A COMPARISON OF THE DIETS OF CONFIRMED TYPE 2 DIABETIC SUBJECTS AT THE NATIONAL DIABETES MANAGEMENT AND RESEARCH CENTER, WITH NON-DIABETIC SUBJECTS.

BY

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DEDICATION

Dedicated to all diabetic patients in Ghana.

DECLARATION

This thesis is the result of research work undertaken by Rebecca Kissiwa Anim in the Department of Nutrition and Food Science, University of Ghana Legon, under the supervision of Dr. W. B. Owusu of the Department of Nutrition and Food Science, University of Ghana, Legon and Prof. A. G. B. Amoah of the Department of Medicine, University of Ghana Medical School, Korle-Bu.

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Abstract

A Comparison of the Diet of Confirmed Type 2 Diabetes Subjects at the National Diabetes Management and Research Center, with Non-Diabetic Subjects.

OBJECTIVE: The study objective was to compare the diet and nutritional status of diabetic subjects to non-diabetic subjects and to evaluate whether recommendations given as part of diet-therapy for diabetics are being followed.

METHODS: A cross-sectional study design was followed. One hundred and fifty one diabetic subjects were identified from the National Diabetic Management and Research Center, Korle-Bu. Non-diabetic subjects (n =140) were identified from staff of Korle-Bu Teaching Hospital, Kaneshie Presbyterian Church and Mt. Zion Methodist Church, Korle-Bu. Dietary intake information was obtained by the administration of a Food Frequency Questionnaire and 24-hour dietary recall. Anthropometric indicators (height, weight, waist circumference and hip circumference) were measured for each subject. Fasting plasma glucose, blood pressure and pulse were determined. Nutritional status was assessed using body mass index (BMI), waist to hip ratios (WHR) and Waist Circumference.

RESULTS: The mean macronutrient, energy and dietary fiber intakes were comparable among diabetics and non-diabetics with no significant differences. Percent contribution of macronutrient especially total fat and carbohydrate to total energy intake among most diabetic subjects suggests that they are not following dietary recommendations. Diabetic subjects were significantly more obese based on BMI, WHR and Waist Circumference ($p=0.03$; $p<0.01$; $p<0.01$) respectively than non-diabetics. No correlations were found between dietary intake and nutritional status in both groups. Together, dietetic advice, waist circumference and pulse explained 41% of the variation in FPG levels.

CONCLUSION: Appropriate dietetic advice needs to be given to diabetic patients to ensure effective management of the disease.

CHAPTER ONE

1.0 INTRODUCTION

Type 2 diabetes is an increasing problem in Ghana, particularly as a result, in part, of changing lifestyles and eating patterns. Research suggests that diabetes is primarily a lifestyle disorder with the major part of lifestyle contributing to the occurrence of the disease being food and also physical inactivity.

Diabetes is a metabolic disorder of multiple aetiology characterized by chronic hyperglycemia and associated with impaired carbohydrate, fat and protein metabolism (Parillo and Riccardi, 2004). There are two major forms of diabetes, juvenile-onset (<40 years) also called type 1 diabetes and adult-onset (>40 years) also called type 2 diabetes (Wardlaw and Insel, 1995). Diabetes has no cure, once it is acquired, it can only be managed. Among the various methods of managing the disease are dietary modifications and regiments based on individual conditions.

Scientific evidence has established the role of nutrition and dietary modification in prevention and management of type 2 diabetes (Fung *et al.*, 2004; Feskens *et al.*, 1991; McKeown *et al.*, 2002; Montonen *et al.*, 2003). The problem of type 2 diabetes in Ghana is implicated in the fact that its prevalence among the adult population in the Greater Accra Region doubled from 3% (Vuvor, 1998) to 6% (Amoah, 2000). This has serious public health implications especially considering its complications, the high expense in managing it and the implications it has on society.

Due consideration should also be given to the fact that Ghana's population, like many other developing countries, is aging. The elderly population (65 years^{+}) in the country increased from 4% in 1984 to a little over 5% in 2000 (GSS, 2004). If this trend of adult-onset diabetes should continue, we would need to expend a lot of resources in caring for the increasing number of people who would potentially be affected by the disease.

1.1 Rationale

An important issue to consider is that there has been a major change in dietary lifestyle among the populace over the past couple of decades due to modernization and changes in our lifestyle (e.g. consumption of more sugary, salty and more fatty foods). All these things have been shown through various studies to predispose adults to obesity which is also a risk factor for diabetes (Akpene *et al.*, 2003; Ledo, 2005).

A lot of studies about diet in the management of type 2 diabetes have been documented (Stevens *et al.*, 2002; McKeown *et al.*, 2002; Montonen *et al.*, 2003). Incidentally, most of these studies were done in different countries with different dietary and other practices. Little has been done on this issue in Ghana. Therefore there is an information gap that needs to be bridged through knowledge from studies conducted among diabetics in Ghana. This need was the basis for this study.

In addition, there have been no studies to investigate how well dietary recommendations given as part of diet-therapy for diabetics are followed by the diabetic population in Ghana. Information to highlight any modifications in nutritional behaviour among diabetics would help in the formulation of policies that would improve hopefully, the prevention and management of diabetes among Ghanaian adults. The study therefore had the following objectives:

1.2 Objectives

As its primary objective, the study sought to compare the habitual diets of diabetic subjects to non-diabetic subjects and to evaluate whether dietary recommendations are being followed.

The secondary objectives were to:

- Assess the nutritional status of diabetic subjects compared with non-diabetic subjects using BMI, WHR and Waist Circumference.
- Determine the correlation between dietary intake and nutritional status of diabetic subjects compared with non-diabetic subjects.
- Identify potential risk factors for type 2 diabetes.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Characteristics of diabetes mellitus.

Diabetes mellitus is a metabolic disorder of multiple aetiology characterized by chronic hyperglycemia and associated with impaired carbohydrate, fat and protein metabolism. These abnormalities are the consequences of either inadequate insulin secretion or impaired insulin action, or both. Diabetes has been recently reclassified into four distinct types: type 1, type 2, gestational diabetes mellitus and other specific types (WHO, 1999; American Diabetes Association, 1997).

Long-term complications of type 2 diabetes include retinopathy (with potential loss of vision) nephropathy (leading to renal failure), peripheral neuropathy (with risk of foot ulcers and gangrene) and autonomic neuropathy (which contributes to erectile dysfunction and cardiac arrhythmia). However, most morbidity and mortality associated with diabetes is attributable to macrovascular complications, such as myocardial infarction and acute stroke (Parillo and Riccardi, 2004). Diabetes is associated with an age-adjusted cardiovascular mortality between 2 and 4 times that of the non-diabetic population, whiles life expectancy is reduced by 5-10 years in middle-aged patient with type 2 diabetes (Roselli della Rovere *et al.*, 2003).

Diabetes mellitus occurs in all populations. However, the incidence of IDDM and NIDDM varies considerably with age, country and ethnic group. Both types are associated with premature mortality and a high risk of vascular, renal, retinal and neuropathic complications (WHO, 1996).

2.1.1 The current situation of type 2 diabetes in some countries

Type 2 diabetes, until recently referred to as non-insulin-dependent diabetes, accounts for about 85%-95% of all disease cases. In Western countries, the estimated prevalence in the population is 4-6%. Half of these cases are diagnosed, while a similar number remains unrecognized. The disease is observed much more frequently in older people and in some ethnic communities. The WHO has predicted that the global prevalence of type 2 will more than double from 1995-2025, from 135 million to 300 million (King *et al.*, 1998; Choi and Shi, 2001).

Among West Africans in particular, westernization and duration of migration exacerbate insulin resistance and hyperinsulinemia (Mbanya *et al*, 1999; Osei *et al.*, 1997). Lifestyle modifications aimed at weight reduction and regular physical activity have been found to be effective in the prevention of diabetes and are encouraged for all populations (both diabetic and non-diabetic).

2.1.2 How type 2 diabetes occurs

The hormone insulin acts to check the rise in glucose levels in the blood. To achieve this, it acts directly on the liver, muscle cells and adipocytes to increase glycogen synthesis and fatty acid synthesis and to enhance the uptake of glucose by cells. In diabetes, however, absence or deficiency of insulin allows persistently high glucose levels. Fasting plasma glucose (FPG) ≥126mg/dl or 7.0 mmol/l or higher, obtained on two or more occasions may be considered diagnostic of diabetes (American Diabetes Association, 1997). Uncared for, diabetes can lead to serious and life-threatening complications. Early signs of diabetes, or its uncontrolled state include: increased thirst (polydipsia), increased urination (polyuria), increased hunger (polyphagia) and weight loss (Williams, 1994).

2.2 Risk factors of type 2 diabetes

Lifestyle factors that have, so far, been consistently associated with increase risk of type 2 diabetes are overweight and physical inactivity. Recent epidemiological studies have shown that the risk of type 2 diabetes is also associated with diet composition, particularly with low fiber intake, high trans fatty acid intake and a low unsaturated / saturated fat intake ratio and absence of or excess alcohol consumption. The ability to correct these behaviour in the population is estimated to reduce the incidence of diabetes by as much as 87 % (Parillo and Riccardi, 2004).

2.2.1 Overweight/ obesity as a risk factor for type 2 diabetes

Overweight/ obesity is by far the most important risk factor for type 2 diabetes. Almost 70-80% of type 2 diabetic patients are either overweight or obese; several long-term prospective studies have shown a higher risk of diabetes with increasing body weight (Curb and Marcus, 1991; Perry *et al.*, 1995; Maggio and Xavier, 1997). The degree of overweight and the distribution of fat are important in the development of diabetes. An upper body or central distribution of body fat, independently of the absolute level of obesity, increases the risk of diabetes (Boyko *et al.*, 2000; Samaras and Campbell, 2000).

Abdominal adipose tissue not only has a greater metabolic activity but also is anatomically positioned closer to the liver, implying a greater flux of NEFA (Non-esterified fatty acids) going to the liver. This in turn, can interfere with glucose oxidation and hepatic extraction of insulin. There is evidence indicating that elevated plasma NEFA levels could also impair insulin secretion at the level of the pancreatic β- cells (Wiesenthal *et al.*, 1999; Frayn, 2000).

2.2.1.1 Waist to Hip ratios (WHR) and Waist Circumference

Defining obesity in terms of a central distribution with increased waist: hip ratio makes it a more accurate marker of insulin resistance (Evans *et al.*, 1984) and the relationship appears most close with truncal subcutaneous fat (Abate et al., 1995). Abdominal fat can be evaluated with anthropometric measurements such as waist circumference and waist: hip circumference ratio. The respective normal (healthy) WHR figures for females and males are < 0.85 and <0.90. Females with WHR > 0.85 and males with > 0.90 are classified as centrally obese (WHO, 1999). Patients with central adiposity (waist circumference > 1.02 m in male and >0.88m in female) have higher insulin levels and are more insulin resistant than subjects with similar weight but a peripheral-type of obesity (Abate *et al.*, 1995; Samaras and Campbell, 2000; Laaksonen *et a*l, 2003).

Excessive release of free fatty acids from adipocytes is a feature of obesity and may be greater in central obesity (Jensen et al., 1989). Increased free fatty acid concentrations may reduce skeletal-muscle glucose metabolism and provide a possible explanation of insulin resistance of obesity (Ferrannini et al., 1983).

2.2.1.2 Body mass index (BMI)

BMI is a measure which takes into account a person's weight and height to gauge total body fat especially in overweight, obese, normal and underweight. It will however overestimate fatness in people who are muscular or athletic (Halls, 2001). The respective figures for underweight, normal (healthy) overweight and obese categories are BMI< 18.5, 18.5-24.9, 25.0-29.9 and 30.0^{+} (WHO, 1995). BMI 25.0-29.9 and beyond has been associated with increased risk of type 2 diabetes (Maggio and Xavier, 1997).

2.2.1.3 Recommendation by the American Diabetes Association

Structured intensive lifestyle programs aimed at regular physical activity and standard weight reduction diets should work together to produce long-term weight loss on the order of 5%-7% of starting weight (American Diabetes Association, 2003)

2.2.2 Diet composition as a risk factor for type 2 diabetes

Diet composition can influence the development of type 2 diabetes by affecting body weight. Laboratory experiments in animals and clinical studies in human subjects have repeatedly shown that dietary factors, particularly fat and energy intakes are strongly and positively associated with excess body weight (Riccardi *et al.*, 2004). Population base studies on diet and obesity however, have yielded inconsistent results due to a number of factors, including weakness in the study design and systematic measurement errors in dietary data. There is evidence that consumption of a low-energy (high fiber) diet reduces energy intake, thus facilitating weight reduction (Yao and Roberts, 2001).

Many populations have experienced a 'nutritional transition'(cyclical changes in the nutritional profile of human populations produced by modifications in both dietary and nutrient expenditure patterns and determined by interplay of economic, demographic, environmental and cultural changes occurring in the society). This has resulted in dietary changes from the more unrefined, high-fiber diets to the more refined diets in most populations Monteiro *et a*l., 2002). NIDDM is particularly prevalent, affecting up to 35% of adults in some populations that have changed rapidly from a traditional to a modern lifestyle e.g. American Indians, Pacific Islanders, Australian Aborigines and Migrant Asian Indians (Riccardi *et al.*, 2004).

2.2.2.1 Dietary fiber (definition)

Trowell (1972) first defined dietary fiber (DF) as "the remnants of the plant cell wall that are not hydrolyzed by the alimentary enzymes of man". A food industry *ad hoc* working group (Anonymous, 1994) proposed a definition in consideration of the first conclusions of the European Scientific Committee for Foods, based on both chemical and physiological considerations and included oligosaccharides and lignin. One of the most recent definitions proposed by the Food and Nutrition Board of the Institute of Medicine (Anonymous, 2001) introduce a new approach, which is to distinguish between intrinsic (naturally present) and intact components of plants called 'dietary fiber' and extrinsic (added fiber), the sum of the two being called 'total fiber'.

Most scientists in the world approve the broad definitions of DF including non-starch polysaccharides (mostly of plant and algal origin), resistant starches (RS) and oligosaccharides (Lee and Prosky, 1995).

2.2.2.1.1 Dietary fiber and its association with type 2 diabetes

It is generally recognized that the consumption of food naturally rich in DF is beneficial to maintenance of health. Fiber-rich foods often have a low glycemic index (GI), although some foods with low-fiber content may also have low GI (Bjorck *et al.*, 2000). Several beneficial effects of high-fiber low-GI diets have been shown, including lower postprandial glucose and insulin responses, improved lipid control and possible improved insulin sensitivity (Wolk *et al.*, 1999; Chandalia *et al.*, 2000).

It is noteworthy that in most prospective studies cereal-fiber intake in particular, is inversely associated with risk of type 2 diabetes (Stevens *et al* ., 2002; McKeown *et al.*, 2002; Montonen *et al.*, 2003). This same correlation was not observed when total DF intake was considered (Salmeron *et al.*, 1997*a;* Salmeron *et al.*, 1997*b*). However, fruit and vegetable consumption is also associated with a reduced risk of type 2 diabetes (Ford and Mokdad, 2001; Sargeant *et al.*, 2001). Several results also support a protective role for whole grain and also for cereal fiber in the development of insulin resistance and /or type 2 diabetes (Salmeron *et al.*, 1997*a;* Salmeron *et al.*, 1997*b;* Meyer et al., 2000; Pereira *et al.*, 2002). Most of these epidemiological studies prospectively evaluating the relationship between dietary fiber intake and risk of type 2 diabetes are consistent in showing a protective effect of fiber consumption towards the development of diabetes.

Specific DF, which are often highly viscous, such as β- glucans from oats, pectins, guar gums and psyllium, exhibit a significant effect on post-prandial glycaemia and insulinaemia but their impact on the risk of type 2 diabetes is not clearly proven (Bourdon *et al.*, 1999).

2.2.2.1.2 Recommendations by the American Diabetes Association

Early short-term studies using large amounts of fiber (>30g/day) in small numbers of sub optimally controlled type 1 subjects suggested a positive effect of fiber on glycaemia. Recent randomized control trials showed a significant reduction in mean daily blood glucose concentration ($P < 0.05$) after consumption of high fiber (>50g/day) diet (Giacco et al., 2000). In subjects with type 2 diabetes, it appears that ingestion of very large amounts of fiber (≥50g/day) are necessary to confer metabolic benefits on glycemic control.

2.2.2.2 Carbohydrate and its association with type 2 diabetes

In epidemiological studies the intake of either total carbohydrate or sugars (sucrose) does not predict the risk of diabetes (Yang *et al.*, 2003). In most studies in which the relationship between intake of refined sugars and incidence of type 2 diabetes has been examined, the results show no positive associations between sucrose consumption and risk of diabetes (Howard and Wylie-Rosett, 2002; Janket *et al*, 2003).

The average Ghanaian diet consists predominantly of carbohydrate with relatively little fruit and vegetable component. In a study to investigate fatty acids, diet, and body indices of type II diabetic American Whites and Blacks and Ghanaians, Ghanaian controls recorded higher mean energy intake than did the other controls (black and white) although this difference was not statistically significant. The major macronutrient contributing to the high energy intake was carbohydrate (Akpene *et al.*, 2003).

Carbohydrate-rich foods can be classified based on their effects on postprandial glycaemia, expressed as glycemic index (GI- the total amount of glucose appearing in the blood after eating a specific food with the total amount of glucose appearing in the blood after eating the same amount of carbohydrate in the form of white bread or glucose) (Wardlaw and Insel, 1995).

Factors such as dietary fiber content, digestion rate and total fat content are important in the determination of glycemic index. Generally, foods containing much soluble fiber (e.g. oatmeal) are digested slowly and thus produce a slow increase in blood glucose after eating. In contrast, foods such as potatoes are digested quickly, producing a rapid increase in blood glucose after eating (Wardlaw and Insel, 1995). The large increase in glycaemia observed after consumption of high–GI foods are often followed by a subsequent decrease in glycaemia values below baseline. After intake of low-GI foods, in contrast, the moderate elevations in blood glucose are followed by a slow return to baseline values, without any sign of hypoglycemia.

For patients with type 2 diabetes, it is suggested that most of their dietary energy intake should come from a combination of carbohydrates and monounsaturated fatty acids, with a special emphasis on carbohydrates with low GI (FAO/WHO, 1998)

2.2.2.2.1 Recommendation by the American Diabetes Association

Carbohydrate and monounsaturated fat should together provide 60-70% of energy intake. However, the metabolic profile and need for weight loss should be considered when determining the monounsaturated food content of the diet. Foods containing carbohydrate from whole grains, fruits, vegetable and low-fat milk are important components and should be included in a health diet (American Diabetes Association, 2003).

2.2.2.3 Dietary fat and its association with type 2 diabetes

Recent prospective studies, taking into account the total fat intake and type of fat consumed have been done. In the San Luis Valley Diabetes Study, 134 subjects with impaired glucose tolerance were followed for 3 years; fat consumption in those who developed diabetes was 43.4% total energy intake compared with 40.6% in those who still had impaired glucose tolerance (n=43) and 38.9% in those who reverted to normal glucose tolerance (n 60). An increase in fat intake (40g/d) was associated with a 6% greater risk of developing diabetes (95% CI: 1.2, 29.8). Saturated fat was also marginally associated with an increase risk of diabetes (P =0.06) (Marshall *et al.*, 1991; Marshall *et al.*, 1994; Marshall *et al.*, 1997).

In the Finnish and the Dutch cohorts of the Seven Country Study, total fat consumption and saturated fat intake contributed to the risk of type 2 diabetes (Feskens *et al.*, 1995).

In the Nurses Health Study, 84 204 women were followed prospectively for 14 years with 2507 incident cases of type 2 diabetes. The main findings were:

- no association between total fat, saturated fat or monounsaturated fat intake and incidence of diabetes;
- a positive association between a higher trans fatty acid intake and risk of diabetes;
- a negative association between a 5% higher energy intake from polyunsaturated fat and incidence of diabetes (-35%).
- a positive association between the intake of animal fat and the incidence of diabetes (this relationship was no longer statistically significant after correcting for vegetable fat consumption) (Salmeron *et al.*, 2001)

In the Health Professionals' Study, which included 42 504 male subjects followed for 12 years, total and saturated fat intakes were associated with a higher risk of type2 diabetes (relative risk 1.27 and 1.34 respectively), but these associations disappeared after adjustments for BMI. However, there was an increased risk for diabetes in men who consumed processed meat at least five times per week compared with those who consumed processed meats less than once per month (van Dam *et al.*, 2002).

The role of animal (saturated) fat, as a risk factor for type 2 diabetes, as opposed to the protective role played by vegetable (unsaturated) fat , has been recently confirmed (Thanopoulou *et al.*, 2003).

The primary dietary fat goal in persons with diabetes is to limit saturated fat and dietary cholesterol intake. Dietary fat intake can be reduced by lowering the amount of high fat foods in the diet or by providing lower fat or fat-free versions of foods and beverages or by using fat replacers (ingredients that mimic the properties of fat but with significantly fewer calories in food formulations.

2.2.2.3.1 Polyunsaturated fatty acids and type 2 diabetes

Few epidemiological studies evaluating the effects of long-chain *n*-3 fatty acids (especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) found in fishy oil) on the risk of diabetes found an inverse association observe between fish intake and incidence of impaired glucose tolerance or diabetes (Feskens *et al.*, 1991). Consistent with this finding is the inverse association between increase fish consumption and incidence of type 2 diabetes observed in the Nurses' Health Study (Salmeron *et al.*, 2001).

Available evidence (derived almost exclusively from observational studies) indicates that shifting from a diet predominantly based on fat from animal sources to a diet in which vegetable fat is more often employed might be beneficial in relation to the prevention of type 2 diabetes. An exemption to this paradigm is represented by fish consumption, since in some studies it is associated with a lower risk of diabetes. Whether the protective effect of fish is due to its n-3 fatty acid content or to other components, such as protein is a matter of debate (Lavigne *et al.*, 2001).

2.2.2.3.2 Mechanism by which dietary fat relates to type 2 diabetes

The mechanism by which dietary fat consumption could influence the development of diabetes is strictly linked with insulin sensitivity. Dietary fat can influence insulin sensitivity independently of any change in body weight. Several studies have examined dietary fat in relation to fasting and post-load plasma insulin concentrations, which are both markers of insulin resistance. The consistent finding is a positive association between saturated fat intake and hyperinsulinemia, independently of body fat (Vessby, 2000).

The mechanism linking dietary fat quality to insulin sensitivity are not completely understood, however, the effects of dietary fatty acids on insulin sensitivity are thought to be mediated, at least partially, through the fatty acid composition of cell membranes (Vessby *et al.*, 1994; Storlien et al., 1996; Vessby, 2000). A specific fatty acid profile in cell membranes could influence insulin action through several potential mechanisms, including altered insulin receptor binding or affinity, and by influencing ion permeability and cell signaling (Parillo and Riccardi, 2004).

The results of human studies consistently show that the fatty acid composition of body tissues (serum lipids, phospholipid in erythrocyte membranes, triacylglycerol in adipose tissue, phospholipid in skeletal muscle membranes) reflects, at least in part , the fat composition of the habitual diet (Riccardi et al., 2004). The fatty acid pattern mirrors the average composition of the diet during the preceding weeks (serum lipids, erythrocytes), months (possibly skeletal muscle) and even years (adipose tissue). The strength of the relationships between the proportion of a specific fatty acid in the diet and in body tissues varies greatly between different fatty acids and for different tissues (Aro, 2003)

Insulin resistance and insulin resistant states are associated with a plasma fatty acid pattern characterized by an increased proportion of palmitic acid and a low proportion of linoleic acid, with a distribution of other fatty acids that indicates an increased activity of Δ^9- Δ^6-desaturase. These changes are probably related, to a large extent, to the type of fat in the diet and are consistent with a diet where animal (saturated) fat consumption is increased and vegetable (unsaturated) fat consumption reduced (Vessby et al., 2001).

2.2.2.3.3 Lipoprotein abnormalities in type 2 diabetes

Although the levels of total cholesterol are similar in diabetic and non-diabetic subjects, disturbances in the subclasses of cholesterol are common in type 2 diabetes. Concentrations of HDL-cholesterol are reduced (Laakso *et al.*, 1993) and there is an increase in the proportion of small dense LDL particles, which may be particularly related to cardiovascular risk (Austin et al., 1995). These abnormalities may both be the consequence of impaired removal of non-esterified fatty acids from triacylglycerol-rich lipoproteins through subnormal activity of lipoprotein lipase, and resulting triacylglycerol enrichment of IDL and LDL (Feingold *et al.*, 1992). The role of reduced activity of lipoprotein lipase is also evident in the other major abnormality of lipoproteins in type 2 diabetes, i.e. hypertriaclglycerolaemia, in particular after a fatty meal (Tan *et al.*, 1995). All these lipid abnormalities are related to insulin resistance (Stewart *et al.*, 1993), are commoner in obese subjects and antedate the development of the diabetic state (Haffner., 1990).

2.2.2.3.4 Recommendation by the American Diabetes Association

Less than 10% of energy intake should be derived from saturated fats. Some individuals (persons with LDL cholesterol ≥100mg/dl) may benefit form lowering saturated fat intake to <7% of energy intake. Polyunsaturated fat intake should be approximately 10% of energy intake. Together, total fat intake should be <30% of total daily energy intake (American Diabetic Association, 2003). The effect of *trans*-unsaturated fatty acids (formed when vegetable oils are processed and made more solid through hydrogenation), is similar to saturated fats in raising plasma LDL cholesterol. In addition, *trans*-fatty acids lower plasma HDL cholesterol. Therefore, intake of *trans*-fatty acids should be limited.

2.2.2.4 Protein and type 2 diabetes

As for the general population, protein intake of 15-20% of total dietary energy intake is recommended for both diabetics and non-diabetics. However, in patients with type 2 diabetes, it has been demonstrated that moderate hyperglycemia can contribute to increased turnovers of protein, which suggests an increased need for protein. However, for most adults, protein intake is greater than 50% above recommended intake. As such, people with diabetes appear to be protected against protein malnutrition when consuming a usual diet. (American Diabetic Association, 2003). A number of studies in healthy subjects and in persons with controlled type 2 diabetes have demonstrated that glucose from ingested protein dose not appear in the general circulation, and therefore protein does not increase plasma glucose concentrations. Furthermore, the peak glucose response to carbohydrate alone is similar to that of carbohydrate and protein, suggesting that protein does not slow the absorption of carbohydrate. In persons with type 2 diabetes, ingested protein does not increase plasma glucose concentrations, although protein is just as potent a stimulant of insulin secretion as carbohydrate.

2.2.2.4.1 Recommendation by the American Diabetes Association

For persons with diabetes, there is no evidence to suggest that usual protein intake (15-20% of total daily energy) should be modified if renal function is normal (American Diabetes Association, 2003).

2.2.2.5 Alcohol intake and type 2 diabetes

Several studies have evaluated the relationship between alcohol intake and diabetes, they are consistent in showing that moderate alcohol consumption (one to two drinks per day) is associated with a 30-40% lower risk of type 2 diabetes compared with abstainers (Stampfer *et al.*, 1988; Perry *et al.*, 1995; Ajani *et al.*, 2000; Nakanishi *et al.*, 2003). Some studies while suggesting the beneficial effects of moderate alcohol consumption, highlights the possible dangers of high alcohol intake also in relation to diabetes prevention (Kao *et al.*, 2001). In particular, a U-shaped relationship between alcohol intake and incidence of diabetes, with the risk being the lowest in light and moderate drinkers and the highest in heavy drinkers (Wei *et al.*, 2000; Harding *et al.*, 2002; Wannamethee *et al.*, 2003; Nakanishi *et al.*, 2003). Overall, these studies show that a moderate alcohol intake may have a protective effect on the risk of diabetes independently of the type of beverage. The beneficial effects of moderate intake of alcohol on diabetes incidence could be explained by the enhanced insulin sensitivity found in moderate alcohol drinkers (Facchini *et al.*, 1994). The benefits from moderate alcohol consumption on diabetes incidence however, could also be mediated by dietary exposures and other aspects of lifestyle associated with moderate drinking.

2.2.2.6 Cigarette smoking and type 2 diabetes

Various studies have associated cigarette smoking with excess morbidity and mortality due to circulatory and cardiovascular disease among type 1 and 2 diabetics compared to non-diabetics (Walters *et al.*, 1994; Wei *et al.*, 1996; Sowers, 1998). Biesenbach and Zazgornik (1996) showed a significant reduction in survival rate of diabetic smokers on hemodialysis compared with non-smoking patients ($p < 0.05$). Other studies (Norden *et al.*, 1984; Muhlhauser, 1994; Biesenbach *et al.*, 1994) have shown that cigarette smoking may promote the development and progression of diabetic nephropathy and can increase the risk of diabetic neuropathy (Mitchell *et al.*, 1990). For non-diabetics, cigarette smoking can increase the risk of glucose intolerance through diminished insulin sensitivity (Franti *et al.*, 1996).

2.3 Barriers to dietary compliance

Various factors have been found to contribute to poor compliance to dietary recommendations given by health professionals. Notable among them are the following:

2.3.1 Poor clarity concerning quantities to be taken

Studies by Nthangeni *et al.* (2002) on dietary intake and barriers to dietary compliance in black type 2 diabetic patients attending primary health–care services observed the major barriers to dietary compliance to be related to foods allowed and patients understanding of portion-sizes. Patients were given conflicting advice with respect to the types of foods they were allowed to eat and they generally appeared to have little understanding of portion sizes. In general, patients experienced confusion regarding the quantity and types of foods they were told to eat. While some of them were asked to avoid maize meal (a staple food), white rice and white bread, others were asked to avoid all starchy foods. Also, while sugar was to be avoided, patients were to take a teaspoon of sugar when they developed symptoms of hypoglycemia (Personal communication).

2.3.2 Receiving dietary advice from many sources

According to a survey conducted at the Koforidua Regional Hospital, one of the disturbing phenomena, which the hospital is having, was that most of the patients after they have been advised on the effective management of the disease prefer to follow wrong instructions from people outside the clinic (www.ghanaweb.com). Apart from health-care staff, patients receive dietary advice from other sources including, relatives, other type 2 diabetic patients, traditional healers, Christian faith healers and herbalists (Nthangeni *et al*., 2002).

2.3.3 Dietary advice given by untrained personnel

Studies have shown that, at most health care centers, doctors and nurses counsel with respect to dietary treatment. Unfortunately, they have little training in nutrition and additionally, may have poor knowledge with respect to foods that are traditionally eaten. Consequently, the dietary advice given is frequently inconsistent, sometimes incorrect and often confusing to patients (Silvis, 1992).

2.3.4 Ignorance about their condition

Patients have been found to have a poor knowledge regarding their disease and treatment. Most of them know or acknowledge that type 2 diabetes is a chronic condition that can be cured. The belief that their condition is curable has led many patients to try alternative treatments, including raw chicken gall bladder, aloes (plant species), concoctions from herbalist, salt water, prayer water and others. Some also believe that the disease is the result of being bewitched (Nthangeni *et al*., 2002).

2.4 Physical activity

Physical activity is a major factor in the prevention and management of type 2 diabetes. It is associated with weight reduction, consequently reducing insulin resistance and improving insulin sensitivity.

The increased mechanical work of skeletal muscles involved in physical activity clearly requires more energy. During physical activity, therefore, there is increased substrate oxidation by working muscles. Several factors determine the nature of the fuel mix which is oxidized (Tappy *et al.*, 2003). It has been shown that, during an acute bout of exercise in untrained fed subjects carbohydrate oxidation supplies the major portion of the extra energy expended. In endurance-trained individuals, the oxidative capacity of muscle increase (Romiji *et al.*, 1993; Romiji *et al.,* 2000). In addition, there is an increases ability to oxidize lipids, due to up-regulation of the enzyme AMP-activated protein kinase in skeletal muscle (Winder and Hardie, 1999). The consequences are increased maximal oxygen consumption and a higher proportion of fat oxidized during exercise of low to moderate intensity. At high intensity, however, the reliance on carbohydrate increases (Romiji et al., 1993; Romiji *et al.,* 2000).

In healthy lean untrained individuals studied in a respiratory chamber, moderate physical activity increased total energy expenditure, essentially by increasing carbohydrate oxidization when the exercise took place after a meal. However, the same exercise performed in the fasting state before breakfast, led to a marked increase in lipid oxidation. Since the subjects, were fed the same isoenergetic diet under both conditions, it is hypothesized that exercise in the fasting state may preferentially promote lipid utilization and favorably affect body composition by decreasing fat stores (Schneiter *et al.*, 1995).

Evidence is accumulating that regular physical exercise may prevent subsequent diabetes. Some inactive urban communities have higher rates of type 2 diabetes than comparable rural communities (Zimmet *et al.*, 1981). Cross-sectional studies indicate a higher prevalence of type 2 diabetes in less-active than more-active subjects (Dowse *et al.*, 1991). Manson *et al.* (1991) carried out an 8-year follow-up of female nurses. Those engaging in vigorous exercise at least once a week had a reduced risk of diabetes, which persisted after adjustment of body weight, family history of diabetes and age. The nature of the relationship between exercise and diabetes incidence is believed to be a direct effect of exercise on insulin sensitivity or an indirect effect through weight reduction or prevention of weight gain.

2.5 Prevention/ management of type 2 diabetes

Recent intervention studies have shown that type 2 diabetes can be prevented by lifestyle changes aimed at body-weight reduction, increased physical activity and multiple changes in the composition of the diet.

Within this context, the average amount of weight loss needed is not large, about 5% initial weight, which is much less than the weight loss traditionally considered to be clinically significant for prevention of type 2 diabetes (American Diabetes Association. 2003).

Observational data from the Framingham Study on 618 overweight subjects showed the effects of weight loss on risk of diabetes. Sustained weight loss led to a 37% lower risk of diabetes (relative risk 0.63 (95% CI: 0.34, 1.20)) and this effect was stronger for more obese people (BMI >29; relative risk 0.38 (95% CI: 0.18, 0.81)). In particular, those who lost 3.7-4.5 kg had a 33% reduction in diabetes risk, whereas those losing more weight had a 51% reduction in risk (Moore et al., 2000). Intervention studies have show that in persons already affected by the disease, weight loss reduces fasting hyperglycemia because of the reduced postabsorptive rates of hepatic glucose production. Furthermore, weight loss improves insulin sensitivity in peripheral tissues and in particular, increases the capacity of non-oxidative glucose metabolism (Albu et al., 1997; Diabetes Prevention Program Research Group, 2002).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design and area

A cross-sectional study design was used in this study. Diabetic patients were identified from the National Diabetes Management and Research Center at the Korle-Bu Teaching Hospital. Non-diabetic subjects were identified from the Mt. Zion Methodist Church, Korle-Bu, Kaneshie Presbyterian Church, Kaneshie and some staff of the Korle-Bu Teaching Hospital, Korle-Bu.

3.2 Eligibility criteria

The eligibility criteria were persons, both male and female, who had been diagnosed and confirmed as type 2 diabetic patients (repeated fasting plasma glucose (FPG) $\geq$ 7.0 mmol/l) for at least a year before the study. Non-diabetic subjects were person's who were confirmed as such (FPG < 6.1 mmol/l). Written informed consent was sought from both groups.

3.3 Ethical issues

The study conformed to the Helsinki Declaration on Human Experimentation of 1975, revised in 1985 and 1989. In addition, the proposal was submitted to the University of Ghana Medical School Ethical and Protocol Review Committee for ethical approval and scientific review before the study was carried out.

The purpose of the study was explained to all study recruits. It was explained that participation was entirely voluntary and that refusal to participate would not affect or influence the subsequent care that they received. Also, that the subject had the right to withdraw his or her consent at any time after agreeing to take part in the study. The subjects were informed that they would have to spend time answering questions about themselves and that their height, weight, waist and hip circumference would be measured. It was further explained that venous blood sample would be taken and that this procedure would not entail any more risk than what the client would be exposed to for having an FPG test done at the hospital. Finally, the subjects were assured that personal information obtained would be kept in the strictest confidence and that in scientific reporting of the study he or she would not be identified by name. A consent form was signed or thumb printed by the subjects before their participation in the study.

3.4 Sample size

The desired margin of error in our estimation was 0.05. It was determined that using 267 subjects would ensure a 95% confidence interval with the margin of error equal to or less than our desired margin of error (Moore and McCabe, 1993). This was rounded up to 300 to increase precision. Hence, 150 diabetic subjects and non-diabetic subjects (n =150) were recruited.

3.5 Sampling technique and recruitment

On each day of visit, diabetic patients who had been diagnosed of the disease (FPG $\geq$ 7.0 mmol/l) for at least a year preceding the study, attending check-up at the selected hospital, who provided informed written consent were recruited by convenience sampling. Each subject was interviewed and measured only once. Repeated visits were paid to the study center until the number of subjects needed were recruited.

Non-diabetic subjects (FPG < 6.1 mmol/l) were subsequently recruited from the Korle-Bu community mainly from churches within Korle-Bu and its immediate environs. Persons in the church who were of similar age and sex as the diabetic subjects were invited to the National Diabetes Management and Research Center at the Korle-Bu Teaching Hospital for screening, interview and measurement. Each subject was interviewed and measured only once.

3.6 Data collection and analysis

All information was obtained from hospital records, and by the administration of a structured questionnaire. Respondents' anthropometry (height, weight, waist circumference and hip circumference) was also measured. Fasting plasma glucose for diabetic subjects was obtained from hospital records (patients' folders).

The same method used for determining FPG for diabetic subjects at the National Diabetic Management and Research Center was used for non-diabetic subjects. FPG was determined by the "GOD-PAP": enzymatic photometric test method as described by Trinder (1969). Smartlab Auto Analyzer equipment was used. This was performed by laboratory personnel at the Diabetes Research Laboratory, Department of Medicine, University of Ghana Medical School. Systolic blood pressure, diastolic blood pressure and pulse were also measured for both groups using the Digital Blood Pressure Monitor, Model No: Hem-907XL by Omron Health Care Inc. The point of contact was the National Diabetes Management and Research Center at the Korle-Bu Teaching Hospital for both diabetic and non-diabetic subjects.

Normal fasting plasma glucose was defined as FPG ≤6.0 mmol/l. Impaired Fasting Glucose (IFG) was defined as FPG ≥ 6.1 mmol/l and < 7 mmol/l. Diabetes was defined as FPG ≥7 mmol/l (WHO, 1999). Hypertension was defined as systolic and diastolic blood pressure ≥140/ 90 mmHg (WHO/ISH, 1999).

3.6.1 Primary Objective

To compare the habitual diets of diabetic subjects with non-diabetic subjects and to evaluate whether recommendations are being followed.

Dietary intake information was obtained by the administration of a Food Frequency Questionnaire and 24-hour dietary recall. The aim of the Food Frequency Questionnaire was to give information of long-term dietary habits. Subjects reported the average frequency of consumption of foods from a given list during the past week. From their report, the foods were grouped into "most frequently consumed" and "less frequently consumed".

The actual amounts of foods consumed were determined by the use of 24-hour dietary recall. Subjects were required to recall and estimate, using handy measures (e.g. cups, kitchen spoons and plates) all foods consumed within the last 24 hours immediately preceding the day of interview. The weights of all foods consumed was then determined using the Food Weights/ Handy Measures Tables of the Dietetic Group of The Dreyfus Health Foundation, Ghana. ESHA Food Processor (ver 6.02) as well as nutrient composition tables of the Food Research Institute of Ghana (Eyeson and Ankrah, 1975) was used to convert dietary intake into nutrients (carbohydrate, fat and protein), energy as well as dietary fiber intake. WHO/ FAO/UNU, 2003; FAO/ WHO, 1998; FAO/ WHO 1994; Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol protein and amino acids, 2002 (appendix 6) were used as reference data.

Statistical Package for Social Sciences (SPSS- ver 11.0) was used to analyze the data. Variations in nutrient intake between and within groups were determined using independent sample t-test.

3.6.2 Secondary objective 1

To assess the nutritional status of diabetic subjects compared with non-diabetic subjects using BMI, WHR and waist circumference.

Nutritional status was assessed using Body Mass Index (BMI), Waist-to-Hip Ratios (WHR) and waist circumference. These were calculated for all diabetic and non-diabetic subjects. Weight was measured with an electronic Seca scale to the nearest 0.1kg. Subjects stood barefooted on the platform of the scale in minimum clothing. Readings were taken with subjects standing upright with feet close together and knees and back straightened.

BMI was calculated as weight (kg)/ ht (m^2). WHO (1995) was used as reference data (appendix 4).

The relative distribution of fat among different locations of the body was evaluated by measuring waist and hip circumferences and calculating the waist to hip circumference ratio (WHR). With the use of a flexible indistensible steel tape measure, waist and hip circumferences was measured to the nearest 0.1cm.

Waist circumference (WC) was measured by encircling the body horizontally at the visible waist or at the narrowest part of the torso when viewed from the front. Hip circumference (HC) was also measured in a similar way, but at the level of maximal circumference in the hip region, including the buttocks. WHR was calculated as waist circumference (WC) (cm) / height circumference (HC) (cm). WHO (1999) was used as reference data (appendix 4).

Descriptive statistics (means, standard deviation, ranges) were used to analyze the continuous variables. Variances between means were determined using independent sample t-test.

3.6.3 Secondary objective 2

Determine the correlation between dietary intake and nutritional status of diabetic subjects compared with non-diabetic subjects.

From the determination of dietary intake under primary objective and the calculations of BMI and WHR under specific objective 1, multiple regression techniques were used to investigate the correlations between dietary intake and each of BMI and WHR in both diabetic and non-diabetic subjects.

3.6.4 Secondary objective 3

To identify potential risk factors for type 2 diabetes.

Background information as well as the variables obtained under the primary objective and specific objectives 1 and 2 were input in a logistic regression analysis model to identify potential risk factors of type 2 diabetes in the population.

3.7 Quality control measures

- The questionnaire used in obtaining information from subjects was pre-tested to ensure its clarity and adequacy.
- Equipment for all anthropometric measurements were regularly calibrated to ensure their optimum function.

CHAPTER FOUR

4.0 RESULTS

One hundred and fifty one (151) confirmed type II diabetic patients (75 males and 76 females) who had been diagnosed with type 2 diabetes for at least one year were recruited. A group of apparent non-diabetic individuals (n=170) who consented to be part of the study were invited from The Mt. Zion Methodist Church Korle-Bu, Kaneshie Presbyterian Church and some staff of the Korle-Bu Teaching Hospital to be screened at the National Diabetes Management and Research Center, Korle-Bu. Attempt was made to match for age and sex. After carrying out the fasting plasma glucose test on this group however, 23 individuals (6 males and 17 females) were found to have Impaired Fasting Glucose (IFG) (FPG $\geq$ 6.1 mmol/l and < 7 mmol/l). Seven others were also found to be diabetic (FPG $\geq$7 mmol/l). These included males (n=2) and females (n=5).These two groups were excluded from the study. This report is therefore based on 140 true non-diabetic subjects comprising 68 males and 72 females.

4.1 Background characteristics of subjects

Table 1a: Age profile and diabetes duration of subjects

Subject groups	n	Age (years) (Mean ± SD)	Range	Diabetes duration (years) (Mean ± SD)	Range
All Diabetic subjects (D+)	151	54.8 ± 10.9*	29 - 82	6.1 ± 5.3	1 - 30
Male D+	75	55.4 ± 11.5	33 - 82	5.9 ± 5.0	1 - 22
Female D +	76	54.1 ± 10.4	29 - 78	6.3 ± 5.7	1 - 30
All Non-diabetic subjects (D-)	140	51.1 ± 12.5*	29 - 87	NA	NA
Male D-	68	49.9 ± 13.0	30 - 75	NA	NA
Female D-	72	52.2 ± 11.9	29 - 87	NA	NA

*; p = 0.01 (Statistically significant at p<0.05); Independent sample t-test.
NA-Not applicable

From Table 1a, the mean age of all diabetic subjects recruited was significantly higher ($p = 0.01$) than non-diabetics. Although the mean number of years since diagnosis for all diabetic subjects was 6.1 ± 5.3, over 50% of the diabetic patients recruited had developed diabetes within the five years immediately preceding this research (appendix 3). This was especially so among females than males.

Table 1b: Background characteristics of subjects (Frequency and percentage).

Variable	All D+ (n=151)	All D- (n=140)
Marital status		
Single	22 (14.6)	30 (21.4)
Married	103 (68.2)	88 (62.9)
Divorced	7 (4.6)	14 (10.0)
Widowed	19 (12.6)	8 (5.7)
Religion		
Christian	133 (88.1)	138 (98.6)
Moslem	16 (10.6)	1 (0.7)
Traditional	2 (1.3)	1 (0.7
Parity*		
None	10 (6.6)	23 (16.4)
1-3	45 (29.8)	62 (44.3)
4-6	53 (35.1)	49 (35.0)
6+	43 (28.5)	6 (4.3)

*: Differences between diabetic and non-diabetic subjects were statistically significant ($p<0.01$): Pearson's chi square

Over 50% of diabetic and non-diabetic subjects were married. The most dominant religion among both groups was Christianity. Parity was also significantly higher among the diabetic population than non-diabetic population ($p < 0.01$). The majority of diabetic subjects had at least four children while the majority of non-diabetics had at most three children (Table 1b).

4.2 Socio economic characteristics of subjects

The educational level of diabetic subjects was significantly lower than that of non-diabetic subjects ($p < 0.01$). The majority of the former had no formal education at all or at most, primary education compared to the latter. Secondary and tertiary education was common among non-diabetic subjects than diabetic subjects (Table 2). Among the diabetic subjects, a significant number of men were educated compared to women ($p < 0.01$). The difference among non-diabetics was not statistically significant.

Table 2: Socio-economic characteristics of subjects (Frequency and percentage).

Variable	Diabetic subjects (D^+)			Non- diabetic subjects (D^-)		
	Male n =75	Female n =76	All n= 151	Male n= 68	Female n= 72	All n=140
Education level*						
None / Primary	16 (21.6)	46 (59.7)	62 (41.1)	12 (17.6)	24 (33.3)	36 (25.7)
Secondary	34 (44.6)	21 (28.6)	55 (36.4)	36 (52.9)	31 (43.1)	67 (47.9)
Tertiary	19 (25.7)	3 (3.9)	22 (14.6)	18 (26.5)	15 (20.8)	33 (23.6)
Others[1]	6 (8.1)	6 (7.8)	12 (7.9)	2 (2.9)	2 (2.8)	4 (2.9)
Employment*[1]						
Unemployed	2 (2.7)	32 (42.1)	34 (22.5)	3 (4.4)	7 (9.7)	10 (7.1)
Employed	51 (68.0)	37 (48.7)	88 (58.3)	57 (83.8)	54 (75.0)	111 (79.3)
Pensioner	22 (29.3)	7 (9.2)	29 (19.2)	8 (11.8)	11 (15.3)	19 (13.6)
Occupation						
Trader	10 (13.5)	28 (36.4)	38 (25.2)	3 (4.4)	23 (31.9)	26 (18.6)
Teacher	4 (5.4)	3 (3.9	7 (4.6)	6 (8.8)	1 (1.4)	7 (5.0)
Artisan	31 (40.8)	6 (9.1)	37 (24.5)	22 (32.4)	17 (23.6)	39 (27.9)
Office work	11 (14.9)	-	11 (7.3)	12 (17.6)	10 (13.9)	22 (15.7)
Others[2]	-	-	-	14 (20.6)	4 (5.6)	18 (12.8)
Income (¢)						
<500,000	10 (13.5)	24 (31.2)	34 (22.5)	4 (5.9)	19 (26.4)	23 (16.4)
500,000-999,999	11 (14.9)	6 (7.8)	17 (11.3)	19 (27.9)	5 (6.9)	24 (17.1)
1,000,000- 2,000,000	19 (24.7)	2 (3.3)	21 (13.9)	21 (30.9)	8 (11.1)	29 (20.7)
2,000,000+	13 (17.6)	2 (3.3)	15 (9.9)	10 (14.7)	7 (9.7)	17 (12.1)

*: Differences between diabetic and non-diabetic subjects were statistically significant ($p < 0.01$)
*[1]: Differences between male and female diabetic subjects were statistically significant ($p < 0.01$) Significant at $p < 0.05$: Pearson's chi square

1: Vocational / commercial school leaver
2: Nurses, laboratory technicians, Security service

Similar trends were observed in employment status between sex groups ($p < 0.01$). Men were more likely to be employed than women in both groups. The difference was statistically significant among diabetics ($p < 0.01$). In addition, a high percentage of diabetic subjects was either unemployed or on pension compared to non diabetic subjects. The major occupation among both groups was trading.

The income levels of diabetic subjects were generally lower compared to non-diabetics. While more of the former earned less than ¢500,000.00 monthly, more of the latter earned between ¢1,000,000.00 and ¢2,000,000.00 monthly. The difference between groups was however not statistically significant. In general, for both groups, males earned more income monthly than females ($p< 0.001$) (Table 2).

4.3 Lifestyle characteristics of subjects

Smoking was not very prevalent among both groups. All females, both diabetic and non-diabetic, had never smoked. Some male diabetic subjects had stopped smoking while a few (2.7%) were current smokers (Table 3a).

Although the majority of diabetic subjects were teetotalers, a few were habitual drinkers. However, some diabetic subjects had stopped drinking after diagnosis. Among non-diabetic subjects, the majority were occasional and habitual drinkers, while some of them had stopped drinking on their own accord. Alcohol intake habits differed significantly between the two groups in favour of non-diabetic subjects.

Table 3a: Smoking and alcohol intake habits of subjects (Frequency and percentage)

Variable	Diabetic subjects (D+)			Non- diabetic subjects (D-)		
	Male n =75	Female n =76	All n= 151	Male n= 68	Female n= 72	All n=140
Smoking status						
Never smoked	52 (69.3)	76 (100.0)	128 (84.8)	59 (86.8)	72 (100.0)	131 (93.6)
Stopped smoked	21 (28.0)	-	21 (13.9)	8 (11.8)	-	8 (5.7)
Current smoker	2 (2.7)	-	2 (1.3)	1 (1.5)	-	1 (0.7)
Alcohol status*						
Teetotaler	25 (33.8)	7 (61.0)	72 (47.7)	16 (23.5)	28 (38.9)	44 (31.4)
Occasional drinker	22 (29.7)	16 (20.8)	38 (25.2)	41 (60.3)	37 (51.4)	78 (55.7)
Habitual drinker	2 (2.7)	-	2 (1.3)	5 (7.4)	-	5 (3.6)
Stopped drinking	26 (33.8)	13 (18.2)	39 (25.8)	6 (8.8)	7 (9.7)	13 (9.3)

* $p < 0.01$ (Significant at $p < 0.05$): Pearson's chi square

Table 3b: Physical activity profile of subjects (Frequency and percentage).

Variable	Diabetic subjects (D+)			Non- diabetic subjects (D-)		
	Male n =75	Female n =76	All n= 151	Male n= 68	Female n= 72	All n=140
Sitting in a typical day						
Never	-	-	-	-	-	-
Rarely	16 (21.6)	16 (21.1)	32 (21.2)	18 (26.5)	5 (6.9)	23 (16.4)
Sometimes	26 (33.8)	19 (25.0	45 (29.8)	23 (33.8)	25 (34.7)	48 (34.3)
Most times	33 (44.6)	41 (53.9)	74 (49.0)	27 (39.7)	42 (58.3)	69 (49.3)
Walking in a typical day*						
Never	-	-	-	-	-	-
Rarely	18 (24.3)	17 (22.1)	35 (23.2)	8 (11.8)	10 (13.9)	18 (12.9)
Sometimes	29 (38.7)	38 (50.6)	67 (44.4)	22 (32.4)	27 (37.5)	49 (35.0)
Most times	28 (37.3)	21 (27.3)	49 (32.5)	38 (55.9)	35 (48.6)	73 (52.1)
Strenuous Physical Activity in a typical day						
Never	8 (10.7)	15 (19.5)	23 (15.2)	6 (8.8)	19 (26.4)	25 (17.9)
Rarely	34 (45.3)	43 (57.1)	77 (51.0)	31 (45.6)	33 (45.8)	64 (45.7)
Sometimes	17 (22.7)	9 (11.7)	26 (17.2)	22 (32.4)	13 (18.1)	35 (25.0)
Most times	16 (21.3)	9 (11.7)	25 (16.6)	9 (13.2)	7 (9.7)	16 (11.4)

* $p < 0.01$ (Significant at $p < 0.05$): Pearson's chi square

Lifestyle in terms of physical activity did not differ much for both groups. The number of diabetics whose activities in a typical day involved mostly sitting did not differ significantly from that of non-diabetics. A similar observation was made in terms of strenuous physical activity such as jogging. However, a significant number of non-diabetics, in a typical day, did a lot of walking compared to diabetics ($p < 0.01$) (Table 3b).

From Table 3c, while the majority of diabetic subjects had received some form of dietetic advice this was the case for only few non-diabetic subjects. Among the diabetic population, the major source of advice was qualified dieticians at the hospital. In contrast, the media and church counselors were the major source of dietetic advice among non-diabetics.

Table 3c: Profile of subjects who had received dietetic advice (Frequency and percentage).

Variable	Diabetic subjects (D+)			Non- diabetic subjects (D-)		
	Male n =75	Female n =76	All n= 151	Male n= 68	Female n= 72	All n=140
Ever received dietetic advice						
Yes	71(94.7)	68 (89.5)	139 (92.1)	12 (17.6)	25 (34.7)	37 (26.4)
No	4 (5.3)	8 (10.5)	12 (7.9)	56 (82.4)	47 (65.3)	103 (73.6)
Source of advice						
Dietician	58 (77.3)	52 (67.5)	110 (72.8)	5 (7.4)	5 (6.9)	10 (7.1)
Physician	5 (6.7)	6 (7.8)	11 (7.3)	2 (2.9)	5 (6.9)	7 (5.0)
Nurse	4 (5.3)	6 (7.8)	10 (6.6)	1 (1.5)	2 (2.8)	3 (2.1)
All three	3 (4.0)	2 (3.3)	5 (3.3)	-	-	-
Others[1]	1 (1.3)	2 (3.3)	3 (2.0)	4 (5.9)	13 (18.1)	17 (12.1)

[1]: Media and church counselors

Table 4a: Anthropometric profile of subjects (Means, standard deviations and ranges).

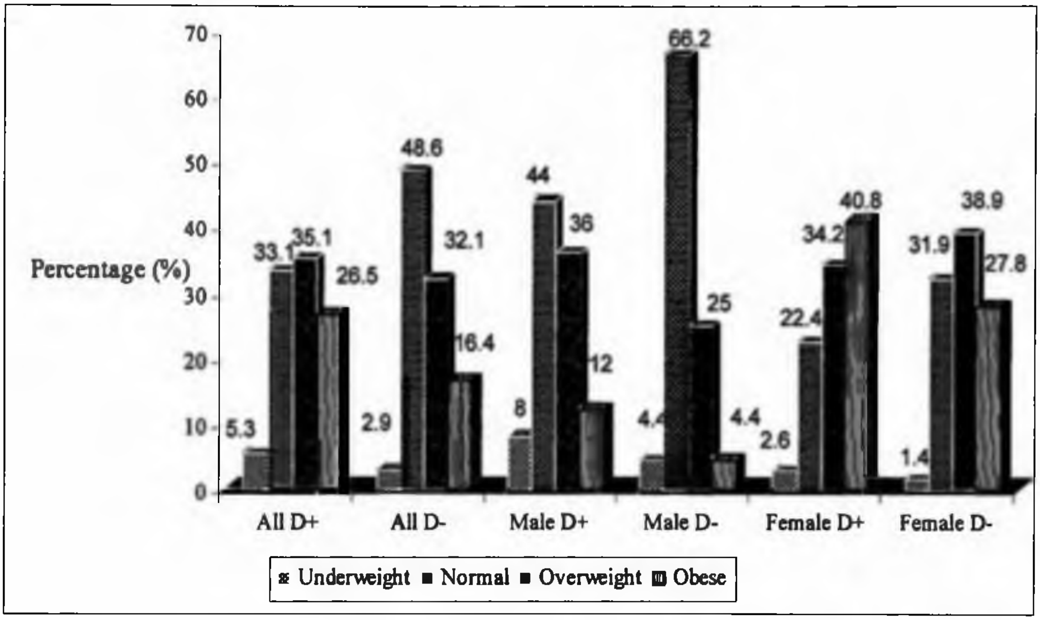
Variable	Diabetic subjects (D^+)			Non- diabetic subjects (D^-)		
	Male (n =75)	Female (n =76)	All (n= 151)	Male (n= 68)	Female (n= 72)	All (n=140)
Height (cm)	172.1 ± 14.6 (168.0 – 189.1)	163.1 ± 7.1 (148.5 – 177.5)	168.2 ± 9.2 (148.5 - 189.1)	170.6 ± 6.7 (154.5 – 183.8)	160.9 ± 7.2 (143.1 – 179.2)	165.6 ± 8.5 (143.1 -183.8)
Weight (kg)	75.6 ± 13.0 (46.0 – 114.0)	74.7 ± 14.9 (43.0 – 124.2)	75.6 ± 14.5^a (43.0 - 124.2)	69.5 ± 13.6 (49.1 – 141.7)	70.8 ± 15.0 (40.2 – 108.3)	70.2 ± 14.3^b (40.2 – 141.7)
BMI (kg/m^2)	25.4 ± 5.0 (15.5 – 38.8)	28.1 ± 5.2 (16.4 - 44.9)	26.8 ± 5.2^a (15.5 – 44.9)	26.6 ± 22.9 (16.5 – 42.5)	27.2 ± 4.8 (16.8 – 42.2)	25.6 ± 4.7^b (16.5 – 42.5)
Waist Circumference (cm)	94.7 ± 10.4 (73.0 – 119.0)	98.2 ± 12.2 (67.5 – 130.2)	96.6 ± 11.7^a (67.5 - 130.2)	86.3 ± 10.1 (68.0 – 121.3)	89.6 ± 11.8 (69.0 – 119.5)	88.0 ± 11.1^b (68.0 – 121.3)
Hip Circumference (cm)	101.7 ± 13.4 (83.0 – 124.0)	106.3 ± 11.9 (69.7 – 135.5)	103.8 ± 10.8 (69.7-135.5)	97.0 ± 7.7 (82.5 – 123.0)	105.7 ± 10.1 (86.1 – 128.0)	101.5 ± 10.0 (82.5 – 128.0)
Waist to Hip Ratio	0.93 ± 0.07 (0.60 – 1.10)	0.93 ± 0.09 (0.8 – 1.4)	0.93 ± 0.08^a (0.6 - 1.4)	0.89 ± 0.06 (0.7 – 1.0)	0.85 ± 0.06 (0.7 – 1.1)	0.87 ± 0.07^b (0.7 – 1.1)

Mean values with different superscripts in the same row are significantly different ($p < 0.05$); Independent sample t-test.

4.4 Anthropometry and medical profile of subjects

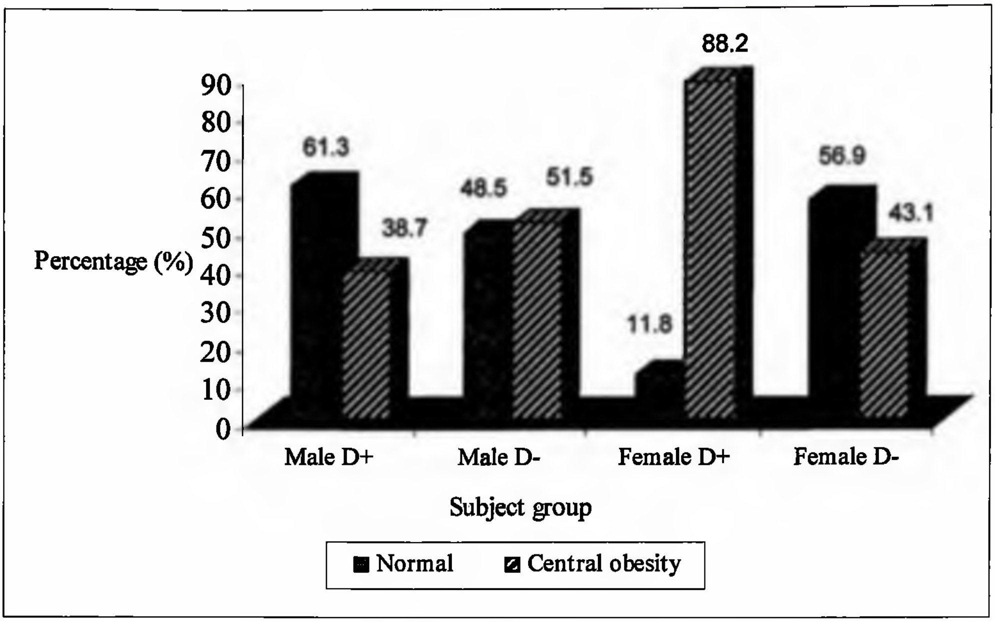
From Table 4a and Fig 1, most non-diabetic subjects (48.6%) had normal BMI compared to diabetic subjects (33.1%). The highest prevalence of obesity was among female diabetic subjects (40.8%). The majority of non-diabetic male subjects (66.2%) had normal BMI compared with (31.9%) of non-diabetic females. A similar observation was made among diabetic males (44.0%) compared to 22.4% among diabetic females.

Fig 1: Classification of subjects by BMI



(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

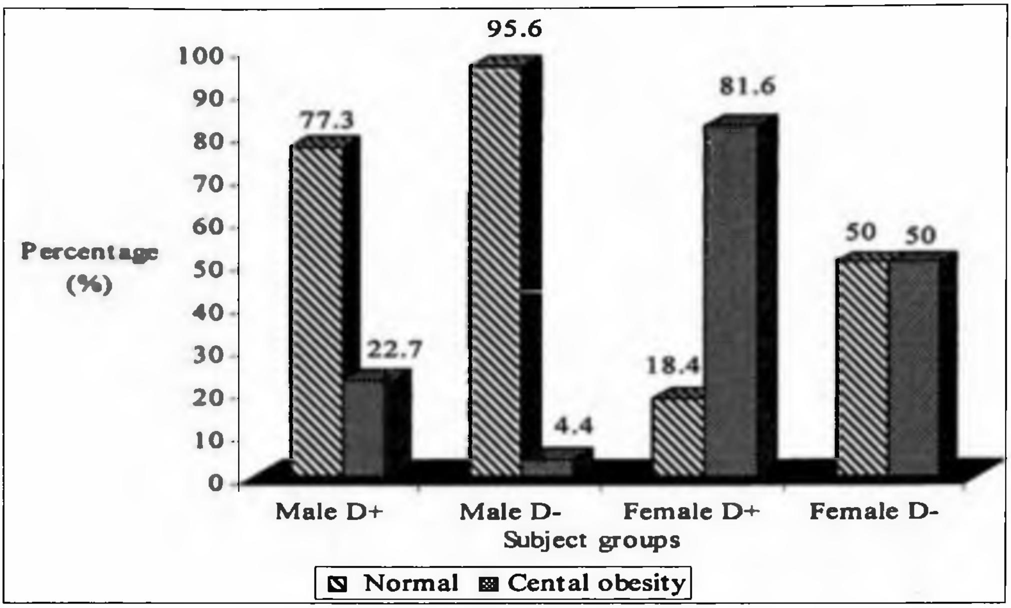
Fig 2: Classification of subjects by WHR



(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

From Fig 2, the majority of non-diabetic males (51.5%) had central obesity compared to diabetic males (38.7%). Diabetic females however, recorded the highest rate (88.2%) of central obesity compared to non-diabetic females (43.1%). The difference in WHR between diabetics and non-diabetics was statistically significant ($p < 0.01$).

Fig 3: Classification of subjects by waist circumference



(NB; D+: Diabetic subjects, D- : Non-diabetic subjects)

Based on waist circumference classification, 18.4% of diabetic female subjects had normal waist circumference while 81.6% were obese in the central part of their body. This compares with 50% each of normal and central obesity among the non-diabetic female subjects. For the male diabetic subjects, 77.3% had normal waist circumference while 22.7% were obese. Among their counterpart male non-diabetic subjects, 95.6% had normal waist circumference while 4.4% were obese in the central part of their bodies (Fig 3).

Table 4b: Medical profile of subjects (Means, standard deviations and ranges).

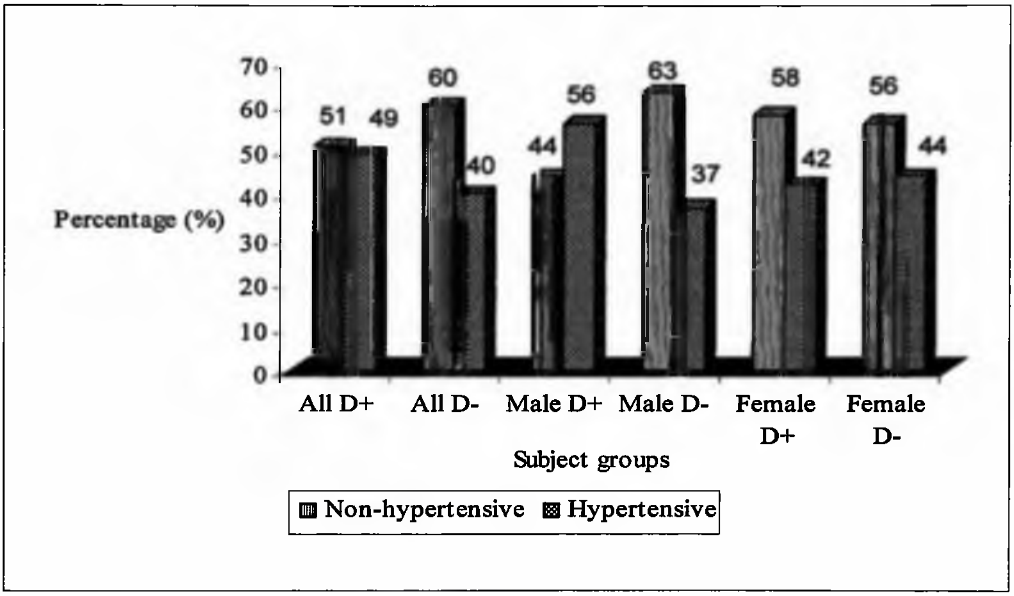
Variable	Diabetic subjects (D^+)			Non- diabetic subjects (D^-)		
	Male n =75	**Female n =76**	**All n= 151**	**Male n= 68**	**Female n= 72**	**All n=140**
Fasting Plasma Glucose (mmol/l)	9.4 ± 4.1 (4.0 – 20.0)	10.3 ± 5.3 (4.1 – 32.1)	9.9 ± 4.8 [a] (4.1 - 32.1)	5.1 ± 0.5 (4.2 – 6.0)	5.1 ± 0.4 (4.0 – 6.0)	5.1 ± 0.4 [b] (4.0 – 6.0)
Systolic Blood Pressure (mmHg)	146.4 ± 26.5 (96 – 210)	137.8 ± 25.3 (82 – 237)	142.2 ± 26.1 (82 – 237)	134 ± 22.2 (96 – 232)	138.5 ± 26.4 (87 – 211)	136.6 ± 24.4 (87 – 232)
Diastolic Blood Pressure (mmHg)	84.6 ± 14.7 (52 – 127)	82.9 ± 13.0 (53 – 130)	83.9 ± 13.8 (52 – 130)	82.9 ± 14.2 (51 – 135)	87.0 ± 14.9 (55 – 136)	85 ± 14.7 (51 – 136)
Pulse	78.2 ± 12.8 (58 – 110)	84.7 ±12.2 (61 – 127)	81.5 ± 12.9 [a] (58 - 127)	71.8 ± 11.0 (46 – 101)	75.7 ± 10.8 (47 – 104)	73.8 ± 11.0 [b] (46 – 104)

Mean values with different superscripts in the same row are significantly different ($p < 0.05$); Independent sample t-test

From Table 4b, there was no significant difference ($p = 0.15$) in fasting plasma glucose between male and female diabetic subjects. Among the non-diabetic subjects, mean FPG was comparable in both sexes.

Though the systolic blood pressure tended to be higher in the diabetic compared to the non-diabetic group, this did not attain statistical significance ($p = 0.06$). Diastolic blood pressure was comparable among both groups.

Fig 4: Hypertension status of subjects



(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

Comparable proportions (51%) and (49%) of diabetic subjects were non-hypertensive and hypertensive respectively. Among non-diabetics, 60% were non-hypertensive while 40% were hypertensive.

Table 5: Macronutrient, energy and dietary fiber intake profile of subjects (Mean, standard deviation and ranges).

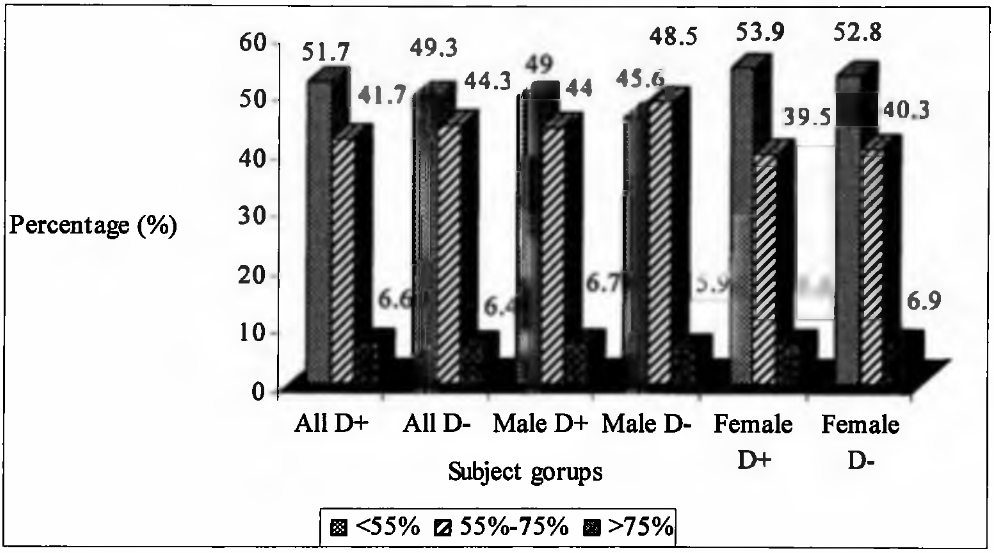
Variable	Diabetic subjects (D^+)			Non- diabetic subjects (D^-)		
	Male n =75	**Female** n =76	**All** n= 151	**Male** n= 68	**Female** n= 72	**All** n=140
*Energy (Cal)	1744.8 ± 753.3 (305.0 – 3940.0)	1454.6 ± 510.9 (435.0 – 3341.0)	1598.7 ± 657.0 (305.0 – 3940.0)	1794.4 ± 508.8 (677.0 – 3006.0)	1428.8 ± 544.1 (425.0 – 2943.0)	1606.4 ± 556.5 (425.0 – 3006.0)
*Carbohydrate (g)	241.8 ± 114.1 (36.3 – 625.0)	195.9 ± 82.4 (57.0 – 684.0))	219.9 ± 107.8 (36.3 – 684.0)	286.2 ± 75.9 (90.3 – 508.0)	193.5 ± 79.2 (82.6 – 431.0)	219.1 ± 81.7 (82.6 – 508.0)
*Fat (g)	57.0 ± 40.0 (2.0 – 172.0)	50.4 ± 36.5 (3.5 – 147.0)	53.6 ± 38.3 (2.0 – 172.0)	55.1 ± 32.6 (6.1 – 125.0)	48.4 ± 33.2 (2.8 – (133.0)	51.6 ± 33.0 (2.8 – 133.0)
*Protein (g)	68.8 ± 35.3 (17.3 – 192.0)	57.5 ± 26.8 (18.4 – 124.0)	63.1 ± 31.7 (17.3 – 192.0)	75.7 ± 39.5 (19.8 – 188.0)	55.5 ± 29.1 (4.8 – 180.0)	65.4 ± 35.8 (4.8 – 188.0)
*Dietary Fiber (g)	20.3 ± 12.9 (2.0 – 64.6)	18.0 ± 9.1 (1.3 – 56.7)	19.2 ± 11.2 (1.3 – 64.6)	19.6 ± 10.2 (1.6 – 125.0)	14.5 ± 9.8 (0.6 – 57.9)	17.0 ± 10.3 (0.6 – 57.9)

*: No statistically significant difference between diabetic and non-diabetic subjects; Independent sample t-test.

4.5 Nutrient intake profile of subjects

From Table 5, the mean energy intakes among diabetic and non-diabetic subjects were comparable. Carbohydrate, total fat and dietary fiber intakes were higher among diabetics compared to non-diabetics though not statistically significant. Energy and protein intakes were however higher among non-diabetics compared to diabetics. Males generally had higher intakes of all nutrients compared to their female counterparts in both groups. There were no statistical differences between subject with and without diabetes with respect to energy, carbohydrate, fat, protein and dietary fiber intake.

Fig 5: Contribution of carbohydrate to the total energy intake of subjects



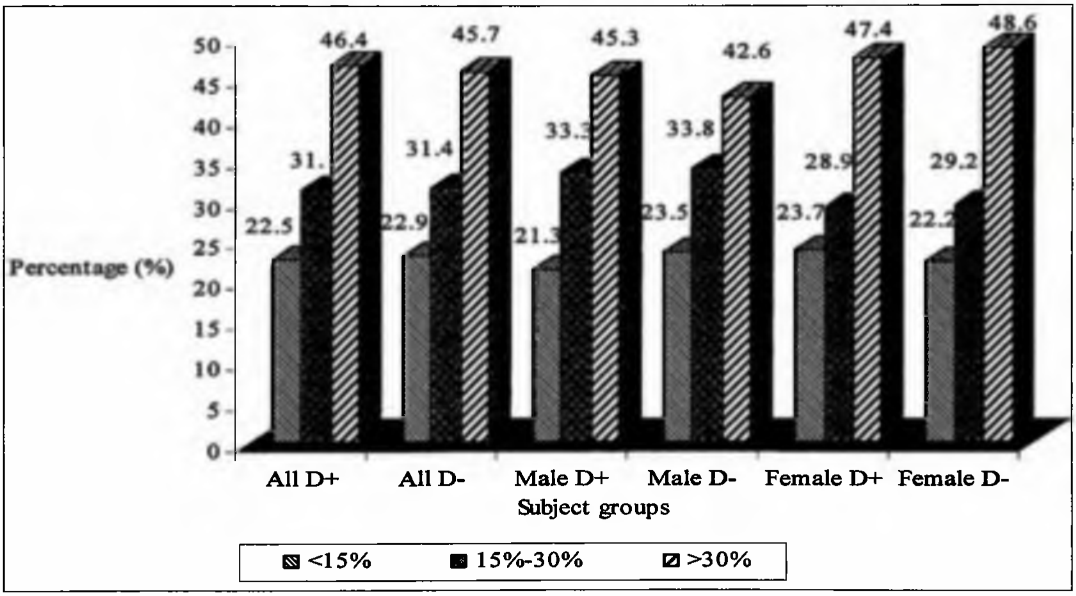
(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

For the majority of diabetic subjects (51.7% and 41.7) and non-diabetics (49.3% and 44.3%), carbohydrate contribution to total energy intake was <55 or between 55% and

75% respectively. This was true for both sexes. For a small percentage of diabetic (6.6%) and non-diabetic subjects (6.4%) however, the contribution of carbohydrate to total calorie intake exceeded 75% (Fig 5).

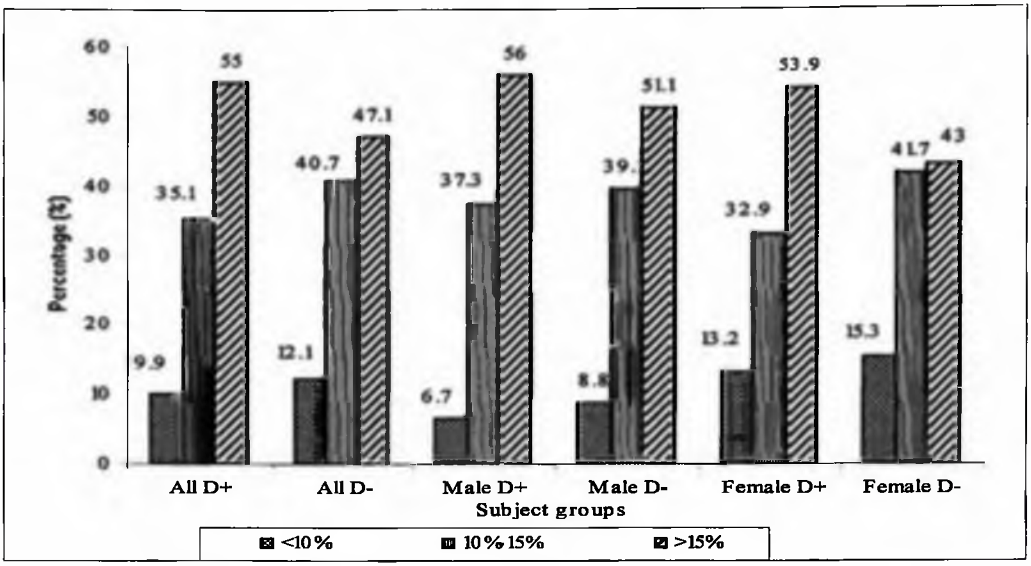
From Fig 6, total fat contribution to total energy intake was high among both diabetics and non-diabetics. Only 22.5% and 31.1% of the former and 22.9% and 31.4% of the latter had total fat contributing <15% and between 15-30% respectively to total energy intake. Comparable percentages of diabetic subjects (46.4%) and non-diabetics (45.7%) had total fat contributing more than 30% of total energy intake.

Fig 6: Contribution of total fat intake to the total energy intake of subjects



(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

Fig 7: Contribution of protein to the total energy intake of subjects



(NB: D+: Diabetic subjects, D- : Non-diabetic subjects)

From Fig 7, a small fraction of both diabetic subjects (9.9%) and non-diabetic subjects (12.1%) had protein contributing less than 10% of total energy intake. The majority of the former (55%) compared with the latter (47.1%) had protein contributing more than 15% of total energy intake. This was prominent among males, both diabetic (56%) and non-diabetic (51.5%).

Table 6: Proportion of subjects (%) meeting at least 80% of RDA

Nutrient			Diabetic subjects			Non-diabetic subjects		
Carbohydrate								
	Male		5.3[a]	8.0[b]	86.7[c]	1.5[a]	2.9[b]	95.6[c]
	Female		6.6[a]	9.2[b]	84.2[c]	11.1[a]	18.1[b]	70.8[c]
	All		5.7[a]	8.6[b]	85.4	6.4[a]	10.7[b]	82.9[c]
Protein								
	Male		28.0[a]	18.7[b]	53.3[c]	22.0[a]	16.2[b]	61.8[c]
	Female		22.4[a]	17.1[b]	60.5[c]	26.4[a]	13.9[b]	59.7[c]
	All		25.1[a]	17.9[b]	57.0[c]	24.3[a]	15.0[b]	60.7[c]
Total fat			ND			ND		
Energy								
	Male	25y-50y	92.0[a]	8.0[b]	0.0[c]	81.6[a]	15.8[b]	2.6[c]
		50^{+}	78.0[a]	6.0[b]	16.0[c]	60.0[a]	30.0[b]	10.0[c]
	Female	25y-50y	60.0[a]	12.0[b]	28.0[c]	64.5[a]	22.6[b]	12.9[c]
		50^{+}	45.0[a]	27.5[b]	27.5[c]	73.2[a]	14.6[b]	12.2[c]
	All		66.2[a]	14.6[b]	19.2[c]	70.7[a]	20.0[b]	9.3[c]
Dietary fiber								
	Male	25y-50y	84.0[a]	12.0[b]	4.0[c]	81.6[a]	10.5[b]	7.9[c]
		50^{+}	70.0[a]	8.0[b]	22.0[c]	72.9[a]	13.6[b]	13.6[c]
	Female	25y-50y	64.0[a]	20.0[b]	16.0[c]	67.7[a]	9.7[b]	22.6[c]
		50^{+}	47.1[a]	17.6[b]	35.3[c]	75.6[a]	12.2[b]	12.2[c]
	All		63.6[a]	13.9[b]	22.5[c]	72.9[a]	13.6[b]	13.6[c]

[a]: Met below 80% of the RDA b: Met at least 80% of the RDA [c]: Exceeded the RDA
ND: Not determined

Table 6 shows the proportions of diabetics and non-diabetics who met at least 80% of recommended daily allowance (RDA). Only a few from each group could not meet at least 80% of the RDA for carbohydrate. The majority of members from both groups exceeded the RDA for carbohydrate especially among diabetics compared to non-diabetics. Intakes of protein, energy and dietary fiber were not as high compared to carbohydrate. A higher proportion of members from both groups did not meet at least 80% of the RDA's for these nutrients and energy and dietary fiber.

Tables 7 and 8 show the correlations between nutrient intake, nutritional status, anthropometry and clinical profile of all diabetic and non-diabetic subjects respectively. Working at a confidence interval of 95% there was no correlation between dietary intake (energy, carbohydrate, total fat, protein and dietary fiber) with nutritional status (BMI, WHR and waist circumference) in both groups.

Among diabetic subjects however, there was a significant correlation between protein intake and age ($r = -0.18$, $p = 0.03$). In the same group, BMI correlated with diastolic blood pressure ($r = 0.16$; $p = 0.05$) while WHR correlated with weight ($r = 0.17$; $p = 0.04$). Other correlations were between height and diastolic blood pressure ($r = -0.18$; $p = 0.03$) as well as height and pulse ($r = -0.18$; $p = 0.03$) (Table 7).

Among non-diabetic subjects, carbohydrate intake correlated positively with weight ($r = 0.19$; $p = 0.03$) and pulse ($r = -0.20$; $p = 0.02$). Total fat also correlated with age ($r = -0.18$; $p = 0.04$). Significant positive correlations also occurred between fasting plasma glucose and waist circumference ($r = 0.22$; $p = 0.01$). BMI correlated with diastolic blood pressure ($r = 0.21$; $p = 0.01$) and pulse ($r = 0.19$; $p = 0.02$) while WHR correlated with age ($r = 0.21$; $p = 0.01$). All correlations were weak but statistically significant.

Table 7: Correlation coefficients of nutrient intake, anthropometry and clinical profile of all diabetic subjects.

	SBP	DBP	PL	HT	WT	BMI	WC	HC	WHR	CHO	FAT	PRT	FB	EGY	FPG	AGE
SBP[1]																
DBP[2]	.73** <0.01															
PL[3]	.03 =.72	.29** <0.01														
HT[4]	-.16 =0.06	-.18* =0.03	-.18* =0.03													
WT[5]	-.04 =0.63	.06 =0.48	-.11 0.19	.30** <0.01												
BMI[6]	.04 =0.60	.16* =0.05	-.00 =0.96	-.28** <0.01	.83** <0.01											
WC[7]	-.00 =0.97	.06 =.043	.00 =0.10	.04 =0.60	.80** <0.01	.77** <0.01										
HC[8]	-.14 =0.10	.04 =0.61	-.05 =0.58	-.03 =0.69	.78**< 0.01	.82** <0.01	.78** <0.01									
WHR[9]	.22** =0.01	.07 =0.41	.07 =0.45	.05 =0.58	.17* =0.04	.13 =0.10	.47** <0.01	-.13 =0.11								
CHO[10]	-.08 =0.31	-.09 =0.28	-.10 =0.23	.08 =0.33	-.07 =0.42	-.11 =0.19	-.04 =0.63	-.07 =0.38	.06 =0.48							
FAT[11]	.03 =.72	.04 =.59	.05 =0.56	.05 =0.52	.03 =0.72	.00 =0.97	-.01 =0.93	-.04 =0.61	.11 =0.19	.32** <0.01						
PRT[12]	-.08 =0.32	-.08 =.32	-.14 =0.08	.16 =.05	.06 =0.44	-.03 =0.72	.01 =0.90	.02 =0.77	-.00 =0.99	.53** <0.01	.32** <0.01					
FB[13]	-.04 =0.59	-.04 =0.65	.04 =0.65	-.01 =0.89	-.04 =0.62	-.03 =0.70	.02 =0.83	-.03 =0.71	.07 =0.36	.79** <0.01	.39** <0.01	.39** <0.01				
EGY[14]	-.07 =0.43	-.07 =0.43	-.09 =0.28	.13 =0.12	.01 =0.96	-.07 =0.43	-.01 =0.88	-.05 =0.58	.09 =0.30.	86** <0.01	.71** <0.01	.71** <0.01	.74** <0.01			
FPG[15]	.05 =0.57	.26** <0.01	.25** <0.01	-.05 =0.57	-.07 =0.40	-.04 =0.65	.04 =0.63	-.02 0.82	.07 =0.43	.06 =0.47	.02 =0.83	0.84 0.305	.06 0.46	.06 =0.43		
AGE	.40** <0.01	.08 =0.32	-.14 =0.08	-.13 =0.10	-.02 =0.81	.05 =0.51	.16 =0.06	.02 =0.80.	.25** <0.01	-.07 =0.40	-.07 =0.37	-.18* =0.03	-.10 =0.20	-.13 =0.11	-.14 =0.08	

Figures above indicate correlation coefficients (r) and those below significant level (p-value)

* Significant at $p< 0.05$

** Very significant $p<0.01$

1: Systolic blood pressure 2: Diastolic blood pressure 3: Pulse 4: Height 5: Weight.
6: Body mass index 7: Waist circumference 8: Hip circumference 9: Waist –to- hip ratio.
10: Carbohydrate intake 11: Fat intake 12: Protein intake 13: Dietary fiber intake
14: Energy intake 15: Fasting plasma glucose

Table 8: Correlation coefficients of nutrient intake, anthropometry and clinical profile of all Non-diabetic subjects

	SBP	DBP	PL	HT	WT	BMI	WC	HC	WHR	CHO	FAT	PRT	FB	EGY	FPG	AGE
SBP[1]																
DBP[2]	.80** <0.01															
PL[3]	.11 =0.18	.17* =0.05														
HT[4]	-.18* =0.03	-.14 =0.09	-.24** =0.01													
WT[5]	-.05 =0.56	.13 =0.11	.05 =0.56	.41** <0.01												
BMI[6]	.02 =0.83	.21* =0.01	.19* =0.02	-.11 =0.21	.86** <0.01											
WC[7]	.02 =0.83	.19* =0.02	.15 =0.08	.07 =0.40	.81** <0.01	.85** <0.01										
HC[8]	.00 =0.96	.20* =0.02	.16 =0.07	-.01 =0.92	.78** <0.01	.86 <0.01	.88** <0.01									
WHR[9]	.03 =0.70	.06 =0.45	.05 =0.53	.12 =0.15	.33** <0.01	.28** <0.01	.63** <0.01	.02 =0.82								
CHO[10]	-.13 =0.12	-.03 =0.75	-.20* =0.02	.41** <0.01	.19* =0.03	-.01 =0.88	-.01 =0.92	-.02 =0.83	.01 =0.91							
FAT[11]	-.07 =0.44	-.07 =0.41	-.09 =0.28	.08 =0.38	.09 =0.31	.05 =0.54	.03 =0.72	-.01 =0.87	.07 =0.41	.35** <0.01						
PRT[12]	-.04 =0.62	.01 =0.95	-.16 =0.06	.29** <0.01	.14 =0.10	-.01 =0.91	.09 =0.28	.03 =0.70	.11 =0.70	.35** <0.01	.30** <0.01					
FB[13]	.01 =0.88	.07 =0.45	-.12 =0.18	.24** <0.01	.06 =0.50	-.07 =0.44	-.05 =0.56	-.04 =0.65	-.03 =0.75	.60** <0.01	.26** <0.01	.35** <0.01				
EGY[14]	.06 =0.43	-.07 =0.43	-.09 =.28	.13 =0.12	.01 =0.96	-.07 =0.43	-.01 =0.88	-.05 =0.58	.09 =0.30	.86** <0.01	.17** <0.01	.71** <0.01	.74** <0.01			
FPG[15]	.03 =0.75	.05 =0.55	.11 =0.22	-.04 =0.67	.08 =0.38	.13 =0.13	.22* =0.01	.09 =0.32	.27** <0.01	-.13 =0.13	.02 =0.80	.00 =0.96	-.06 =0.47	.06 =0.43		
AGE	.38** <0.01	.19* =0.02	-.04 =0.68	-.21* =0.02	-.15 =0.09	-.06 =0.51	.13 =0.13	.01 =0.89	.21* =0.01	-.36** <0.01	-.18* =0.04	-.16 =0.06	-.12 =0.15	-.33** <0.01	.14 =0.11	

Figures above indicate correlation coefficients (r) and those below significant level (p-value)
* Significant at $p < 0.05$
** Very significant: $p < 0.01$

1: Systolic blood pressure 2: Diastolic blood pressure 3: Pulse 4: Height 5: Weight
6: Body mass index 7: Waist circumference 8: Hip circumference 9: Waist –to- hip ratio.
10: Carbohydrate intake 11: Fat intake 12: Protein intake 13: Dietary fiber intake
14: Energy intake 15: Fasting plasma glucose

Tables 9a and 9b show the association between socioeconomic and lifestyle characteristics with anthropometry, medical profile and dietary intake of non-diabetic and diabetic subjects respectively by Pearson's chi-square.

Among the non-diabetic subjects, statistically significant associations between sitting in a typical day and variables including BMI, carbohydrate intake and fiber intake were observed. Other associations were between employment status and energy intake and carbohydrate intake. Borderline associations were also observed between active physical activity and energy intake as well as education level with WHR and energy intake (Table 9a).

For the diabetic subjects, statistically significant associations were observed between sitting in a typical day and WHR, alcohol intake and pulse and between income and protein intake. Other associations were between employment status and BMI as well as systolic blood pressure and between education level and protein intake. Borderline associations were also observed between walking in a typical day and systolic blood pressure and between education level and carbohydrate intake as well as WHR (Table 9b).

Table 9a: Association between socioeconomic and lifestyle characteristics with anthropometry, medical profile and dietary intake of non-diabetic subjects.

	BMI	WCM	WHR	SBP	DBP	PULSE	ENERGY	CHO	FAT	PROTEIN	FIBER
SITTING IN A TYPICAL DAY	<0.01 *	0.23	0.21	0.34	0.85	0.68	0.65	0.03*	0.36	0.58	0.03*
ACTIVE PHYSICAL ACTIVITY	0.99	0.07	0.30	0.48	0.88	0.40	0.05*	0.67	0.36	0.35	0.39
WALKING IN A TYPICAL DAY	0.16	0.87	0.56	0.63	0.67	0.58	0.42	0.06	0.19	0.68	0.13
SMOKING	0.31	0.44	0.48	0.21	0.15	0.43	0.23	0.30	0.30	0.22	0.26
ALCOHOL INTAKE	0.41	0.77	0.92	0.12	0.91	0.29	0.92	0.43	0.55	0.78	0.93
INCOME	0.12	0.94	0.28	0.77	0.86	0.61	0.25	0.25	0.92	0.35	0.26
EMPLOYMENT	0.58	0.60	0.51	0.12	0.45	0.35	0.04*	0.01*	0.71	0.13	0.95
EDUCATION LEVEL	0.68	0.22	0.05*	0.21	0.10	0.58	0.05*	0.10	0.96	0.25	0.79
DIETETIC ADVICE	0.27	0.37	0.25	0.08	0.65	0.28	0.62	0.45	0.16	0.21	0.19

*: Significant at ($p<0.05$): Pearson's chi square
**: Categorized for analysis

**SBP- Systolic blood pressure
**WHR- Waist –to- hip ratio.
**FIBER- Dietary fiber intake
**DBP- Diastolic blood pressure
**CHO- Carbohydrate intake
**ENERGY- Energy intake
**BMI- Body mass index
**FAT- Fat intake
**FPG- Fasting plasma glucose
**WCM- Waist circumference
**PROTEIN- Protein intake

Table 9b: Association between socioeconomic and lifestyle characteristics with anthropometry, medical profile and dietary intake of diabetic subjects.

	BMI	WHR	WCM	SBP	DBP	PULSE	FPG	ENERGY	CHO	FAT	PROTEIN	FIBER
SITTING IN A TYPICAL DAY	0.48	0.04*	0.40	0.17	0.62	0.12	0.55	0.29	0.31	0.37	0.27	0.42
ACTIVE PHYSICAL ACTIVITY	0.18	0.93	0.33	0.45	0.22	0.10	0.33	0.69	0.11	0.23	0.32	0.69
WALKING IN A TYPICAL DAY	0.57	0.33	0.11	0.05*	0.66	0.29	0.20	0.31	0.29	0.42	0.57	0.91
SMOKING	0.73	0.55	0.14	0.17	0.37	0.43	0.54	0.09	0.08	0.10	0.07	0.86
ALCOHOL INTAKE	0.32	0.94	0.76	0.54	0.51	0.02*	0.49	0.91	0.89	0.65	0.54	0.36
INCOME	0.21	0.63	0.26	0.47	0.71	0.51	0.31	0.16	0.07	0.73	0.05*	0.93
EMPLOYMENT	0.02 *	0.13	0.19	<0.01 *	0.06	0.44	0.66	0.08	0.12	0.17	0.08	0.24
EDUCATION LEVEL	0.60	0.05*	0.28	0.94	0.74	0.31	0.58	0.77	0.05*	0.35	0.03*	0.66
DIETETIC ADVICE	0.71	0.28	0.77	0.91	0.35	0.92	0.09	0.54	0.85	0.19	0.81	0.88

*: Significant at ($p<0.05$): Pearson's chi square
**: Categorized for analysis

**SBP- Systolic blood pressure
**WHR- Waist –to- hip ratio.
**FIBER- Dietary fiber intake
**DBP- Diastolic blood pressure
**CHO- Carbohydrate intake
**ENERGY- Energy intake
**BMI- Body mass index
**FAT- Fat intake
**FPG- Fasting plasma glucose
**WCM- Waist circumference
**PROTEIN- Protein intake

Table 10: Potential risk factors for type 2 diabetes [Odds Ratio (95%CI)] adjusted for age and sex.

Independent variables	Odds Ratio	p-value	R^2
Dietetic advice			0.41
Yes	1.00		
No	22.74 (9.89-52.27)	<0.01	
Waist circumference			
Normal	1.00		
Central obesity	5.01(2.45 – 10.24)	<0.01	
Pulse			
Normal	1.00		
Above normal	0.29 (0.14 - 0.61)	<0.01	

Binary logistic regression analysis

The variables that explained the variation in the prevalence of type 2 diabetes based on binary logistic regression analysis is shown in Table 10. Individuals who had not received dietetic advice were about 23 times more likely to be type 2 diabetic compared to those who had. Those with central obesity were about 5 times more likely to have the disease compared with normal waist circumference. In the same way, individuals with above normal pulse were 71% less likely to have the disease compared to those with normal pulse. These variables were identified as the potential risk factors for type 2 diabetes explaining 41% of the variation in FPG levels after adjusting for age and sex.

Tables 11a and 11b show the average number of times particular foods were eaten weekly among diabetic and non-diabetic subjects respectively. The most frequently consumed staples by the majority of diabetic subjects were kenkey (a maize-based product) and unripe plantain. Similarly, among non-diabetic subjects, kenkey and banku were the most frequently consumed staples. They were consumed between 5-9 times on average every week. Fish and milk formed the major source of protein for the majority of individuals in both groups with average weekly consumption of between 5-9 times. Kontomire stew, okro stew and tomatoes stew were the most frequently consumed stews among diabetic subjects compared to garden egg stew, kontomire stew and tomatoes stew among non-diabetics with average weekly intakes of between 2-4 times.

Both groups generally did not frequently consume oily soups such as palm soup and groundnut soup.

Fruits and vegetables were rarely consumed. The majority of individuals in both groups consumed fruits only once per week with a few others recording intakes of between 2-4 times weekly. Only a few had fruits and vegetables forming part of their daily dietary intake. The most frequently consumed fruits among the majority of diabetic and non-diabetic subjects were orange followed by pawpaw. Carrot and cucumber were frequently consumed among the majority of diabetic subjects compared to carrot and fresh tomatoes among the majority of non-diabetic subjects. These were consumed once weekly or between 2-4 times on average every week.

Table 11a: Average number of times particular foods were eaten weekly among diabetic subjects (n=151) (Frequency and percentage)

Food	Never	Once	2-4 Times	5-9 Times	Not Known
Carbohydrate rich foods					
Waakye	58 (38.4)	39 (25.8)	15 (9.9)	1 (0.7)	38 (25.2)
Jollof rice	46 (30.5)	41 (27.2)	27 (17.9)	2 (1.3)	35 (23.2)
Kenkey	6 (4.0)	32 (21.2)	51 (33.8)	45 (29.8)	17 (11.3)
Fufu	22 (14.6)	44 (29.1)	58 (38.4)	13 (8.6)	14 (9.3)
Banku	19 (12.6)	38 (25.2)	56 (37.1)	26 (17.2)	12 (7.9)
Kokonte	126 (83.4)	6 (4.0)	1 (0.7)	1 (0.7)	14 (9.3)
Yam	20 (13.2)	47 (31.1)	54 (35.8)	10 (6.6)	20 (13.2)
Gari	112 (74.2)	17 (11.3)	3 (2.0)	1 (0.7)	18 (11.9)
Unripe plantain	13 (8.6)	16 (10.6)	69 (45.7)	40 (26.5)	13 (8.6)
Ripe plantain	99 (65.6)	23 (15.2)	10 (6.6)	1 (0.7)	18 (11.9)
Koko	32 (21.2)	27 (17.9)	47 (31.1)	30 (19.9)	15 (9.9)
Oats	83 (55.0)	26 (17.2)	16 (10.6)	4 (2.6)	22 (14.6)
Protein rich foods					
Milk	25 (16.6)	27 (27.9)	64 (42.4)	23 (15.2)	12 (7.9)
Poultry	48 (31.8)	40 (26.5)	30 (19.9)	5 (3.3)	28 (18.5)
Fish	13 (8.6)	15 (9.9)	46 (30.5)	69 (45.7)	8 (5.3)
Meat	30 (19.9)	31 (20.5)	51 (33.8)	16 (10.6)	23 (15.2)
Egg	56 (37.1)	43 (28.5)	20 (13.2)	2 (1.3)	30 (19.9)
Stews					
Okro stew	39 (25.8)	46 (30.5)	34 (22.5)	10 (6.6)	22 (14.6)
Garden egg stew	14 (9.3)	69 (45.7)	10 (6.6)	21 (13.9)	37 (24.5)
Kontomire stew	10 (6.6)	24 (15.9)	83 (55.0)	22 (14.6)	28 (18.5)
Beans stew	58 (38.4)	37 (24.5)	23 (15.2)	5 (3.3)	28 (18.5)
Tomatoes stew	20 (13.2)	29 (19.2)	68 (45.0)	22 (14.6)	12 (7.9)
Soups					
Light soup	7 (4.6)	27 (17.9)	87 (57.6)	17 (11.3)	13 (8.6)
Groundnut soup	64 (42.4)	40 (26.5)	14 (9.3)	2 (1.3)	31 (20.5)
Palm soup	30 (19.9)	55 (36.4)	42 (27.8)	3 (2.0)	21 (13.9)
Fruits					
Pawpaw	37 (24.5)	35 (23.2)	44 (29.1)	18 (11.9)	17 (11.3)
Orange	14 (9.3)	34 (22.5)	58 (38.4)	29 (19.2)	16 (10.6)
Banana	56 (37.1)	41 (27.2)	16 (10.6)	7 (4.6)	31 (20.5)
Mango	73 (48.3)	33 (21.9)	22 (14.6)	2 (1.3)	21 (13.9)
Pineapple	55 (36.4)	42 (27.8)	25 (16.6)	6 (4.0)	23 (15.2)
Vegetables					
Cabbage	36 (23.8)	46 (30.5)	38 (25.2)	10 (9.9)	16 (10.6)
Carrot	24 (15.9)	37 (24.5)	59 (39.1)	15 (9.9)	16 (10.6)
Cucumber	35 (23.2)	27 (17.9)	56 (37.1)	16 (10.6)	17 (11.3)
Fresh tomatoes	56 (37.1)	28 (18.5)	35 (23.2)	9 (6.0)	23 (15.2)
Fats					
Butter / margarine	56 (37.1)	28 (18.5)	43 (28.5)	8 (5.3)	16 (10.6)
Alcohol	69 (45.7)	40 (26.5)	22 (14.6)	3 (2.0)	17 11.3)

Table 11b: Average number of times particular foods were eaten weekly among non-diabetic subjects (n= 140) (Frequency and percentage).

Food	Never	Once	2-4 Times	5-9 Times	Not Known
Carbohydrate rich foods					
Waakye	83 (59.3)	23 (16.4)	11 (7.9)	5 (3.6)	18 (12.9)
Jollof rice	43 (30.7)	58 (41.4)	23 (16.4)	1 (0.7)	15 (10.7)
Kenkey	18 (12.9)	36 (25.7)	45 (32.1)	30 (21.4)	11 (7.9)
Fufu	30 (21.4)	46 (32.8)	45 (32.1)	11 (7.9)	8 (5.7)
Banku	22 (15.7)	42 (30.0)	57 (40.7)	14 (10.0)	5 (3.6)
Kokonte	111 (79.3)	9 (6.4)	3 (2.1)	-	17 (12.1)
Yam	26 (18.6)	47 (33.6)	47 (33.6)	8 (5.7)	12 (8.6)
Gari	86 (61.4)	27 (19.3)	9 (6.4)	-	18 (12.9)
Unripe plantain	28 (20.0)	36 (25.7)	53 (37.9)	6 (4.3)	16 (11.4)
Ripe plantain	50 (35.7)	33 (23.4)	35 (25.0)	6 (4.3)	16 (11.4)
Koko	36 (25.7)	28 (20.0)	45 (32.1)	18 (12.9)	13 (9.3)
Oats	78 (55.7)	23 (16.4)	16 (11.4)	-	23 (16.4)
Protein rich foods					
Milk	28 (20.0)	21 (15.0)	49 (35.0)	34 (24.3)	8 (5.7)
Poultry	30 (21.4)	35 (25.0)	42 (30.0)	12 (8.6)	21 (15.0)
Fish	3 (2.1)	5 (3.6)	56 (40.0)	76 (54.3)	-
Meat	42 (30.0)	39 (27.9)	35 (25.0)	7 (5.0)	16 (11.4)
Egg	45 (32.1)	46 (32.8)	35 (25.0)	4 (2.9)	10 (7.1)
Stews					
Okro stew	49 (35.0)	41 (29.3)	31 (22.1)	7 (5.0)	12 (8.6)
Garden egg stew	33 (23.4)	38 (27.1)	47 (33.6)	7 (5.0)	15 (10.7)
Kontomire stew	29 (20.7)	42 (30.0)	49 (35.0)	8 (5.7)	12 (8.6)
Beans stew	64 (45.7)	32 (22.9)	27 (19.3)	2 (1.4)	15 (10.7)
Tomatoes stew	17 (12.1)	30 (21.4)	59 (42.1)	28 (20.0)	6 (4.3)
Soups					
Light soup	16 (11.4)	41 (29.3)	55 (39.3)	23 (16.4)	5 (3.6)
Groundnut soup	41 (29.3)	53 (37.9)	26 (18.6)	2 (1.4)	18 (12.9)
Palm soup	22 (15.7)	57 (40.7)	39 (27.9)	5 (3.6)	17 (12.1)
Fruits					
Pawpaw	44 (31.4	38 (27.1)	34 (24.3)	12 (8.6)	12 (8.6)
Orange	17 (12.1)	37 (26.4)	52 (37.1)	23 (16.4)	11 (7.9)
Banana	41 (29.3)	39 (27.9)	38 (27.1)	10 (7.1)	12 (8.6)
Mango	86 (61.4)	14 (10.0)	6 (4.30	6 (4.3)	28 (20.0)
Pineapple	44 (31.4)	40 (28.6)	33 (23.4)	6 (4.3)	17 (12.1)
Vegetables					
Cabbage	47 (33.6)	39 (27.9)	31 (22.1)	10 (7.1)	13 (9.3)
Carrot	48 (34.3)	37 (26.4)	32 (22.9)	11 (7.9)	12 (8.6)
Cucumber	61 (43.6)	34 (24.3)	21 (15.0)	9 (6.4)	15 (10.7)
Fresh tomatoes	46 (32.9)	39 (27.9)	27 (19.3)	15 (10.7)	13 (9.3)
Fats					
Butter / margarine	87 (62.1)	22 (15.7)	12 (8.6)	7 (5.0)	12 (8.6)
Alcohol	93 (66.4)	21 (15.0)	5 (3.6)	4 (2.9)	17 (12.1)

CHAPTER FIVE

5.0 DISCUSSION

5.1 Nutritional issues

Based on 24-hour dietary recall, the mean macronutrient, energy and dietary fiber intakes among diabetics and non-diabetics were comparable with no significant differences. However, the standard deviations were higher among diabetics than non-diabetics, suggesting a wider distribution and ranges of intake among the former than the latter. The possible explanation is that, in an effort to control their blood sugar as well as for economic reasons, some diabetic patients had reduced their dietary intakes drastically to levels that were no longer compatible with good health while others starved themselves for long hours inspite of the implications to health such as hypoglycemia. Some patients ate only one main meal a day and supported that with some snacks. Subsequently, 66.2% had energy intakes below 80% of the recommended daily allowance for healthy adults.

On the other hand, others were not mindful of their current health status and continued their previous apparently unhealthy dietary habits. This was evident in the fact that 19.2% of diabetics had energy intakes exceeding the recommended daily allowance. This was compared to 9.3 % among non-diabetics. Also among non-diabetics, due to demands of their jobs, most of them spent long hours at their offices without eating. This was especially so among those with white-collar jobs. Most of them also skipped breakfast due to time restraint. As such about 70% had energy intakes below 80% of the recommended daily allowance for energy.

Carbohydrate and total fat intake were higher among diabetic subjects compared to non-diabetics though not statistically significant. There was no significant difference between the two groups with respect to energy and protein intakes. These results contradict that of Akpene *et al.* (2003) who recorded higher intakes of energy and all the macronutrients among Ghanaian non-diabetics compared to Ghanaian type 2 diabetic subjects. In their study, a 3-day diet recall constituting 2 weekdays and 1weekend day was taken for all subjects. The present study is limiting in the sense that dietary recall was conducted only once for each subject on their clinic days. As a result, the mean nutrient intake for each individual could not be determined. There is also the possibility that nutrient intakes obtained were lower than usual because interviews were done on their clinic days. Patients may have reduced their usual dietary intake the day before their clinic days in order to get favourable FPG results when they came for checkup.

Results from the Food Frequency Questionnaire showed similar trends in dietary intake in terms of choice of foods among both diabetic and non-diabetic subjects. While the most frequently consumed staples by the majority of diabetic subjects were kenkey (a maize-based product) and unripe plantain, kenkey and banku (prepared from maize and cassava dough) were the most frequently consumed staples by the majority of non-diabetics. Most diabetics preferred these staples because they had been informed of their relatively low energy content. These were consumed on average, between 5-9 times per week. Studies by Brakohiapa et al. (1997) on blood glucose response of five Ghanaian carbohydrate sources revealed that Ga kenkey showed the least changes in blood glucose responses as measured by the glycemic index. Yam exhibited the least favourable blood glucose responses. Significant difference were observed between the glycemic indices of kenkey and yam; Kenkey and gari ($p < 0.01$); rice and yam, plantain and yam ($p < 0.05$). The intake of kenkey and unripe plantain by the majority of diabetic subjects therefore is commensurate with good health. The relative availability of maize all year round and its affordability explained the choices among non-diabetic subjects. The location of the study could also explain these findings, since Korle-Bu is a predominantly Ga community where maize and maize-based products are the traditional staples.

For the majority of members in both groups fish and milk were the most frequently consumed protein-rich foods. Epidemiological studies evaluating the effects of long-chain *n*-3 fatty acids [especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA] found in fishy oil) on the risk of diabetes have found an inverse association between fish intake and incidence of impaired glucose tolerance or diabetes.(Feskens *et al.*, 1991). Consistent with this finding is the inverse association between increased fish consumption and incidence of type 2 diabetes observed in the Nurses' Health Study (Salmeron *et a*l., 2001).

Kontomire stew (which is high in dietary fiber) together with okro and tomatoes stew (which have relatively lower fiber content) were the most frequently consumed stews by the majority of diabetic subjects compared to Kontomire stew, garden egg stew and tomatoes stew among the majority of non-diabetics. They were consumed on average, between 2-4 times per week for both diabetic and non-diabetic subjects. These vegetable stews turned out to be the major source of vegetable intake among most members in both groups since intake of other sources of vegetables such as cabbage were minimal.

Intakes of oily soups such as palm soup and groundnut soup were generally minimal among majority of both diabetic and non-diabetic subjects. Economic reasons, food intolerance as well as time and energy demands involved in their preparation were some of the reasons for the generally low consumption especially among non-diabetics. However, some diabetic subjects did not often consume them because they had been advised by dietitians to reduce their intake of fat. From these food choices, there is an indication of efforts being made by some diabetic subjects to effectively manage their condition. Support in the form of adequate and appropriate dietetic advice needs to be given to them.

The intakes of fruits and vegetables among the majority of both diabetic and non-diabetic subjects were minimal. For the majority of subjects in both groups, fruits and vegetables were consumed once a week or at most 2-4 times a week. Only few individuals from both groups had fruits and vegetables forming part of their daily dietary intake. The most frequently consumed fruit was orange followed by pawpaw. This was so in both groups. Very often, these fruits were bought from retailers as snacks but not as part of the main meal. The full benefits of consuming them with the main meal such as enhancing dietary nutrient absorption may therefore be lost to these individuals.

The nutritional benefits of fruits and vegetables in the prevention and management of type 2 diabetes has been documented (WHO, 2003). Their sufficient daily intake is effective in the prevention of many chronic diseases such as cardiovascular diseases, diabetes and cancers. Fruits and vegetables also could reduce the risk of obesity, which is a risk factor for type 2 diabetes (WHO, 2003). Due to their fiber-rich nature, they have been found to have low glycemic index (GI) (Bjorck *et al.*, 2000). Fruits and vegetables also lower postprandial glucose and insulin responses, improve lipid control and possibly improve insulin sensitivity (Wolk *et al.*, 1999; Chandalia *et al.*, 2000). These properties therefore make them necessary for the effective management of type 2 diabetes. Patients are therefore at a disadvantage if they do not take in adequate amounts of fruits and vegetables.

Dietary recommendations for diabetic patients have been given mostly in terms of percent contributions to total energy intake since energy is regarded as the primary fuel whose metabolism is impaired in diabetes. For about 50% of both diabetic and non-diabetic subjects, the contribution of carbohydrate to total energy intake was below the minimum recommended 55%. This suggests that energy was obtained from sources other than carbohydrate. It was not surprising therefore, to observe that total fat contributed more than the maximum recommended 30% to the total energy intake for about 46% of both diabetic and non-diabetic subjects. Similarly, protein contribution to total energy intake exceeded the maximum recommended 15% among 55% of diabetic subjects and 47.1% of non-diabetic subjects. From these results, there is evidence that both the diabetic and non-diabetic subjects had similar eating habits with high total fat intake. This has serious health implications for members in both groups especially the diabetic subjects. The situation is compounded by the fact that the fat could be more saturated than unsaturated. This study did not find out the actual saturated, monounsaturated and polyunsaturated fat components of total fat intake due to limitations of food composition tables available.

Bivariate analysis found no correlations between the nutrient intake and fasting plasma glucose levels. Also, no nutrient component contributed to the binary logistic regression model for this study. A possible explanation may be that, nutrient intake truly did not count or was represented by correlating anthropometric variables such as waist circumference which contributed to the model.

5.2 Anthropometry and medical issues

Nutritional status, as predicted by both BMI, WHR and waist circumference differed significantly ($p = 0.03$; $p < 0.01$; $p < 0.01$) respectively, between diabetic and non-diabetic subjects. All three indices predicted the highest prevalence of obesity among diabetic subjects, which was especially evident among females than males. The majority of non-diabetic subjects had normal weight compared to diabetic subjects. Evidence of a general sedentary lifestyle as well as poor education and socioeconomic status among the diabetic subjects could contribute to these results. A common feature observed among the male non-diabetics was their pot-bellies, possibly as a result of their alcohol intake habits since 60.3% of them were occasional and habitual (7.4%) drinkers compared to 29.7% and 2.7% respectively among the male diabetic subjects. Central obesity was also more common in diabetic subjects than non-diabetics. The association of obesity, especially central or visceral obesity rather than gluteal fat accumulation (apple shape as opposed to the pear shape) with insulin resistance and other features of metabolic syndrome has been reported by Ha and Lean (1998) and Despres *et al.* (2001).

From the binary logistic model developed, subjects with waist circumference above normal cutoffs (>102cm in males and >88cm in females) were 5 times more likely to be diabetic (Odds Ratio = 5.0; 95% CI: 2.5-10.2) than those with normal waist circumference. Evidence from this study suggests that higher proportions of diabetic subjects especially females (81.6%) were centrally obese compared to 50% of the female non-diabetic subjects (Fig 3).

A factor that has been strongly associated with type 2 diabetes is blood pressure. In their study to detect diabetes patients by population-based stepwise screening, Spijkerman *et al.* (2002) found hypertension present in approximately 70% of all diabetic patients. This present study found hypertension present in 49% of all diabetics compared to 40% among non-diabetics. Compared to the current prevalence of hypertension among Ghanaian adults which is 30% (Ghana Health Service, 2004), the observed prevalence among non-diabetic subjects is high. This probably is due to differences in age distribution of participants in this study. In an effort to match for age with the diabetic subjects, over 50% of the non-diabetics recruited were above 50 years of age.

5.3 Lifestyle issues

It was observed from this study that cigarette smoking was generally uncommon among both diabetic and non-diabetic subjects. All females in both groups had never had any smoking experience in their life time. However, compared with the non-diabetic male subjects, more diabetic males had smoked at some point in their lifetime. This could partly explain their current health state. Continued smoking among diabetic patients have serious health implications. Franti *et al.* (1996) established an association of cigarette smoking with acute deterioration of glucose tolerance probably due to diminished sensitivity to insulin in both healthy non-smokers as well as usual tobacco smokers. It is encouraging to note that most of the diabetic male subjects had stopped smoking upon diagnosis. However, a few continued to smoke and are therefore at increased risk of nephropathy (Sawicki et al., 1994), retinopathy (Muhlhauser et al., 1996) and albuminuria (Ikeda et al., 1997).

Alcohol intake differed significantly among the two groups ($p < 0.001$) in favour of non-diabetic subjects. The majority of non-diabetics subjects were occasional and habitual drinkers compared to diabetics. Higher proportions of diabetic teetotalers than non-diabetics were also recorded. Upon diagnosis, some diabetic subjects had quit drinking in an effort to improve their health state. Some studies have associated moderate alcohol intake (one to two drinks per day) with a 30% - 40% lower risked of developing type 2 diabetes compared with abstainers (Stampfer et al., 1988; Perry et al., 1995; Ajani et al., 2000; Nakanishi et al., 2003). In this current study, since alcohol intakes were recorded as categorical data, actual intakes were not recorded.

In estimating the physical activity status of both groups, subjects were asked how often they sat, walked and performed strenuous physical activity such as jogging on a typical day. Pearson's chi square analysis showed no significant difference in the sitting and strenuous physical activity habits of diabetic and non-diabetic subjects. Due to their higher unemployment rate and the fact that most diabetics were pensioners in their old age, most of their day was spent at home with very little activity. Secondly, some diabetics had complications such as foot infections and partial paralysis due to strokes. Because of these reasons they were often limited in their movements. Sitting was therefore their major activity in a typical day. Among those who were employed, especially traders and office workers, their work involved mostly sitting.

Non- diabetics were generally more active partly because they were younger. For the majority of them walking formed their major activity on a typical day. The traders among this group were mostly hawkers who displayed their wares and carried them round on their heads. Others such as laboratory technicians, and security persons did a lot of walking in a typical day. In general, males in both groups were more physically active, doing less sitting and more walking and strenuous physical activity than females.

Dietetic advice is an integral part in the management of type 2 diabetes. Studies by Tuomilehto *et al.* (2001) and The Diabetes Prevention Program Research Group (2002) confirmed the effectiveness of dietetic advice in the prevention and management of type 2 diabetes. In our study, dietetic advice was one of the three variables in the multiple regression model, which together explained 41% of the variation in fasting plasma glucose levels. Subjects who had never had any dietetic advice were about 23 times (Odds Ratio = 22.7; 95% CI: 9.9-52.3) more likely to be diabetic than those who had. The source of dietetic advice however did not contribute significantly to the risk of developing diabetes.

As part of consultations at the National Diabetes Management and Research Center, Korle-Bu, all patients are required to report at the Diet-Therapy unit to see a dietitian. Evidence from this study showed however, that 92.1% of the patients had some form of dietetic advice, with 72.8% actually making the appointment with the Dietitian. The rest of them (6.6%) had settled for the brief orientation given at the center by the nurses. Others (7.3%) were satisfied with their consultation with the physician, hence they found no need to see the dietitian. A few others (3.3%) had discussed their health situation with relatives or friends in the health profession or who had encountered the same health problem earlier, while others (2.0%) depended on media and church counselors for dietetic advice. For the remaining 7.9% who had no dietetic advice at all, they gave reasons such as delays and unfriendly response at the Diet-Therapy center

5.4 Socioeconomic issues

The majority of diabetic subjects had no formal education compared to non-diabetics. The difference was statistically significant ($p < 0.001$). In their study, Chaturvedi and Stephenson (1996) reported a poor glycemic control among those with least education, for both men and women. College educated men had lower smoking rates, higher rates of physical exercise, higher intake of dietary fiber and a more favorable lipid pattern than primary educated men. The reported differences in risk factors were not so marked in women. In the current study, education level was associated with waist-to hip-ratio for both diabetic and non-diabetic subjects. In addition, among the non-diabetics, it was associated with energy intake and with carbohydrate and protein intake among the diabetic subjects.

Unemployment rate, a proxy for socioeconomic status also differed significantly ($p < 0.01$) between the two groups in favour of non-diabetic subjects. Although not statistically significant, the income levels of diabetics were also generally lower than non-diabetics.

The association of socioeconomic status with differences in diabetes control and complications has been reported (Connolly and Kesson, 1996), though the reasons for the differences were not clear. In another study, a significant inverse relation between the prevalence of type 2 diabetes and socioeconomic status, which is most marked between the ages of 40-69yrs was reported (Connolly et al., 2000). The possible explanation to this was given as an earlier and increased exposure to lifestyles and environmental risk factors for type 2 diabetes among people from areas of low socioeconomic status. It is of interest to note that about a third of diabetic subjects had attained the pension age of 60 years (appendix 2) while 22.5% were unemployed (Table 2). Unemployment typically is associated with reduced income after considering all other factors of importance. In this study, unemployment and low income were more prevalent among diabetic subjects compared to non-diabetics. This can have some impact on their ability to cater for their care because medications that are prescribed are expensive. One will therefore expect that the non-diabetics who had higher employment and income, given the same knowledge will be better able to provide for their care than the diabetics, all other factors being equal.

Among the diabetic subjects, poor economic status was more evident in females than males. Statistically significant differences ($p < 0.01$) in education, employment and income occurred between diabetic males and diabetic females with males at an advantage in all cases. It is therefore not surprising that mean FPG was higher in female diabetic subjects than males, though not statistically significant. The mean BMI was also higher among diabetic females than males ($p < 0.01$). These results are consistent with that of Robbins *et al.* (2000). In their study to determine type 2 diabetes in African-American women and men aged 40-74 years and socioeconomic status, excess type 2 diabetes prevalence among African-American women was attributed to differences in income and body size.

5.5 Other issues

Out of 170 apparent non-diabetics who were screened for diabetes, based on new world standards (American Diabetes Association, 1997) 23 had impaired fasting glucose (IFG) while 7 were diabetic. This suggests an IFG and diabetes prevalence rates of 13.5% and 4.1% respectively, among the adult population at Korle –Bu and its immediate environs. Amoah *et al* (2002) reported an IFG and diabetes prevalence of 6.1% and 6.4% respectively among Ghanaian adults.

Although the adult population at Korle-Bu are not representative of all adults in Ghana, the high prevalence of IFG gives cause for concern since if not addressed, it can lead to diabetes. It becomes even more important if we consider the fact that in this study, approximately 60% of all the diabetic subjects recruited had developed the disease within five years, an indication of growing incidence of diabetes among adult Ghanaians. In this study, the mean age of diabetic subjects differed significantly from that of non-diabetics ($p = 0.01$). This could be explained by the procedure that was used in identifying the non-diabetics from the Korle-Bu community. Parity was also significantly higher among diabetic subjects than non-diabetics ($p < 0.001$). This could be explained in part by the age difference between the two groups.

CHAPTER SIX

6.1 CONCLUSION

The diets of diabetic subjects did not differ significantly from those of non-diabetics. Percent contribution of total fat and carbohydrate to total energy intake among most diabetic subjects suggests that they were not following dietary recommendations. Since their dietary intakes were similar to that of non-diabetics, there was no evidence to suggest any modification in their diets upon diagnosis. Fruit and vegetable intake in the diets of both diabetic and non-diabetic subjects were poor.

No significant correlations were found between nutritional status and BMI, WHR and waist circumference with dietary intake among both groups. The majority of diabetic subjects were overweight and obese compared with non-diabetics. Among non-diabetic subjects, waist circumference correlated positively and significantly ($r=0.22$; $p=0.01$) with FPG. Generally, among both diabetic and non-diabetic subjects, strenuous physical activity was uncommon. Members in both groups were physically inactive although this was more common among diabetic subjects compared to non-diabetics.

Individuals not exposed to dietetic advice were about 23 times more likely to have increased or higher FPG. Those with waist circumference indicative of central obesity were also about 5 times more likely to have high FPG. Participants with pulse above normal were about 70% less likely to have high FPG. Together, dietetic advice, waist circumference and pulse explained 41% of the variation in FPG levels. Although not statistically significant, mean FPG was higher among female diabetic subjects than males.

6.2 RECOMMENDATIONS

Appropriate nutritional education needs to be given to all subjects with diabetes to improve their understanding of the role diet therapy plays in their management. This would avoid misconceptions and facilitate their appreciation of dietary and lifestyle recommendations. In line with this, a qualified dietitian at the National Diabetes Management and Research Center is recommended. This would ensure that all diabetic patients receive timely and adequate dietetic advice.

The general adult population needs to be encouraged to include fruits and vegetables in their daily meals. In particular, patients should be educated about the benefits of frequent intake of fruits and vegetables.

More education needs to be done to emphasize the need for adequate physical activity for improved health.

Further studies need to be conducted to provide further insight into the care of diabetics and how they relate to their general health and well-being.

Reference:

Abate, N., Garg, A., Peshock, R. M., Stray-Gundersen, J and Grundy, S. M (1995). Relationships of generalized and regional adiposity to insulin sensitivity in men. *Journal of Clinical Investigation* 96, 88-98.

Ajani, U. A., Hennekens, C. H., Spelsberg, A and Manson, J E (2000). Alcohol consumption and risk of type 2 diabetes mellitus among US male physicians. *Arch Intern Med* 160, 1025-1030.

Akpene, E. B., Allen, J. C., Allen, H.G and Lartey, A (2003). Fatty acids, diet and body indices of type II diabetic American Whites and Blacks and Ghanaians. *Nutrition.* Elsevier Inc. 19, 9, 722-726.

Albu, J., Allison, D., Boozer, C. N, et al (1997). Obesity solutions: report of a meeting. *Nutrition Review* 55,150-156.

American Diabetes Association (1997). Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* 20, 1183-1197.

American Diabetes Association (2003). Evidence based nutrition principles and recommendations for the treatment and prevention for diabetes and related complications. *Diabetes Care* 26, S51-S61.

Amoah A. G. B et al. A national diabetes care and education programme: The Ghana model. *Diab Res. Clin Pract.* 2000; 149-157.

Amoah, A. G. B., Owusu, S.K and Adjei, S (2002). Diabetes in Ghana: a community based prevalence study on Greater Accra. *Diabetes Research and Clinical Practice*. 56; 197-205.

Anonymous (1994). Defining dietary fiber for nutrition labeling purposes. Report from Food industry *ad hoc* working group on dietary fiber. International Food Ingredients 1, 46-49

Anonymous (2001). Dietary Reference Intakes-Proposed Definition of Dietary Fiber. A Report of the Panel on the Definition of Dietary Fiber and the Standing Committee on the Scientific Evaluation of Dietary References Intakes (Food and Nutrition Board, Institute Of Medicine). Washington, DC: National Academy Press.

Aro, A (2003). Fatty acid composition of serum lipids: is this marker of fat intake still relevant for identifying metabolic and cardiovascular disorders? *Nutr Metab Cardiovasc Dis* 13, 253-255.

Austin, M. A., Mykkanen, L., Kuusisto, J., Edwards, K. L., Nelson, C., Haffner, S. M.,Pyorala, K and Laaksso, M (1995). Prospective study of small LDLs as a risk factor for non-insulin dependent diabetes mellitus in elderly men and women. *Circulation* 92, 1770-1778.

Biesenback, G., Zazgornik, J (1996). Influence of smoking on the survival rate of diabetic patients requiring hemodialysis. *Diabetes Care*.19; 6, p 625-628

Biesenback, G., Janko, O and Zazgornik, J (1994). Similar rate of progression in the pre-dialysis phase in type 1 and type 2 diabetes mellitus. *Nephrol Dial Transplant* 9: 1097-1102

Bjorck, I., Liljeberg, H and Ostman, E (2000). Low glycaemic index foods. *British Journal of Nutrition* 83.

Bourdon, I., Yokoyama,W., Davis, P., Hudson, C., Backus, R., Richter, D., Knuckles, B and Schneeman, B (1999). Postprandial lipid, glucose, insulin, and cholecystokinin responses in men fed barley pasta enriched with β-glucan. *American Journal of Clinical Nutrition* 69, 55-63.

Boyko, E. J., Fujimoto, W. Y., Leonetti, D. L and Newell- Morris, L (2000).Visceral adiposity and risk of type 2 diabetes: a prospective study among Japanese Americans. *Diabetes Care* 23, 465-471.

Brakohiapa, L.A., Quaye, I.K, Amoah, A. G., Harrison, E. K., Kennedy, D. O, Kido and Ofei, F (1997) Blood glucose responses to mixed Ghanaian diets in healthy adult males. West Afr J Med.16 (3): 170-3

Chandalia, M., Garg, A., Utjoahann, D. von Bergmann, K., Grundy, S and Brinkley, L.J (2000). Beneficial effects of high dietary fiber intake in patients with type 2 diabetes mellitus. *N Engl J Med* 342, 1392-1398.

Chaturvedi, N and Stephenson, J. M (1996). The relationship between socioeconomic status and diabetes control and complications in the EURODIAB IDDM complications study. *Diabetes Care*. 19; 5; 423-430

Choi, B.C.K and Shi, F (2001). Risk factors for diabetes mellitus by age and sex: results of the National Population Health Survey. *Diabetologia* 44, 1221-1231.

Connolly, V. M and Kesson, C. M (1996). Socioeconomic status and clustering of cardiovascular diabetes risk factors in diabetic patients. *Diabetes Care*. 19; 5 419-422.

Connolly, V., Unwin, N., Sherriff, P., Bilous, R and Kelly, W (2000). Diabetes prevalence and socioeconomic status: a population based study showing increased prevalence of type 2 diabetes mellitus in deprived areas. *J Epidemiol Community Health*; 54: 173-177.

Corbin, C. B., Lindsey, R., Welk, G.I and Corbin, W. R. Concept of fitness and wellness. A comprehensive lifestyle approach (2002). (4th edition) Mc Graw Hill. Boston 296.

Curb J. D and Marcus, E. B (1991). Body fat and obesity in Japanese Americans. *Am J Clin Nutr* 53, Suppl. 6, 1552S-1555S.

Despres, J. P., Lemieur, I and Prud'homme, D (2001). Treatment of obesity: need to focus on high risk abdominally obese patients. *Br Med J*; 322: 716-720

Diabetes Prevention Program Research Group (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 346, 393-403.

Diabetes UK (2003). The implementation of nutritional advice for people with diabetes. *Diabetic Medicine*, 20 786-607

Dowse, G. K., Zimmet, P. Z., Gareeboo, H., Alberti, K. G. M. M., Tuomilehto, J., Finch, C. F., Chitson. P and Tulsidas, H (1991). Abnormal obesity and physical activity as risk factors for NIDDM and impaired glucose tolerance in Indian, Creole and Chinese Mauritians. *Diabetes Care* 14, 271-282.

Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002). Food and Nutrition Board, Institute of Medicine, National Academies.

Evans, D. J., Murray, R and Kissebah, A. H (1984). Relationship between skeletal muscle insulin resistance, insulin mediated glucose disposal and insulin binding. Effects of obesity and body fat topography. *Journal of Clinical Investigation* 74, 1515-1525.

Eyeson, K. K and Ankrah, E. K (1975). Composition of foods commonly used in Ghana. Food Research Institute/ Council for Scientific and Industrial Research. Accra- Ghana.

FAO/ WHO 1998. Carbohydrate in human nutrition. Report of a joint FAO/ WHO Expert Consultation. Rome, Food and Agriculture Organization of the United Nations (FAO Food and Nutrition Paper. No 66), 1-140

FAO/WHO (1994). Fats and oils in human nutrition. Report of a Joint FAO/ WHO Expert Consultation. Rome, Food and Agriculture Organization of the United Nations (FAO Food and Nutrition Paper. No 57).

Facchini, F., Chen, Y-Di and Reaven, G. M (1994). Light to moderate alcohol intake is associated with enhanced insulin sensitivity. *Diabetes Care* 17, 115-119.

Feingold, K. R.,Grunfeld, C., Pang, M., Doerrler, W and Kauss, R. M (1992). LDL subclass phenotypes and triglyceride metabolism in non-insulin-dependent diabetes. *Arteriosclerosis and Thrombosis* 12, 1496-1502.

Ferrannini, E., Barrett, E. J., Bevilacqua, S and De Fronzo, R. A (1983). Effects of fatty acids on glucose production and utilization in man. *Journal of Clinical Investigation* 72, 1737-1747.

Feskens, E. J., Bowles, C. Hand Kromhout, D (1991). Inverse association between fish intake and risk of glucose intolerance in normoglycemic elderly men and women. *Diabetes Care* 14, 935-941.

Feskens, E. J., Virtanen, S. M., Rasanen, L., Toumilehto, J., Stengard, J., Pekkanen, J., Nissinen, A and Kromhout, D (1995). Dietary factors determining diabetes and impaired glucose tolerance. A 20-year follow-up of the Finnish and Dutch cohorts of the Seven Countries Study. *Diabetes Care* 18, 1104-1112.

Ford, E. S and Mokdad, A. H (2001). Fruit and vegetable consumption and diabetes mellitus incidence among U.S. adults. *Prev Med* 32, 33-39.

Franti, A. C., Iniestra, F and Ariza, C.R (1996). Acute effect of cigarette smoking on glucose tolerance and other cardiovascular risk factors. *Diabetes Care*. 19: 2, 112-118.

Frayn, K. N (2000). Visceral fat and insulin resistance - causative or correlative? *Br. J Nutr* 83, Suppl. 1, S71-S77

Fung, T. T., Schulze, M., Manson, J. E., Willett, W. C and Hu, F. B (2004). Dietary patterns, meat intake, and the risk of type 2 diabetes in women. *Arch Intern Med.* 164 , 2235-2240.

Ghana Statistical Service (GSS), Noguchi Memorial Institute for Medical Research (NMIMR) and ORC Macro (2004). Ghana Demography and Health Survey 2003. Calverton, Maryland: GSS, NMIMR, and ORC Macro.

Ghana Health Service (2004). Imagine Ghana free of malnutrition; a conceptual paper for addressing malnutrition in Ghana as a developmental problem using health as an entry point. GHS Document No.2

Giacco R, Parillo M, Rivellese AA, Lasorellla G, Giacco A, D'Episcopo L, Riccardi G (2000). Long-term dietary treatment with increased amounts of fiber-rich low-glycemic index natural food improves blood glucose control and reduces the number of hypoglycemic events in type 1 patients with diabetes. *Diabetes Care* 23:1461–1466

Guthrie, H. A and Picciano, M.F (1995). Human Nutrition. Mosby Year Book Inc. Baltimore.

Haffner, S. M., Stern, M. P., Hazuda, H. P., Mitchell, B. D and Patterson, J. K (1990). Cardiovascular risk factors in confirmed pre-diabetic individuals. Does the clock of coronary heart disease start ticking before the onset of clinical diabetes? *Journal of the American Medical Association* 263, 2893-2898.

Ha, T. K. K and Lean, M. E. J (1998). Technical Review. Recommendations for the nutritional management of patients with diabetes. *Eur J Clin Nutrition*; 52; 467-481.

Halls, S. B (2001). A body mass index calculator you will like. http:www.halls.md/ body mass index/bmi.htm.

Harding, A. H., Sargeant, L. A., Khaw, T., Welch, A., Oakes, S., Luben, R. N., Bingham, S., Day, N. E and Wareham, N. J (2002). Cross-sectional association between total level and type of alcohol consumption and glycosylated hemoglobin level: the EPIC Norfolk Study. *Eur J Clin Nutr* 56, 882-890.

Howard, B. V and Wylie- Rosett, J (2002). Sugar and cardiovascular disease. *Circulation* 106, 523-527.

Ikeda, Y., Suehiro, T., Takamatsu, K., Yamashita, H., Tamura, T and Hashimoto, K (1997). Effect of smoking on the prevalence of albuminuria in Japanese men with non-insulin–dependent diabetes mellitus. *Diabetes Res Clin Pract* 36:57-61.

Janket, S. J., Manson, E. J., Sesso, H., Buring, J.E and Liu, S (2003). A prospective study of sugar intake and risk of type 2 diabetes in women. *Diabetes Care* 26, 1008-1015.

Jensen, M. D., Haymond, M. W., Rizza, R. A., Cryer, P. E. and Miles, J. M (1989). Influence of body fat distribution on free fatty acid metabolism in obesity. *Journal of Clinical Investigation* 83, 1168-1173.

Kao, W. H. L., Puddey I. B., Boland, L. L., Warson, R. L and Brancati, F. L (2001). Alcohol consumption and the risk of type 2 diabetes mellitus: atherosclerosis risk in communities study. *Am J Epidemiol* 154, 748-757.

King, H. Aubert, R. E and Herman, W. H (1998). Global burden of diabetes 1995-2025: prevalence, numerical estimates and projections. *Diabetes Care* 21, 1414-1431.

Laakso, M., Lehto, S., Penttila,I and Pyorala (1993). Lipids and lipoproteins predicting coronary heart disease mortality and morbidity in patients with non-insulin dependent diabetes. *Circulation* 88, 1421-1430.

Laaksonen, D. E., Kainulainen, S., Rissanen, A and Niskanen, L (2003). Relationship between changes in abdominal fat distribution and insulin sensitivity during a very low calorie diet in abdominally obese men and women. *Nutr Metab Cardiovasc Dis* 13, 349-356.

Lavigne, C., Tremblay, F, Asselin, G., Jacques, H and Marette, A (2001). Prevention of skeletal muscle insulin resistance by dietary cod protein in high fat-fed rats. *Am J Physiol Endocrinol Metab* 281, E62-E71.

Ledo, J (2005). The association between salt intake and blood pressure in the elderly. A dissertation resented to the Department of Nutrition and Food Science, University of Ghana, Legon.

Lee, S.C and Prosky, L (1995). International survey on dietary fiber: definition, analysis, and reference materials. *Journal of AOAC International* 78, 22-36

Maggio, C. A and Xavier Pi- Sunyer (1997). The prevention and treatment of obesity. *Diabetes Care* 20, 1744-1766.

Manson, J. E., Rimm, E. B., Stampfer, M. J., Colditz, G. A., Willett, W. C., Krolewski, A. S., Rosner, B., Hennekens, C. H and Speizer (1991). Physical activity and incidence of non-insulin dependent diabetes mellitus in women. *Lancet* 338, 774-778.

Marshall, J. A., Bessesen, D. H and Hamman, R.F (1997). High saturated fat and low starch and fiber are associated with hyperinsulinemia in a non-diabetic population: the San Luis Diabetes Study. *Diabetologia* 40, 430-438.

Marshall, J. A., Hamman, R.F and Baxter, J (1991). High fat low carbohydrate diet and the etiology of NIDDM: the San Luis Valley Diabetes Study. *Am J Epiemiol* 134, 590-603

Marshall, J. A., Shetterly, D., Hoag, S and Hamman, R. F (1994). Dietary fat predicts conversion from impaired glucose tolerance to NIDDM: the San Luis Valley Diabetes Study. *Diabetes Care* 17, 50-56.

Mbanya, J. C., Cruickshank, J. K., Forrester, T., Balkau, B., Ngogang, J Y., Riste, L., Forhan, A., Anderson, N. M., Bennett, F and Wilks, R (1999). Standardized comparison of glucose intolerance in West African-origin populations of rural and urban Cameroon, Jamaica and Caribbean migrants to Britain. *Diabetes Care* 22,434-440.

Mckeown, N.M., Meigs, J. B., Liu, S., Wilson, P. W and Jacques, P. F (2002). Whole-grain intake is favorably associated with metabolic risk factors for type 2 diabetes and cardiovascular diseases in the Framingham Offspring Study. *Am J Clin Nutr* 76, 390-398.

Meyer, K.A., Hushi, L.H., Jacobs, D.R., Slavin, J., Sellers, T. A and Folsom, A. R (2000).Carbohydrates, dietary fiber and incident type 2 diabetes in older women. *American Journals of Clinical Nutrition* 71, 921-930.

Mitchell, B., Hawthorne, V and Vinik A (1990). Cigarette smoking and nephropathy in diabetic patients. *Diabetes Care* 13:434-447.

Monteiro, C.A., Conde, W.C. and Popkin, B. M (2002). Is obesity replacing or adding to undernutrition? Evidence from different social classes in Brazil. *Public Health Nutrition.* CABI Publishing 105-112.

Montonen, J., Knekt, P., Jarvinen, R., Aromaa, A and Reunanen, A (2003). Whole-grain and fiber incidence of type 2 diabetes. *Am J Clin Nutr* 77, 622-629.

Moore, D. S. and McCabe, G. P. (1993). Introduction to the Practice of Statistics. 2nd edition. W.H Freeman and Company Ltd. New York.

Moore, L., Visioni, A. J., Wilson, P. W., D'Agostino, R. B., Finkle, W. D and Ellison, R. C (2000). Can sustained weight loss in overweight individuals reduce the risk of diabetes mellitus? *Epidemiology* 11, 269- 273.

Muhlhauser, I (1994).Cigarette smoking and diabetes: an update. *Diabetic Med* 11: 336-343

Muhlhauser, I., M Bender, R., Bott, U., Jorgens, V., Grusser, M.,Wagener, W., Overmann, H and Berger,M (1996). Cigarette smoking and progression of retinopathy and nephropathy in type 1 diabetes. *Diabet Med* 13; 536-543.

Nakanishi, M., Suzuki, K and Tatara, K (2003). Alcohol consumption and risk for development of impaired fasting glucose or type 2 diabetes in middle-aged Japanese men. *Diabetes Care* 26, 48-54.

Norden, G., Nyberg G (1984). Smoking and diabetic nephropathy. *Acta Med Scand* 215: 257-261.

Nthangeni, G., Steyn, N. P., Alberts, M., Steyn, K., Levitt, N.S., Laubscher,R., Bourne, L., Dick, J and Temple, N (2002). Dietary intake and barriers to dietary compliance in black type 2 diabetic patients attending primary health- care services. *Public Health Nutrition.* CABI Publishing 329-338

O'Dea, K (1992). Diabetes in Australian aborigines: impact of the western diet and lifestyle. *J Intern Med* 232, 103-117.

Osei, K., Schuster, D. P., Owusu, S. K and Amoah, A. G. B (1997). Race and ethnicity determine serum insulin and C-peptide concentrations and hepatic insulin extraction and insulin clearance: Comparative studies of three populations of West African ancestry and White Americans. Metabolism 46, 53-58.

Parillo, M and Riccardi, G (2004). Diet composition and the risk of type 2 diabetes: epidemiological and clinical evidence. *Br J Nutr* 92, 7-19.

Perry, I. J., Wannamethee, S. G., Walker, M. K., Thomson, A.G., Whinncup, P.H. and Shaper, A. G (1995). Prospective study of risk factors for development of non-insulin dependent diabetes in middle aged British men. *Br. Med J* 4, 560- 564.

Pereira, M.A., Jacobs, D.R., Pins, J.J., Raatz, S.K., Gross,M.D., Slavin, J. L and Seaquist E.R (2002). Effect of whole grains and insulin sensitivity in overweight hyperinsulinemic adult. *American Journals of Clinical Nutrition.* 75 848-855.

Riccardi, G., Aggett, P., Brighenti, F., delzenne, N., Frayn, N., Nieuwenhuizen, A., Theis, S and Vessby, B (2004). Body weight regulation, insulin sensitivity and diabetes risk. *Eur J Nutr* (In the Press).

Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* 1997 22, 7 1188-1197.

Robbins, J. M., Vaccarino, V., Heping, Z and Stanislav, V. K (2000). Excess type 2 diabetes in African-American women and men aged 40-74 and socioeconomic status: evidence from the Third National Health and Nutrition Examination Survey. *J Epidemiol. Community Health* 54:839-845.

Roselli della Rovere, G., Lapolla, A., Sartore, G., Rossetti, C., Zambon, S., Minicuci, N., Crepaldi, G., Fedele, D and Manzato,E (2003). Plasma lipoproteins, apoproteins and cardiovascular disease in type 2 diabetic patients. A nine-year follow-up study. *Nutr Metab Cardiovasc Dis* 13, 46-51.

Romiji, J. A., Coyle, E. F., Sidossis, L. S., Gastaldelli, A., Horowitz, J. F., Endert, E and Wolfe, R. R (1993). Regulation of endogenous fat and carbohydrate metabolism in relation to exercise intensity and duration. *Am J Physiology* 265, E380-E391

Romiji, J. A., Coyle, E. F., Sidossis, L. S., Rosenblatt, J and Wolfe, R. R (2000). Substrate metabolism during different exercise intensities in endurance-trained women. *Journal of Applied Physiology* 88, 1707-1714.

Samaras, K and Campbell, L. V (2000). Increasing incidence of type 2 diabetes in the third millennium: is abdominal fat the central issue? *Diabetes Care* 23, 441-442.

Salmeron, J., Hu, F A., Manson, J. E., Colditz, G. A., Stampfer, M .J., Rimm, E. B and Willett, W. C (2001). Dietary fat intake and risk of type 2 diabetes in women. *Am J Clin Nutr* 73, 1019-1026.

Salmeron, J., Ascherio, A., Rimm, E. B., Colditz, G. A., Spiegelman, D., Jenkins, D. J., Stampfer, M..J., Wing, A. L and Willett, W. C (1997*a*). Dietary fiber, glycemic load, and risk of NIDDM in men. *Diabetes Care* 20, 545-550

Salmeron, J., Manson, J.E., Stampfer, M. J., Colditz, G. A., Wing, A. L and Willett, W. C (1997 *b*). Dietary fiber, glycemic load and risk of NIDDM in women. *Journal of the American Medical Association* 277, 472-477.

Sargeant, L. A., Khaw, K. T., Bingham, S., Day, N. E., Luben, R. N., Okaes, S., Welch, A and Wareham, N. J (2001). Fruit and vegetable intake and population glycosylated haemoglobin levels: the EPIC Norfolk Study. *Eur J Clin Nutr* 55, 342-348.

Sawicki, P., Didjurgeit, U., Muhlhauser, I., Bender, R., Heinemann, L and Berger, M (1994). Smoking is associated with progression of diabetic nephropathy. *Diabetes Care* 17:126-131.

Schneiter, P., Di Vetta, V., Jequier, E and Tappy, L (1995). Effect of physical exercise on glycogen turnover and net substrate utilization according to the nutritional state. *American Journal of Physiology* 269 E1031-E1036.

Silvis, N. Nutritional recommendations for individuals with diabetes mellitus. *South African Journal of Food Science and Nutrition,* 1992: 81:162-166.

Sowers, J (1998). Diabetes mellitus and cardiovascular disease in women. *Arch Intern Med* 158:617-621.

Spijkerman, A. M. W., Adriaanse, M. D., Dekker, J. M and Nijpels, G (2002). Diabetic patients detected by population-based stepwise screening already have a diabetic cardiovascular risk profile. *Diabetes Care*: 25; 10; 1784-1789

Stampfer, M. J., Colditz, G. A., Willett, W. C., Manson, J. E., Arky, R. A., Hennekens, D. H and Speizer, F. E (1988). A prospective study of moderate alcohol drinking and the risk of diabetes in women. *Am J Epidemiol* 128, 549-558.

Stevens, J., Ahn, K., Juhaeri., Houston, D., Steffan, L and Couper, D (2002). Dietary fiber intake and glycemic index and incidence of diabetes in African- American and white adults. The ARIC Study. *Diabetes Care* 10, 1715-1721.

Stewart, M.W., Laker, M. F., Dyer, R.. G., Game, F., Mitcheson, J., Winocour, P. H and Alberti, K. G. M. M (1993). Lipoprotein compositional abnormalities and insulin resistance in type 2 diabetic patients with mild hyperlipidemia. *Arteriosclerosis and Thrombosis* 13, 1046-1052.

Storlien, L. H., Baur, L. A., Kriketors. A. D., Pan, D. A., Cooney, G. I., Jenkins, A. B., Calvert, G. D., and Campbell, L. V (1996). Dietary fats and insulin action, *Diabetologia* 39, 621-631.

Tan, K. C. B., Cooper, M. B., Ling, K. L. E., Griffin, B. A., Freeman, Packard, C. J., Shepherd, J., Hales, C. N and Betteridge, D. J (1995). Fasting and postprandial determinants for the occurrence of small dense LDL species in non-insulin-dependent diabetic patients with and without hypertriglyceridaemina: the involvement of insulin, insulin precursor species and insulin resistance. *Atherosclerosis* 113,273-287.

Tappy, L., Binnert, C and Schneiter, P. (2003). Energy expenditure, physical activity and body-weight control. *Proceeding of the Nutrition Society*. CABI Publishers 62, 663-666

Thanopoulou, A. C., Karamanos, B. G and Angelico, F. V (2003). Dietary fat intake as a risk factor for the development of diabetes. *Diabetes Care* 26, 302-307.

Trinder, P (1969). Ann Clin Biochem. 6 (24)

Trowell, H. (1972). Ischemic heart disease and dietary fiber. *American Journal of Clinical Nutrition* 25, 926-932.

Tuomilehto, J., Lindstrom, J., Eriksson, J. G., Valle, T. T., Hamalainen, H., Ilanne-Parikka, P et al., (2001). Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Eng J Med*; 344: 1343-1350.

Van Dam, R. M., Hu, F A., Stampfer, M. .J., Rimm, E. B and Willett, W. C (2002). Dietary fat and meat intake in relation to risk of type 2 diabetes in man. *Diabetes Care* 25, 417-424.

Vessby, B (2000). Dietary fat and insulin action in humans. *Br J Nutr* 83, Suppl. 1, S91-S96.

Vessby, B., Aro, A., Skarfors, E., Berglund, L., Saltinen, I and Lithell, H (1994). the risk to develop NIDDM is related to the fatty acid composition of the serum cholesterol esters. *Diabetes* 43, 1353-1357.

Vessby, B., Uusitupa, M., Hermansen, K et al., (2001). Substituting dietary saturated for monounsaturated fat impai4rs insulin sensitivity in healthy men and women: the KANWU study. *Diabetologia* 44, 312-319.

Vuvor, M. K. F (1998). Population-based study of prevalence of diabetes mellitus and its associated risk factors in adult Ghanaians in the Greater Accra Region. M.Phil thesis report submitted to the Department o Nutrition and Food Science. University of Ghana, Legon.

Wannamethee, S. G., Camargo, C. A Jr., Manson, J. E., Willet, W. C and Rimm, E. B (2003). alcohol drinking patterns and risk of type 2 diabetes mellitus among younger women. *Arch Intern Med* 163, 1329-1336.

Wardlaw, G.M and Insel, P, M. (1995). Perspectives in Nutrition (3rd Edition). Mosby Year Book, Inc. St Louis.

Walters, D., Gatling, W., Houston, A., Mulle, M., Julious, S., Hill, R (1994). Mortality in diabetic subjects: an eleven-year follow-up of a community-based population. *Diabet Med* 11: 968-973

Wei, M., Mitchell, B., Haffner, S and Stern, M (1996). Effects of cigarette smoking, diabetes, high cholesterol and hypertension on all-cause mortality and cardiovascular disease morality in Mexican –Americans. The San Antonio Heart Study. *Am J Epidemiol* 144:1058-1065.

Wei, M., Gobbons, L. W., Mitchell, T. L., Kampert, J. B and Blair, S.N (2000). Alcohol intake and incidence of type 2 diabetes in men. *Diabetes Care* 23, 18-22.

Wiesenthal, S. R., Sandhu, H., McCall, R. H., Tchipasshvili, V, Polonsky, K., Shi, Z. Q., Lewis, G. F., Mari, A and Giacca, A (1999). Free fatty acids impair hepatic insulin extraction in vivo. *Diabetes* 48, 766-774.

Winder, W. W and Hardie, D. G (1999). AMP-activated protein kinase, a metabolic master switch: possible roles in type 2 diabetes. *American Journal of Physiology* 277, E1-E10

WHO (1995). Physical Status; the Use and Interpretation of Anthropometry. WHO Technical Report Series. WHO, Geneva.

WHO/ISH (1999). E:\Braun - WHO-ISH 1999 2.htm

WHO (1999). Definition, diagnosis and classification of diabetes mellitus and its complications: Report of WHO consultation. Geneva.

WHO (1996). Control of hereditary diseses. Report of a WHO Scientific Group. WHO Technical Report Series. Geneva 865, 31.

WHO (2003). Fruit and Vegetable Promotion Initiative – report of the meeting. Geneva August ,2003.

WHO/FAO /UNU (2003). Protein and amino acid requirements in human nutrition. Report of a Joint WHO/FAO/UNU Expert Consultation. Geneva. World Health Organization (in press).

WHO (1996). Hypertension Control: Report of a WHO Expert Committee. WHO Technical Report Series.862. Geneva.

Williams S, R (1994). Essentials of Nutrition and Diet Therapy. Sixth editions. Mosby Year Book, Inc. St Louis.

Wolk, A., Mason, J.E., Stampfer, M.J., Colditz, G.A., Hu, F.B., Willett, W. C., Speizer, F.E and Hennekens, C.H (1999). Long –term intake of dietary fiber and decreased risk in coronary heart disease among women. *Journal of the American Medical Association*. 281, 1998-2004.

Yang, E. J., Kerver, J. M., Park, U. K., Kayitsinga, J., Allison, D. B and Song W. O (2003). Carbohydrate intake and biomarkers of glycemic control among US adults: the third National Health and Nutrition Examination Survey (NHANES III). *Am J Clin Nutr* 77, 1426-1433.

Yao, M, and Roberts, S. B (2001). Dietary energy density and weight regulation. *Nutr Rev* 59, 247-258.

Zimmet, P., Faaiuso, S., Ainuu, J., Whitehouse, S., Milne, B and D Boer, W (1981). The prevalece of diabetes in the frural and urban Polynesian population of Western Samoa. *Diabetes* 30, 45-51.

http: // (www.ghanaweb.com).

APPENDIX 1:

Department of Nutrition and Food Science University of Ghana, Legon

Questionnaire on "Comparison of Diet of Confirmed Type 2 Diabetes Subjects at the National Diabetes Management and Research Center, with Non-Diabetic Subjects".

Section A Demographic Information **ID………..**

(1) Age (years) [1]< 20 [2] 21-30 [3] 31-40 [4] 41-50 [5] 50⁺ AGE ☐

(2) Gender [1] Female [2] Male GENDER ☐

(3) Marital status [1] Single] [2] Married [3] Divorced [4] Widower MARSTAT ☐

(4) Religion [1] Christian [2] Moslem [3] Traditional [4] Other RELIGION ☐

(5) Number of children [1] None [2] 1-3 [3] 4 -6 [4] 6⁺ NUMCHD ☐

(6) For how many years have you been diagnosed as diabetic? ______________________

Section B- Socioeconomic Characteristics

(7) Educational level [1] Primary [2] Secondary [3] Tertiary [4] Other EDULEV ☐

(9) (8) (8) Employment status [1] Unemployed [2] employed EMPSTAT ☐

[3] Pensioner

(9) Occupation ______________________________ ☐

(10) What is your net monthly income in cedis? [1]< 500,000 INCME

[2] 600.000-999,999 [3]1,000,000-2000, 000 [4]4 >2000, 000

Section C- Lifestyle

(11) Smoking status [1] Never smoked [2] stopped smoking [3] current smoker SMOK ☐

(12) Alcohol status [1] never drank [2] occasional drinker ALCOSTS ☐

[3] habitual drinker [4] stopped drinking

(13) How often do you sit during a typical day?

[1]Never [2] rarely [3] sometimes [4] most times SITDAY ☐

(14) How often do you walk during a typical day?

[1]Never [2] rarely [3] sometimes [4] most times WALKDAY ☐

(15) How often do you engage in strenuous physical activity e.g. jogging, running etc during a typical day? [1]Never [2] rarely [3] sometimes [4] most times APADAY ☐

(16) Have you ever received any dietetic advice?

[1] Yes [2] No DIETAVC ☐

(17) If yes, who advised you?

[1]Dietician [2] physician [3] nurse [4] all three WHOCONC ☐

[5] others

Section D- Biochemical and Anthropometric Information

Fasting plasma glucose mmol/l	
Blood pressure (mmHg)	
Pulse	
Height (cm)	
Weight (kg)	
Waist circumference (cm)	
Hip circumference (cm)	

Section F- Food Frequency Questionnaire

I am going to read out a list of various foods. Tell me how many times you eat them on average every week. (NK-Not known)

Foods	**1**	**2**	**3**	**4**	**9**	**CODE**	
Staples							**FQ**
Waakye	0x	1x	2-4x	5-9x	NK	WK	
Jollof rice	0x	1x	2-4x	5-9x	NK	JR	
Kenkey	0x	1x	2-4x	5-9x	NK	KK	
Fufu	0x	1x	2-4x	5-9x	NK	FF	
Banku	0x	1x	2-4x	5-9x	NK	BK	
Kokonte	0x	1x	2-4x	5-9x	NK	KT	
Yam	0x	1x	2-4x	5-9x	NK	YM	
Gari	0x	1x	2-4x	5-9x	NK	GR	
Unripe plantain	0x	1x	2-4x	5-9x	NK	UP	
Ripped plantain	0x	1x	2-4x	5-9x	NK	RP	
Stews							
Okro stew	0x	1x	2-4x	5-9x	NK	OS	
Garden egg stew	0x	1x	2-4x	5-9x	NK	GE	
Kontomire stew	0x	1x	2-4x	5-9x	NK	KP	
Beans stew	0x	1x	2-4x	5-9x	NK	BS	
Brown stew	0x	1x	2-4x	5-9x	NK	BR	
Soups							
Light soup	0x	1x	2-4x	5-9x	NK	LS	
Groundnut soup	0x	1x	2-4x	5-9x	NK	GS	
Palm soup	0x	1x	2-4x	5-9x	NK	PS	
Okro soup	0x	1x	2-4x	5-9x	NK	OP	
Cereal and other Beverages							
Rice water	0x	1x	2-4x	5-9x	NK	RW	

Section F cont. (NK-Not known)

Foods	**1**	**2**	**3**	**4**	**9**	**CODE**	
							FQ
Maize/millet porridge	0x	1x	2-4x	5-9x	NK	MP	
Oats	0x	1x	2-4x	5-9x	NK	OT	
Vegetables							
Cabbage	0x	1x	2-4x	5-9x	NK	CB	
Carrot	0x	1x	2-4x	5-9x	NK	CR	
Cucumber	0x	1x	2-4x	5-9x	NK	CC	
Fresh tomatoes	0x	1x	2-4x	5-9x	NK	FT	
Fruits							
Pawpaw	0x	1x	2-4x	5-9x	NK	PP	
Orange	0x	1x	2-4x	5-9x	NK	OR	
Banana	0x	1x	2-4x	5-9x	NK	BN	
Mango	0x	1x	2-4x	5-9x	NK	MN	
Pineapple	0x	1x	2-4x	5-9x	NK	PP	
Miscellaneous							
Butter/ Margarine	0x	1x	2-4x	5-9x	NK	BM	
Milk	0x	1x	2-4x	5-9x	NK	MK	
Poultry	0x	1x	2-4x	5-9x	NK	PT	
Fish	0x	1x	2-4x	5-9x	NK	FH	
Meat	0x	1x	2-4x	5-9x	NK	MT	
Egg	0x	1x	2-4x	5-9x	NK	EG	
Alcohol	0x	1x	2-4x	5-9x	NK	EG	
Others							
	0x	1x	2-4x	5-9x	NK		
	0x	1x	2-4x	5-9x	NK		
	0x	1x	2-4x	5-9x	NK		

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My Ref. No:**MS-AA/C.2/Vo.9^A**
Your Ref. No.

September 9, 2005

Ms. Rebecca Kissiwa Anim,
Department of Nutrition and Food Science.
University of Ghana
Legon

ETHICAL CLEARANCE

Protocol Identification Number: MS-Et/M.01-P1.2/2005-06

The Ethical and Protocol Review Committee of the University of Ghana Medical School on 8th September 2005 unanimously approved your research proposal.

TITLE OF PROTOCOL: **Comparison of the Diet of Confirmed Type 2 Diabetes Subjects at the National Diabetes Management and Research Center, Korle-Bu, with Non-Diabetic Subjects.**

PRINCIPAL INVESTIGATOR: **Ms. Rebecca Kissiwa Anim**

This approval requires that you submit three-monthly review reports of the protocol to the Committee and a final full review to the Ethical and Protocol Review Committee at the completion of the study. The Committee may observe, or cause to be observed, procedures and records of the study during and after implementation.

Please note that any significant modification of this project must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this study to the Ethical and Protocol Review Committee within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this study. You will therefore be required to furnish the Committee with any manuscript for publication.

Please always quote the protocol identification number in all future correspondence in relation to this protocol.

Signed:..............................
PROFESSOR R.B. BIRITWUM
(CHAIRMAN, ETHICAL AND PROTOCOL REVIEW COMMITTEE)

cc: Dean
Head of Department

APPENDIX 3: Background characteristics of subjects (Frequencies and percentage).

	Diabetic subjects (D^+)			Non- diabetic subjects (D^-)		
Variable	Male n =75	Female n =76	All n= 151	Male n= 68	Female n= 72	All n=140
Age (yrs)[1]						
21-30	-	1 (1.3)	1 (0.7)	3 (4.4)	1 (1.4)	4 (2.9)
31-40	7 (9.3)	10 (13.2)	17 (11.3)	17 (25.0)	12 (16.7)	29 (20.7)
41-50	18 (24.0)	14 (18.4)	32 (21.2)	18 (26.5)	18 (25.0)	36 (25.7)
51-60	24 (32.0)	31 (40.8)	55 (36.4)	13 (19.1)	24 (33.3)	37 (26.4)
61-70	18 (24.0)	18 (23.7)	36 (23.8)	12 (17.6)	13 (18.0)	25 (17.9)
70+	8 (10.7)	2 (2.6)	10 (6.6)	5 (7.5)	4 (5.6)	9 (6.4)
Marital status						
Single	11 (14.9)	11 (14.3)	22 (14.6)	15 (22.1)	15 (20.8)	30 (21.4)
Married	61 (81.1)	42 (55.8)	103 (68.2)	49 (72.1)	39 (54.2)	88 (62.9)
Divorced	-	7 (9.1)	7 (4.6)	4 (5.9)	10 (13.9)	14 (10.0)
Widowed	3 (4.1)	16 (20.8)	19 (12.6)	-	4 (11.1)	8 (5.7)
Religion						
Christian	67 (89.2)	66 (87.0)	133 (88.1)	66 (97.0)	72 (100.0)	138 (98.6)
Moslem	8 (10.8)	8 (10.4)	16 (10.6)	1 (1.5)	-	1 (0.7)
Traditional	-	2 (2.6)	2 (1.3)	1 (1.5)	-	1 (0.7)
Parity						
None	7 (9.5)	3 (3.9)	10 (6.6)	10 (14.7)	13 (18.1)	23 (16.4)
1-3	18 (23.0)	27 (36.4)	45 (29.8)	33 (48.5)	29 (40.3)	62 (44.3)
4-6	27 (36.5)	26 (33.8)	53 (35.1)	23 (33.8)	26 (36.1)	49 (35.0)
6+	23 (31.1)	20 (26.0)	43 (28.5)	2 (2.9)	4 (5.6)	6 (4.3)
Years since diagnosis[2]						
1-5	44 (58.7)	46 (60.5)	90 (59.6)			
6-10	20 (26.7)	20 (26.3)	40 (26.5)			
11-15	6 (8.0)	5 (6.7)	11 (7.3)	NA	NA	NA
16-20	4 (5.3)	2 (2.6)	6 (4.0)			
21-25	1 (1.3)	1 (1.3)	2 (1.3)			
26-30	-	2 (2.6)	2 (1.3)			

APPENDIX 4: Waist-to- Hip Ratio and BMI classification

Waist-To Hip-Ratio Rating Scale		
Classification	**Men**	**Women**
Normal / healthy	≤ 0.90	≤ 0.85
Central obesity	> 0.90	> 0.85

Source: Report of a WHO consultation, 1999

BMI Values.	Interpretation.
<18.5	Thinness/ Underweight.
18.5-24.9	Normal.
25.0-29.9	Overweight.
30.0 +	Obese

Source; WHO, 1995

Appendix 5: Glucose GOD-PAP

Principles of reaction

Glucose in sample is oxidized by glucose oxidase (GOD) to gluconic acid and hydrogen peroxide. The produced hydrogen peroxide reacts in the presence of peroxidase (POD) with p-hydroxybenzoic acid and 4-aminoantipyrine forming a red colored compound with a peak of absorption at 505nm. The intensity of the formed color is proportional to the glucose concentration when measured at 505nm (490 to 550).

$$\text{D-Glucose} \xrightarrow{\text{GOD}} \text{D-Gluconic acid} + H_2O_2$$

$$H_2O_2 + \text{p-HBA} + \text{4-AAP} \xrightarrow{\text{POD}} H_2O + \text{Colored comp.}$$

Appendix 6: Nutrient intake recommendations

Nutrient	% Contribution to total energy	Recommended daily allowance		
Carbohydrate	55% - 75%	Male	130g/d	
		Female	130g/d	
Protein	10% - 15%	Male	56g/d	
		Female	46g/d	
Energy	-	Male	25y-50y	2,900 kcal
			50^+	2,300 kcal
		Female	25y-50y	2,200 kcal
			50^+	1,900 kcal
Dietary fiber	-	Male	25y-50y	38 g/d
			50^+	30g/d
		Female	25y-50y	25 g/d
			50^+	21 g/d
Dietary fat	15% - 30%		*ND*	

ND: Not Determined

Source: WHO/ FAO/UNU, 2003; FAO/ WHO, 1998; FAO/ WHO 1994; Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol protein and amino acids, 2002.