-	-	-	-	-	-	-	.823**
10. Psychoticism	-	-	-	-	-	-	-	-	-	-

** $\rho < 0.01$ (1-tailed), ns = not significant (Source: author's field data, 2013)

NEUROPSYCHOLOGICAL FUNCTIONING AND QUALITY OF LIFE AMONG TYPE 2 DIABETIC PATIENTS IN GHANA

Table 2

Correlation Matrix among Executive function tests and Memory tests

	1	2	3	4	5	6	7	8	9	10	11
<i>Memory Tests</i>											
1. DIGIT SYMB R	-	.501**	.490**	.363**	.397**	.382**	-.406**	-.381**	-.253**	.379**	-.282**
2. DIGIT S F	-	-	.724**	.178*	.154 ^{ns}	.271**	-.444**	-.458**	-.337**	.387**	-.322**
3. DIGIT S B	-	-	-	.317**	.346**	.369**	-.538**	-.496**	-.323**	.481**	-.310**
4. CVLT C D R	-	-	-	-	.798**	.417**	-.305**	-.319**	-.237**	.253**	-.110
5. CVLT D C	-	-	-	-	-	.364**	-.341**	-.383**	-.303**	.334**	-.203*
6. CVLT A %	-	-	-	-	-	-	-.406**	-.290**	-.122 ^{ns}	.230*	-.120 ^{ns}
<i>Executive Function Tests</i>											
7. TMT A	-	-	-	-	-	-	-	.767**	.376**	-.355**	.343**
8. TMT B	-	-	-	-	-	-	-	-	.883**	-.383**	.357**
9. TMT B-A	-	-	-	-	-	-	-	-	-	-.294**	.264**
10. MCST CAT	-	-	-	-	-	-	-	-	-	-	-.773**
11. MCST P E	-	-	-	-	-	-	-	-	-	-	-

** $\rho < 0.01$, * $\rho < 0.05$ (1-tailed), ns = not significant

(Source: author's field data, 2013)

Table 3**Correlation Matrix among Depression and Executive Function tests**

	1	2	3	4	5	6
<i>Mood Disorder</i>						
1. Depression	-	.184 [*]	.120 ^{ns}	.038 ^{ns}	-.497 ^{**}	.314 ^{**}
<i>Executive Function</i>						
2. Trail Making Test A	-	-	.767 ^{**}	.376 ^{**}	-.355 ^{**}	.150 ^{ns}
3. Trail Making Test B	-	-	-	.883 ^{**}	-.383 ^{**}	.244 ^{**}
4. Trail Making Test B-A	-	-	-	-	-.294 ^{**}	.243 ^{**}
5. MCST # of Categories	-	-	-	-	-	-.554 ^{**}
6. MCST Non-Perseverative	-	-	-	-	-	-
Errors						

** $\rho < 0.01$, * $\rho < 0.05$ (1-tailed), ns = not significant

(Source: author's field data, 2013)