

**CONSUMPTION OF OMEGA-3 FATTY ACIDS AND THE RISK OF TYPE 2
DIABETES MELLITUS AMONG A RURAL AND AN URBAN POPULATION
IN KENYA. //**

By

WANJIHIA VIOLET WANJIKU (B.Ed- Home-Economics)

Reg. No. I57/11591/04

Department of Public Health, Kenyatta University

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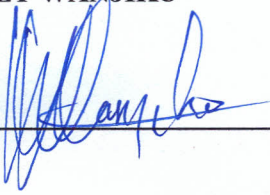
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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

WANJIHIA VIOLET WANJIKU
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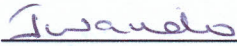
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This thesis has been submitted for examination with our approval as university supervisors.

1. PROF. JUDITH N. WAUDO**Dean, Graduate School****Kenyatta University**

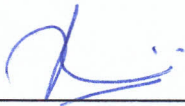
SIGNED



DATE

2/7/08**2. DR. MICHAEL F. OTIENO****Chairman, Pre-clinical sciences Department,****Kenyatta University**

SIGNED



DATE

03/07/2008

DEDICATION

To my mum, Teresa, my dad, Peter, and my son, Peter, who have been the fire in my step, every inch of the way.



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EBENEZER- FOR THIS FAR, THE LORD HAS WALKED WITH ME.

I am greatly indebted to my family who planted the first seed for the desire to set off this work; my mum, **Teresa**, my dad, **Peter**, my son **Peter jr.**, and my siblings, for their patience, encouragement and understanding during the course of my studies.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
DHA	Docosahexaenoic Acid
DM	Diabetes Mellitus
ELISA	Enzyme Linked Immunosorbent Assay
EPA	Eicosapentaenoic Acid
FBG	Fasting Blood Glucose
FFA's	Free Fatty Acids
GI	Glucose Intolerance
HDL	High Density Lipoproteins
IFG	Impaired Fasting Glucose
IGT	Impaired Glucose Tolerance
IR	Insulin Resistance
LDL	Low Density Lipoproteins
MSA	Metropolitan Statistical Areas
NCHS	National Center for Health Statistics
NG	Normal Glycemic
NIDDM	Non-Insulin-Dependent-Diabetes- Mellitus
OGTT	Oral Glucose Tolerance Test
O3FA	Omega 3 Fatty Acids
T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organisation

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ABSTRACT

Background: Both the amount and quality of dietary fat may modify glucose tolerance and insulin sensitivity. A high fat content in the diet may result in deterioration of glucose tolerance by mechanisms like decreased binding of insulin to its receptors and consequently impaired glucose transport. Our bodies need fat. However, it must be the right kind. O3FA are a form of polyunsaturated fats, Key O3FA includes eicosapentaenoic acid (EPA C 20,5) and docosahexaenoic acid (DHA C22,6), both found primarily in fish, they are increasingly recognized as important to human health but it is not yet clear how beneficial they can be in averting the risk of T2DM.

Objective: to compare the risk of T2DM, in relation to O3FA (DHA & EPA) intake among a rural population whose traditional diet comprised of fish rich in Omega 3 Fatty Acids and an urban population whose diet had evolved from a traditional one and can now be termed as "modern".

Methods: A descriptive, cross-sectional comparative survey. The risk of T2DM was determined in a rural and an urban community in Kenya, by measuring factors such as Impaired Glucose Tolerance (IGT), Impaired Fasting Glucose (IFG) according to WHO diagnostic criteria. Obesity was also measured via Body Mass Index. The intake of O3FA (EPA & DHA) was determined using a 24 Hr, dietary recall that recorded the type and quantity of fish ingested. A total of 623 subjects, 405 rural (185 men, 220 women) and 218 urban (125 men and 93 women) aged 20-60 were included in the study. The rural population was drawn from Nyang'oma division of Bondo district and the urban population was drawn from Nairobi. Data was analysed using SPSS and Nutri-Survey Program. Pearson Correlation Coefficient was used to test correlation between O3FA consumption and factors associated with the risk of T2DM. The inter-group comparisons were performed by using an independent-sample *t* test and a one-way analysis of variance followed by Duncan's Multiple Range Test.

Results: The prevalence of IGT, IFG & BMI was found to be higher among the urban population, as well as among the females for both rural & urban populations. There was also a significant positive correlation between age and prevalence of IGT ($r=0.204$, $p<0.05$) & BMI ($r=0.174$, $p<0.05$). The difference between BMI levels among males and females was also very significant $p=0.003$, with a majority of the females presenting very high levels. EPA & DHA were found to be consumed in the rural areas at a mean of 0.5964 and 0.0163 per day respectively and a mean of 0.1156 and 0.0137 respectively in the urban area. There was a highly significant negative correlation between EPA & DHA consumption and factors related to the risk of T2DM like IGT, IFG and BMI. The level of significance was considered at $P<0.05$.

Conclusion: There is evidence of a high inverse correlation between the factors associated with the risk of T2DM and consumption of O3FA. The rural population who consumed a lot of O3FA, recorded lower levels of the risk factors, than the urbanites who had much lower consumption.

Recommendation: Effective screening methods should be used at the existing health units to determine IGT and IFG patients and advise them accordingly on lifestyle changes

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Diabetes Mellitus (DM) is a metabolic disorder characterized by chronic hyperglycaemia with disturbances in carbohydrate, fat and protein metabolism. This arises from a defect in insulin secretion, action or both (WHO, 1999). Two distinct types of Diabetes Mellitus are Type I Diabetes Mellitus (Also called Insulin Dependent Diabetes Mellitus (IDDM) that is characterized by destruction or dysfunction of pancreatic cells and effectively no insulin production. It accounts for 5-10% of all diabetes cases. The second one is Type II Diabetes Mellitus (Also called Non-Insulin Dependant Diabetes Mellitus (NIDDM), characterised by either insufficient insulin secretion or insensitivity to its action. It accounts for about 90-95% of all cases (National Diabetes Fact Sheet, 2002).

The effects of diabetes mellitus are long-term damage, dysfunction and failure of various organs. In patients with T2DM, hyperglycaemia is highly associated with microvascular and macrovascular complications (Stratton *et al*, 2000).

Impaired glucose tolerance and impaired fasting glucose form an intermediate stage in the natural history of diabetes mellitus. Impaired Glucose Tolerance (IGT) is defined as two-hour glucose levels of 140 to 199 mg per dL (7.8 to 11.0 mmol per L) on the 75-g oral glucose tolerance test. Impaired Fasting Glucose (IFG) is defined as glucose levels of 100 to 125 mg per dL (5.6 to 6.9 mmol per L) in fasting patients, according to WHO criteria (WHO, 1999). These glucose levels are above normal but below the level that is diagnostic for diabetes. Patients with impaired glucose tolerance or impaired fasting glucose have a significant risk of developing diabetes and thus they can be termed as having a high susceptibility or pre-disposition to Type 2 Diabetes Mellitus (WHO, 2003).

Susceptibility to Type II Diabetes Mellitus should be considered in obese patients with a body mass index greater than 30 kg per m², and visceral obesity, patients having a first degree relative suffering type 2 diabetes mellitus, those with sedentary lifestyle and hypertension. Also in patients with high triglycerides (>250 mg/dL) or low HDL-C (High Density Lipoproteins- Cholesterol (<35mg/dL) those with “apple body shape”, characterised by high waist-to-hip ratio. Age is also a pre-disposing factor, where people over 40 years are vulnerable (Isley, Oki and Schade, 2004).

Our bodies need fat. However, it must be the right kind. The fatty acids that are required for good health and that cannot be made by our bodies are called essential fatty acids (EFAs). EFAs are needed by every living cell in our body. They are essential for rebuilding and producing new cells. One category of EFAs is omega-3. An excellent source of omega-3 EFAs is fish (Storlein *et al*, 1991).

O3FA are a form of polyunsaturated fats, one of four basic types of fat that the body derives from food. (Cholesterol, saturated fat, and monounsaturated fat are the others.) All polyunsaturated fats, including the omega-3s, are increasingly recognized as important to human health (Rotella, 2004).

1.2 Statement Of The Problem

At a global level, the diabetes epidemic is being fuelled by rapid cultural and social changes. It is occurring concurrently with increased urbanisation and with a modernisation or westernisation of lifestyle (Osei, 2003). These changes normally include a shift from a low-fat and largely unprocessed plant food or “natural” diet and high physical activity to an “affluent” high-fat diet that includes more saturated fat and cholesterol and low physical activity (Jenkins, *et al*, 2003, van Dam *et al*, 2002).

In Africa, diabetes prevalence is much higher in urban than rural areas, with subjects demonstrating elevated blood pressure and triglycerides levels (Motala, Omar and Pirie, 2003). In Africa alone, the predicted increase in Type II Diabetes is approximately 50% (from 9.4 million to 14.1 million) between 2001 and 2010 (Osei, 2003). This is therefore a clear indication that a good number of the population in the developing world are in the pre-diabetes stage, worse still, they may not be aware of it and hence will eventually proceed to T2DM or even suffer microvascular and macrovascular damage resulting from asymptomatic hyperglycaemia.

In Kenya today there is the “Nyama choma” and fast food culture that is part of the urban lifestyle resulting to a departure from a low fat and natural diet. This is giving rise to many lifestyle diseases formerly believed to be diseases of “affluence” but which are now afflicting people across all socio-economic strata and ages.

1.3 Research Questions

- How does consumption of O3FA in fish and fish oils influence the risk of developing T2DM?
- How does consumption of O3FA affect the IGT and FBG levels in rural and urban populations?
- How does consumption of O3FA affect the BMI levels of rural and urban populations?

1.4 Objectives

1.4.1 General Objective

The general objective of this study was to compare the risk of T2DM, in relation to O3FA (DHA & EPA) intake among a rural population whose traditional diet comprised of fish rich in Omega 3 Fatty Acids and an urban population whose diet had evolved from a traditional one and can now be termed as “modern”.

1.4.2 Specific Objectives

- a) To measure and compare IGT and IFG levels in a rural and an urban population.
- b) To measure and compare BMI levels of a rural and an urban population.
- c) To determine and compare intake of O3FA and relate this to IGT, IFG and BMI levels among the rural and urban population.

1.5 Significance Of The Study

There is a dramatic increase in incidence of T2DM as predicted in the developing world by the WHO. The World Health Organization expects 150 million new diabetic cases by 2025, of which 70% will occur in the developing world.

Clinically, early detection of diabetes provides an opportunity to reduce the progression of microvascular or macrovascular diseases caused by asymptomatic hyperglycemia. The study aimed at identifying the key risk factors for Type II Diabetes Mellitus, which gave a clear indication of the extent of the hidden diabetic epidemic waiting to happen.

This study was also geared towards exploring whether O3FA in fish, play a role in the control of these risk factors as opposed to saturated fats, which have been proven to elevate them.

It was of great importance to compare two populations starkly contrasting by way of lifestyle, optimally diet, so as to mark the extent to which Populations that are in transition from a traditional lifestyle and diet towards modernization suffer the risk of T2DM. Having the two populations; one in the rural areas and another one in the urban area and studying these two simultaneously in a cross-sectional study, eliminated the need to have a cohort study to follow migrating communities and see what long term effect their change in diet was going to have on the factors associated with the risk of T2DM.

1.6 Study Limitations

It was not possible to link other aspects associated to susceptibility to T2DM, like genetics and physical activity and exercise as this would have expanded the study significantly and made the cost of investigation prohibitive, where funds were limited. It was also not possible to control these factors.

1.7 Assumptions of the study

- It was assumed that there was low fish consumption among the urban area population and relatively higher fish consumption among the rural area population.
- It was assumed that there was high cholesterol and saturated fats intake among the urban area population and relatively low consumption among the rural area population.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Diabetes in Urban & Rural Areas

A higher prevalence of diabetes was found in urban (8.1%) compared with rural populations (2.3%) in Bangladesh (Hussain, 2005). Prevalence of T2DM in rural areas remains low but urban areas are experiencing an increase in prevalence.

This is clearly demonstrated in a preliminary community survey for diabetes in the Bo District of Southern Sierra Leone, there was a prevalence of 2.4% in the urban population, and 0% in the rural villages (Ceesay *et al.*, 1997).

In some rural areas, nevertheless, diabetes may increasingly become a public health concern. According to Rural Healthy People survey, diabetes was identified as the third highest ranking rural health concern (Gamm *et al.*, 2002). It is therefore very crucial to have the risk factors of the rural inhabitants explored so as to avert the danger it may cause.

2.2 Overview of some factors associated with risk to T2DM

Metabolic syndrome is a cluster of risk factors such as central obesity, dyslipidemia, glucose intolerance, hypertension and insulin resistance (Isley, Oki and Schade, 2004).

Unfortunately, many people in the pre-clinical stages of diabetes have not been diagnosed. By the time blood glucose becomes elevated to the clinical definition of diabetes, irreversible complications may have occurred (Harris, 2001).

2.2.1 Hyperglycemia

Diagnosis of diabetes is solely determined by the demonstration of hyperglycemia (Table 1). Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) form an intermediate stage in the natural history of diabetes mellitus (WHO, 1999).

Impaired glucose tolerance is defined as two-hour glucose levels of 140 to 199 mg per dL (7.8 to 11.0 mmol per L) on the 75-g oral glucose tolerance test, and impaired fasting glucose is defined as glucose levels of 100 to 125 mg per dL (5.6 to 6.9 mmol per L) in fasting patients. These glucose levels are above normal but below the level that is diagnostic for diabetes (WHO, 1999). Patients with impaired glucose tolerance or impaired fasting glucose have a significant risk of developing type 2 diabetes mellitus (Rao, Disreali and McGregor, 2004)

Table 2.1: Values for diagnosis of Type II Diabetes Mellitus.

Diagnostic blood glucose concentrations mmol/L (mg/dl)					
Diagnosis	Sample	Venous plasma	Venous blood	Capillary blood	Capillary plasma
Normal	fasting	< 6.1	< 5.6	< 5.6	< 6.1
IFG	fasting	$\geq 6.1 (\geq 110)$ & < 7.0 (< 126)	$\geq 5.6 (\geq 100)$ & < 6.1 (< 110)	$\geq 5.6 (\geq 100)$ & < 6.1 (< 110)	$\geq 6.1 (\geq 110)$ & < 7.0 (< 126)
	2 h post glucose	< 7.8 (< 140)	< 6.7 (< 120)	< 7.8 (< 140)	< 8.9 (< 160)
IGT	fasting	< 7.0 (< 126)	< 6.1 (< 110)	< 6.1 (< 110)	< 7.0 (< 126)
	2 h post glucose	$\geq 7.8 (\geq 140)$ & < 11.1 (< 200)	$\geq 6.7 (\geq 120)$ & < 10.0 (< 180)	$\geq 7.8 (\geq 140)$ & < 11.1 (< 200)	$\geq 8.9 (\geq 160)$ & < 12.2 (< 220)
DM	fasting	$\geq 7.0 (\geq 126)$	$\geq 6.1 (\geq 110)$	$\geq 6.1 (\geq 110)$	$\geq 7.0 (\geq 126)$
	2 h post glucose	$\geq 11.1 (\geq 200)$	$\geq 10.0 (\geq 180)$	$\geq 11.1 (\geq 200)$	$\geq 12.2 (\geq 200)$

Source: (WHO, 1999).

2.2.1.1 IGT levels in rural and urban populations

The prevalence of diabetes and IGT was determined in a rural and urban community in Cameroon using the 75-g OGTT according to WHO diagnostic criteria (WHO, 1999).

The prevalence of diabetes in the rural and urban population respectively was 0.9% and 0.8% for men and 0.5% and 1.6% for women. The prevalence of IGT was 5.8% and 1.8% for men, and for women, 2.2% and 2.0% in rural and urban populations respectively. These data indicated a low prevalence of diabetes in Cameroon; however, the prevalence of IGT suggests an early stage of a diabetes epidemic, especially among the rural population (Mbanya *et al*, 1997).

In a study conducted in Pleszew, Poland, to assess the prevalence of undiagnosed diabetes in a population of professionally active inhabitants, who claimed to be healthy, clinically latent diabetes or impaired glucose tolerance was found in 5.3% cases. 92.8% patients with IGT or diabetes were obese or overweight (BMI > 25 kg/m²) (Weirusz-Wysocka *et al*, 2001).

The prevalence of IGT and T2DM in a rural population in South India was assessed from inhabitants of two villages located in the North Arcot District of Tamil Nadu. After an overnight fast, 467 randomly selected subjects, aged 40 years or over, were given 75 g glucose orally. After two hours the capillary glucose level was determined. The prevalence of IGT (2 h value \geq 7.8 mmol/l and < 11.1 mmol/l) was 6.6% (31 subjects). T2DM (2 h value \geq 11.1 mmol/l) was found in 23 subjects (4.9%). Of these, 53% were previously unknown. The findings suggest that in a considerable proportion (11.5%) of the rural South Indian population aged 40 years or over have glucose intolerance (Patandin *et al*, 1994).

2.2.2 Visceral Obesity

Accumulation of fat in the upper body is associated with metabolic complications of obesity and with the development of the metabolic syndrome. Insulin resistance is responsible for this association and it is frequently present in individuals with upper-body obesity (Evans, Murray and Kissebah, 1984). Visceral or abdominal obesity is a greater indicator and a powerful determinant of the risk of developing T2DM than BMI (Chan, J.M., *et al.*, 1994). In a study conducted in Japanese American men for instance, the intra-abdominal fat, as measured from CT scans, was the best anthropometric predictor of diabetes incidence (Boyco *et al.*, 2000).

Increased visceral fat mass is associated with glucose intolerance (Despres, 1993). Insulin sensitivity correlates with visceral fat mass in normal subjects (Goodpaster *et al.*, 1999) and in people with type 2 diabetes (Bernaji *et al.*, 1997).

2.2.3 Obesity

Obesity is a frequent concomitant of T2DM and has been shown to be a powerful predictor of its development (Colditz *et al.*, 1990). It has been observed that an increase in obesity is accompanied by an increasing prevalence of type 2 diabetes (Mokdad *et al.*, 2001).

Data from the Nurses' Health Study suggest that the lowest risk of diabetes occurs in individuals who have a body mass index (BMI) <21, with increasing prevalence seen as obesity levels increase (Colditz *et al.*, 1990). A person's body mass index is used to determine obesity.

2.3 The role of dietary fat in T2DM

Both the amount and quality of dietary fat may modify glucose tolerance and insulin sensitivity (Hu, *et al.*, 2001). A high fat content in the diet may result in deterioration of glucose tolerance by mechanisms like decreased binding of insulin to its receptors and consequently impaired glucose transport (Grundleger and Thenen 1982). The fatty acid composition of the diet, in turn, affects tissue phospholipids composition, which may relate to insulin action by altering membrane fluidity and insulin signalling (Storlein *et al.*, 1996).

Higher proportions of saturated fatty acids intake has been associated with higher fasting insulin concentrations (Marshall *et al.*, 1997) and a lower insulin sensitivity index and consequently, higher risk of type 2 diabetes (Lovejoy and Di Girolamo, 1992). On the other hand, there are several studies, which show no association between diabetes risk and total fat intake (Feskens, *et al.*, 1991, Salmeron *et al.*, 2001, Colditz *et al.*, 1992). It was important for this study to be able to establish the risk of T2DM occasioned by saturated fat vis-à-vis polyunsaturated fats like O3FA.

2.4 Omega-3 Fatty Acids and T2DM

Key O3FA includes eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), both found primarily in fish. Plant foods rarely contain EPA or DHA. However, a third omega-3, called alpha-linolenic acid (ALA), is found primarily in dark green leafy vegetables, flaxseed oils, and certain vegetable oils, like canola, soybean oil, pumpkin seed oil and walnut oil. ALA must be converted to EPA before it exerts biological effects similar to EPA, in the human body (Nettleton, 1991).

Omega-3 fatty acids have been known to increase the sensitivity to insulin in diabetic patients and also to lower triglycerides and low-density lipoproteins (Friedberg, *et al.*, 1998). However the role of Omega 3 Fatty Acids in contributing to or averting the risk of T2D in non-diabetic subjects is not very clear. Studies indicating the effect of O3FA on the risk or predisposition of T2DM in non-diabetic patients are needed (Montori *et al.*, 2000).

There was a paucity of literature among the Kenyan population as regarding the pre-diabetes syndrome and diet in relation to Type II Diabetes.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Introduction

This study was geared towards comparing the risk of T2DM, in relation to O3FA (DHA & EPA) intake among a rural population whose traditional diet comprised of fish rich in Omega 3 Fatty Acids and an urban population whose diet had evolved from a traditional one and can now be termed as “modern”. It was conducted in Nyang’oma division of Bondo district as well as in Nairobi.

3.2 The Study Design

The study was a descriptive, comparative, cross-sectional survey where a total of 663 subjects from the rural community in Bondo district and an urban community in Nairobi were sampled.

There was no intervention carried out but the two populations were compared in a study that involved the collection of data only once.

3.3 Variables

3.3.1 Dependent variables

The risk of T2DM was the outcome or the dependent variable. It was determined using the variables of hyperglycaemia measured using fasting blood glucose, Oral Glucose Tolerance Test according to WHO criteria and Glycated haemoglobin. The Glucose 201+ analyzer using the Glucose oxidase method was used to determine blood sugar.

Other variables for the risk of T2DM were Obesity and Visceral fat.

3.3.2 Independent variables

The independent or predictor variables included the diet of the participants. This was the Omega 3 Fatty acids and the Cholesterol laden or the highly refined and processed foods. Data on this was collected using a 24 hr recall schedule. A software called Nutri-Survey Program was used for calculation of amount of nutrients ingested by the subjects, as well as the O3FA.

3.4 Location of the study

Bondo District is one of the 12 districts in Nyanza Province of Kenya. It is a relatively new district, having been created from the southern part of Siaya District as recently as 1998. It has a population of about 238 780 living in 56 607 households as per Republic of Kenya 1999 population census. Bondo District has five divisions, namely Maranda, Madiany, Rarieda, Nyang'oma and Usigu. Each of them borders Lake Victoria.

The economy of Bondo District is dominated by fishing, small-scale cropping, and animal husbandry. The district has approximately 175 kilometres of shoreline along the eastern part of Lake Victoria. It was chosen based on the traditional life-style it maintains, and the dietary intake, mainly of fish, which is easily available and inexpensive all-year round. Poverty here is mainly due to inadequate access to clean water, health services, sanitation and food. Various stakeholders and development partners within the district address food insecurity and poor resource management as major causes of poverty in the district. The map of Bondo District is indicated in appendix 6.1.1.

In the rural area of Bondo district, Nyang'oma division was purposively sampled since fishing and fish consumption is intensive by virtue of its proximity to the Lake and

extensive shoreline dotted by numerous fishing ports (Wagusu, Wichlum, Ludhi, Uyawi, Sirongo among others) which exceed those of any other division around L.Victoria. Nyang'oma division has a population of 38,853 and a household size of 9,555 (Republic of Kenya, 1999 Census). The map of Nyang'oma division is indicated in appendix 6.1.2.

The comparison group was obtained from the cosmopolitan area of Nairobi which is the capital city in Kenya, where people are likely to migrate to from the rural areas and as a consequence, adapt a change in lifestyle and also change their diet to a more urbanised or westernised one. These changes may include a shift from a low-fat and largely unprocessed plant food or "natural" diet and high physical activity to an "affluent" high-fat diet that includes more saturated fat and cholesterol. It had also been postulated that the population in Nairobi was not likely to have as easier access to fish or to have high intake of fish as compared to our rural population of choice. Nairobi has a total population of 2,143,254 and a household size of 649,426 as per Republic of Kenya 1999 population census. The map of Nairobi is indicated in appendix 6.1.3.

3.5 The Target Population

The study population comprised of adults aged between 20-60 years in Nyan'goma Division of Bondo District and those from Nairobi. In T2DM, age is a pre-disposing factor, where people over 40 years are the most vulnerable although emerging trends indicate that young adults from the age of 20 years are also acquiring the disease due to lifestyle changes. Below the age of eighteen years there is IDDM (Insulin Dependent Diabetes Mellitus) characterised by destruction or dysfunction of pancreatic cells and effectively no insulin production. It accounts for 5-10% of all diabetes cases, so they did not qualify for the target population.

3.5.1 Inclusion criteria

- Age between 20 and 60 years.
- Had lived in study area for at least five years prior to the beginning of study.

3.5.2 Exclusion criteria

- Had not lived in the study area within the last five years and living less than 80% of the time in either of the settings.
- Pregnancy and/or chronic ailments other than diabetes.

3.6 Sampling techniques and sample size

3.6.1 Sampling techniques

Multi-stage sampling technique was used to Sample locations, sub-locations, villages and finally homesteads. The three administrative locations in Nyang'oma namely, south west Sakwa, south Sakwa and central Sakwa, as well as the seven sub-locations, villages and 9,555 homesteads were listed from the demographic data available from the latest surveys by the Central Bureau of Statistics (CBS). SPSS was then used to generate a stratified random list at every stage of locations, sub-locations, villages and finally that gave rise to the homesteads from which the study population was drawn. From each household, all adults between 20-60 years were listed. The sampling frame was the list of adults meeting the inclusion criteria in each homestead.

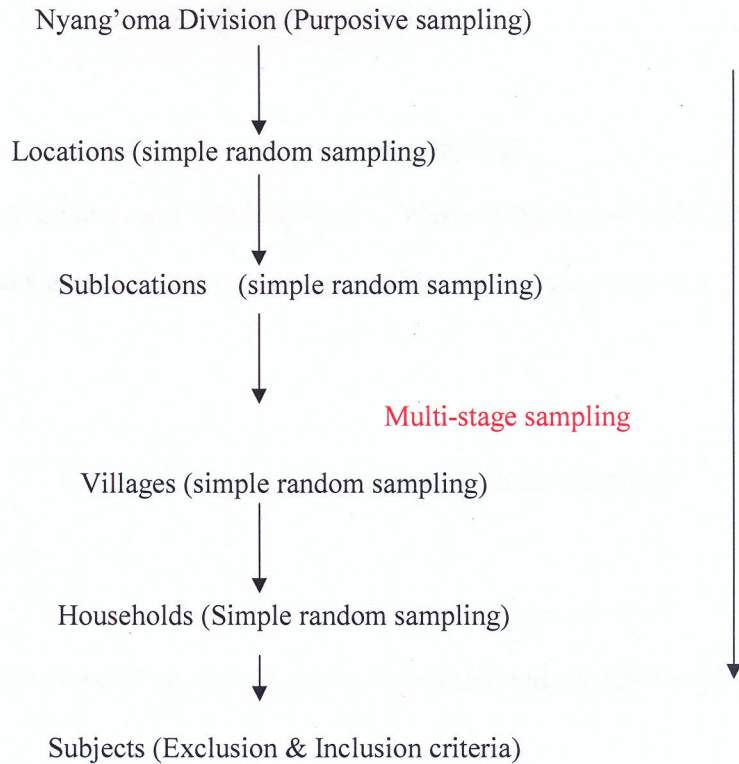


Figure 3.1: Sampling Process for Nyang'oma

For the urban area, in Nairobi, the multi-stage cluster sampling criteria was used. Nairobi's eight divisions were then divided into 3 fairly equal geographical areas, that is eastern (Dagoretti, Westlands and Kibera divisions), western (Embakasi and Kasarani divisions) and central (Central, Pumwani and Makadara divisions) zones, using a map of the city. Each zone was then divided into two sub-areas, to form six sub-areas in total and from each of these six sub-areas two worship centres were selected at random. From each selected twelve worship centres in the three zones, about thirty-eight individuals were chosen randomly from those who turned up following the mobilisation done on the particular day of worship, assuming a refusal rate of 20% adults between 20-60 years were listed to give 376 individuals.

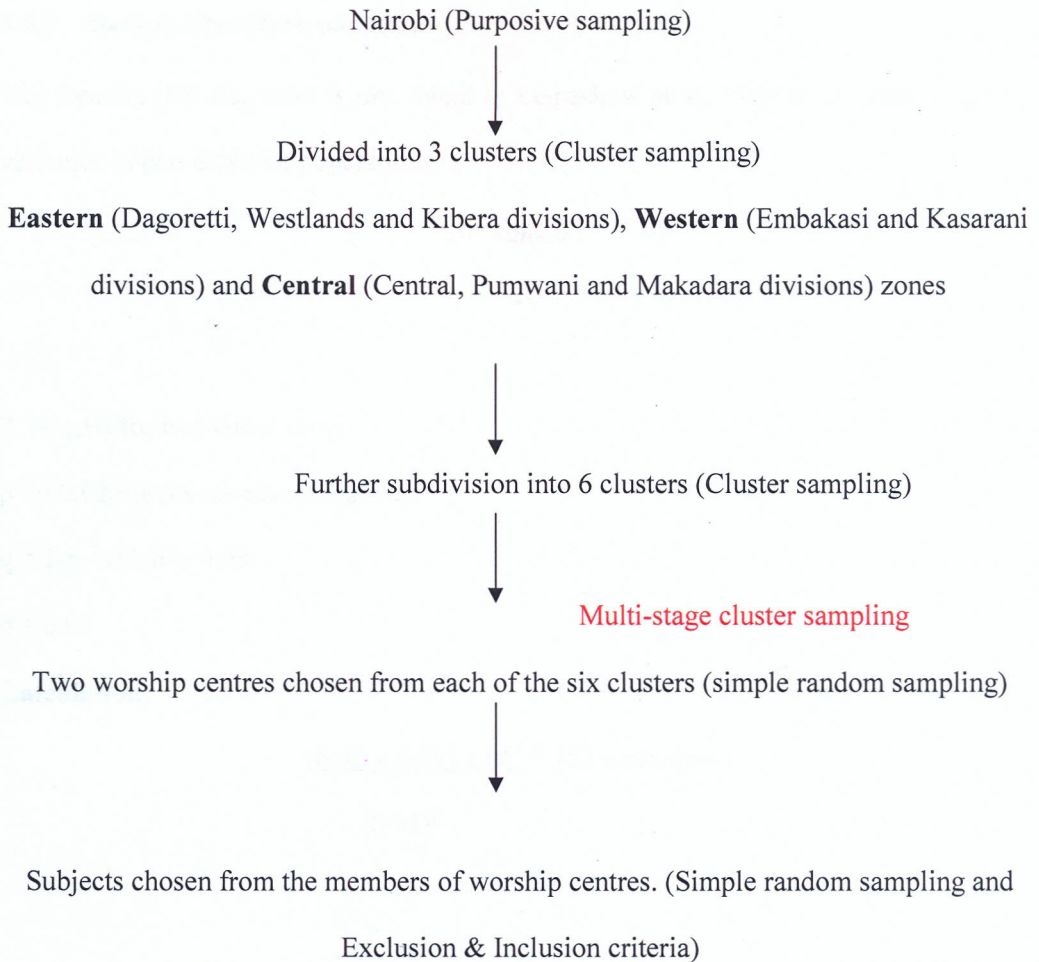


Figure 3.2: Sampling Process for Nairobi

3.6.2 Sample Size Determination

The formula that was used is one found in Lemeshow et al, 1990 to compare continuous variables in two different populations.

$$n = \frac{(pq) Z^2}{d^2}$$

$Z = 1.96$ for two tailed study

$p = 0.02$ the prevalence of diabetes

$q = 1-p$, which is 0.98

$d = 0.01$

Calculation:

$$\frac{(0.02 \times 0.98) 1.96^2}{(0.01)^2} = 752 \text{ participants}$$

3.7 Construction of data collection tools

Data collection tools included Food Frequency Schedule, 24 hour recall, Clinical assessment form, anthropometry and ultrasonography data form.

The Food Frequency and the 24 hr recall interview schedules are methods of nutritional assessment, which are indirect measures involving dietary assessment of the recall nature or assessing what has already taken place to obtain dietary history.

3.7.1 24 Hour Recall

This was an interview schedule that required the participant to recall all that they had ingested in the previous 24 hours, including snacks and fluids, from morning after rising, to the previous evening before effecting their fast. To be recorded was the time the meal

was ingested, where it was eaten, the type of dish, ingredients used to prepare it and method of preparation, as well as the serving amounts. The amounts were to be indicated in household units and measures, for instance cups and mugs. These utensils would be taken from the household prior to the study and pre-weighed with the amounts of food frequently consumed in that household, so that a code for a particular intake could be pre-determined. For foods where this was not possible, then actual food samples had to be provided at the scene of interview so that the participant could demonstrate their recalled intake, which would then be weighed. This way the 24 hour recall schedule, would provide both quantitative and qualitative information on dietary intake (Appendix 6.4.5).

3.7.2 Anthropometry measurement form

The Body Mass Index (BMI) was assessed using anthropometry, which was recorded in the anthropometry measurement form (Appendix 6.4.1).

A person's Body Mass Index (BMI) is used to determine obesity. This number is calculated by taking an individual's weight in kilograms and dividing it by the square of the person's height in meters. Thus defined, a body mass index of 18.5 to 25 kg/m² is deemed normal, over 25 is overweight, and over 30 implies obesity.

The participant's Height and weight was to be measured using a height meter and a bathroom scale respectively and these readings recorded.

To reduce the room for error, the readings would be recorded thrice and the average figure sought.

3.7.3 Clinical Assessment Form

Diagnosis of Impaired Glucose Tolerance and diabetes was done based on fasting blood glucose (FBG) sample and impaired glucose tolerance (IGT). After the initial blood

sample to determine fasting blood glucose, the subject was given an oral glucose load (75g) and blood collected again after 2 hours. The Glucose 201+ analyzer using the Glucose oxidase method was used to determine blood sugar. The results were entered in Blood sugar Assessment Form. Appendix 6.4.2.

In this form, previously diagnosed diabetics were also identified and were not subjected to the OGTT. Details of age and medication were obtained from them.

Anyone who had a Fasting Blood Glucose reading of over 6.9 mmol/L, was not subjected to an OGTT due to their likelihood of being an undiagnosed diabetic, they were instead taken through the glycated haemoglobin test and their blood sugar recorded.

3.8 Pilot Study

A Pilot study was carried out in Nyang'oma Division of Bondo District, where fifteen households were identified, with the help of the village chief and a local community worker. The Food frequency schedule and the 24hr recall were administered, to fifteen members of those households. Their anthropometric measurements were also taken.

The Food Frequency Schedule and 24 hr recall were found to be very long, and engaging the respondents for more than one hour. The Food Frequency Schedule was also found not to be sensitive to the diet of that particular region.

These three instruments were then modified, with the Food frequency and 24 hr recall being administered as different tools for shorter periods of time. The local diet was also put into consideration, as were the utensils commonly used in that region like cups, mug and plates.

A similar pilot study, bearing similar results was also carried out in the Makina area of Kibera, in Nairobi.

Following the pilot study, it was decided that it was easier to conduct the study in camps rather than from house-to-house, for easier handling of the equipment involved during taking some of the measurements like in ultrasonography where the ultrasound scan was used.

3.8.1 Validity

Validity of the instruments was ascertained by ensuring that the answers obtained during the pilot were exactly what was expected from the study, for the purpose of meeting the objectives of the study. Completed questionnaires were checked to ensure that all the questions had been answered correctly and consistently.

For the weighing scales, a 20kg iron weight was used to check the scale accuracy and ensure that the measurements taken were correct.

At regular intervals, the investigator and field assistant compared the measurement values and interview schedules from the same participant to ascertain that the measuring techniques were similar and to reduce inter-observer error.

3.8.2 Reliability

The field assistants were given thorough training on what was expected of them. They were grilled on how to take measurements like anthropometry and how to conduct interviews, without including bias. These assistants were closely supervised and in some instances, the measurements had to be taken by three different people to ensure that as close to the true figure as possible was attained. At various intervals and where possible, the interview or tests were conducted again at random on participants who had already been interviewed, to see whether the same results would be obtained.

3.9 Data collection technique

Study participants were mobilized with the help of the local administration that is the District Officer (D.O) and the chiefs in Nyang'oma and for Nairobi, the help of the religious ministers of the various worship centers chosen was enlisted.

After mobilization, the sampling was conducted as outlined above. The sampled population was advised on the day to report to the screening and interview center. On the reporting day, the participants were required to report early in the morning without having taken breakfast and after an overnight fast.

The following procedure was then observed:

- The participant was given the consent form which appeared in a language that they could understand. Voluntary participation was further emphasized. If the participant could not read, then a trusted aide would read and interpret the information given. The aims, methods, the anticipated benefits and potential risks of the study and any discomfort it would entail were made known to the participants.
- The participants were also informed of the right to abstain from participation in the study or to withdraw consent to participate at any time without reprisal and confidentiality was strictly observed.
- When the participant consented to all the stated, they signed the consent form or appended a thumb print.
- Interviews were carried out to provide general sociodemographic information.
- The participant then had an initial blood sample of 10 ml venous blood drawn from them. Serum collected was kept at -80°C . All blood samples were centrifuged to obtain plasma specimen and immediately frozen in dry ice. Measurement of impaired fasting glucose and glycated haemoglobin (HbA1c) was carried out before the subject was given an oral glucose load (75 g) in 300 ml water, for the oral glucose test. Blood was collected again after 2 hours to obtain the 2H IGT value according to WHO diagnostic

criteria. The Hemocue Glucose 201+ analyzer using the Glucose oxidase method was used to determine blood sugar.

- Dietary intake was assessed using a combination of 24-hour recall and food frequency questionnaire. For the 24-hr recall, the participants were required to recall their food intake for the previous day using food samples that were available on site for weighing, in order to record as near an estimate as possible to what the participant ingested.
- The participants' height and weight was also taken using a heightometer and bathroom scale respectively to determine obesity via Body Mass Index. For the weight measurement, the participant was required to stand on the bathroom scale without shoes and with minimum clothing. For the height, the participant was required to stand with their back against the heightometer with their heels, buttocks, back of the shoulders and back of the head touching it. Then the head part was brought down over the head of the participant to a comfortable level and the height reading taken. Both the height and the weight readings will be taken three times and their average calculated. BMI was calculated by taking an individuals weight in kilograms and dividing it by the square of the person's height in meters. A body mass index of 18.5 to 25 kg/m² is deemed normal, over 25 is overweight, and over 30 implies obesity.
- Visceral fat situated around the abdominal cavity was measured using ultrasonography where the participant was examined via an ultra sound scan and the level of fat observed within the abdomen measured and recorded. The left trunk, right trunk and mid trunk readings were recorded.

3.10 Data Analysis

Data coding, entry and analysis was done using SPSS. The data were first cleaned and verified.

Data were then entered using SPSS version 13.5 and Nutri-Survey Program.

Nutri-Survey Program was modified accordingly using local food composition tables indicative of the O3FA levels in the local fish ingested in the study areas. On input of the amount of fish ingested by a study subject, from the 24 Hr recall schedule, the Nutri-Survey program was able to calculate how much O3FA had been ingested by each person. The program was also able to calculate the individual and mean consumption of nutrients such as protein, energy, Vitamin A and iron.

Pearson Correlation Coefficient was used to test correlation between O3FA consumption and factors associated with the risk of T2DM. The inter-group comparisons were performed by using an independent-sample *t* test and a one-way analysis of variance followed by Duncan's Multiple Range Test. Descriptive statistics like mean, frequencies, percentages were used to describe data and bar charts and comparative line graphs to present data.

3.11 Ethical Considerations

Informed consent was sought from all participants. Each potential participant was adequately informed of the aims, methods, the anticipated benefits and potential risks of the study and any discomfort it would entail. This was done in a language that the participant could understand very well and in very clear, simple and unambiguous terms.

The participant was also informed of the right to abstain from participation in the study or to withdraw consent to participate at any time without reprisal.

Confidentiality was strictly observed.

After the participant had fully understood the information, their freely-given informed consent was obtained in writing. Those who could not write appended their thumb prints before a trusted witness.

Consent to conduct the study was also sought from the ethical review board at Ministry of Health, KEMRI Ethical Review Committee as well as the Post Graduate Board of Kenyatta University.

CHAPTER FOUR

4. RESULTS & DISCUSSION

4.1 Introduction

In this Chapter the results are presented according to the objectives. The factors pertaining to the risk of T2DM, these are, IGT, FBG and Obesity are discussed in the context of comparisons between rural and urban areas, comparisons between male and females as well as comparisons between different age groups.

The relationship between these risk factors and the consumption of O3FA have then been discussed based on the correlation between the risk factors and respective O3FA, that is EPA and DHA.

4.2 Socio-Demographic Characteristics

According to the 1999 Population and Housing Census report the population of Bondo District is 239 110 comprising 111 717 males, 126 348 females and 1 045 special population. The population growth rate is 1.8 per cent, having declined from 3.8 per cent in 1989. The crude birth rate was 13 out of 1 000 and crude death rate was 16.

Approximately 47.2 per cent of the population is poor and 41.1 per cent of households live below the poverty line. The morbidity rate in the district is 78 per cent, with malaria and HIV/AIDS taking the biggest toll. Fifty-five per cent of the population is below 15 years and 5 per cent is over 60 years.

Nairobi has a total population of 2,143,254 and a household size of 649,426 as per Republic of Kenya 1999 population census.

The population that was studied was as shown in the tables below;

Table 4.1:Composition of the study population according to sex

	LOCALITY	NUMBER
Male	Rural	185
	Urban	125
Female	Rural	220
	Urban	93

Table 4.2:Composition of the study population according to age groups

Age category	NUMBER
20-30	194
31-40	151
41-50	172
51-60	106

4.3 Impaired Glucose Tolerance levels

4.3.1 Impaired Glucose Tolerance levels among rural and urban populations

The prevalence of Impaired Glucose Tolerance (IGT) was 5.7% and 7.8% for the rural and urban population respectively. With the urban population having 86.2% of its population falling within the normal range of below 7.8 mmol/l reading after the oral glucose test and 6% of them falling within the diabetic range of above 11.1 mmol/l. The rural population had 93.3% of its population within the normal range and 1.0% within the diabetic range.

This study clearly illustrates that the prevalence of IGT is rising, which can be attributed to urbanization in many developing countries (King & Rewers, 1993).

True to expectations, the prevalence of IGT was higher in the urban than in the rural area, which can be as a result of increased urbanisation and with a modernisation or westernisation of lifestyle (Osei *et al*, 2003). This would include changes involving a shift from a low-fat and largely unprocessed plant food or “natural” diet and high physical activity to an “affluent” high-fat diet that includes more saturated fat and cholesterol and low physical activity (Dressler, 1984), (Dowse *et al*, 1991), (Jenkins *et al*, 2003), (Van Dam *et al*, 2002)

The prevalence of glucose intolerance among Saudi populations in urban and rural communities were investigated among 13177 subjects, 15 years and over, from different regions of Saudi Arabia. Age adjusted prevalence of T2DM was significantly higher in the urban population (males 12 %, 95 % CI 11-13 and females 14 %, 95 % CI 13-15) than in the rural population (males 7 %, 95 % CI 7-8 and females 7.7 %, 95 % CI 7-9) and is among the highest in the world. The prevalence of T2DM increased with age. The lowest and highest prevalence of T2DM in the urban population were 2 % for subjects aged 15-20 years and 49 % for female subjects aged 51-60 years, which is exactly the case with

the subjects that were studied in this case. The lowest and highest prevalence of T2DM among rural population were 1 % for subjects aged 15-20 years and 29 % for female subjects over the age of 60 years. The highest prevalence of obesity, BMI>30, was among urban female subjects. Age, obesity, and family history of T2DM were associated with the disease (Abdul-Rahim *et al*, 2003).

Table 4.3:Prevalence of Impaired Glucose Tolerance among both populations.

LOCALITY	MEAN 2HR BLOOD GLUCOSE Mmol/l	TWO HOUR < 7.8 (Normal)	TWO HOUR IN 7.8 TO 11.1 (IGT)	TWO HOUR > 11.1 (Diabetics)
Rural (N=405)	5.43	93.3%	5.7%	1.0%
Urban (N=218)	6.21	86.2%	7.8%	6.0%

The mean 2h value after the oral glucose tolerance test was therefore higher in urban than in rural populations, with a significant difference ($p < 0.05$) between the overall 2hr blood glucose mean for rural and urban populations.

4.3.2 IGT levels among males and females

The mean 2h value after the oral glucose tolerance test was higher for women than for men in both the rural and urban areas, at 5.8 ± 1.88 for women and 5.6 ± 2.48 for men. Women in total therefore demonstrated levels of IGT that were not significantly higher than men, ($p=0.259$) with the women in the urban area demonstrating even higher levels of IGT, than their rural counterparts. The same is true for the urban men however not at significant levels also.

In a study of over 60 year old women (N=2,595) in Goteborg Sweden, the prevalence of IGT was 14.4% and they also recorded higher values of BMI, waist girth and blood

pressure. This is a clear indication that there is a high correlation between age and Impaired Glucose metabolism especially among females. Among these women, 40% recorded having both IGT and FBG (Brohall *et al*, 2006).

In Australia where the prevalence of abnormal glucose intolerance is one of the highest yet reported from a developed nation, 17.4% of the men and 15.4% of the women from a national sample of 11,247 were found to be suffering from IGT (Dunstan *et al*,2002).

Table 4.4: Mean two-hour blood sugar level and prevalence Impaired Glucose Tolerance in both sexes

CATEGORY	MEAN (mmol/l)	IGT PREVALENCE
Rural Men	5.24 ^a (n=185)	4.9%
Rural Women	5.60 ^a (n=220)	5.6%
Urban Men	6.14 ^b (n=125)	6.4%
Urban Women	6.29 ^b (n=93)	10.8%

Means with the same letter superscript (Superscript ^a or ^b) are not significantly different. Those with different letter superscript are significantly different.

4.3.3 IGT levels among age groups

The two hour mean after oral glucose test was observed to increase with age, with the urban population above 40 yrs having a very high 2h mean as compared to their rural counterparts. There is a significant Positive correlation ($r = 0.204$, $p < 0.01$, $n = 663$) between age and the prevalence of IGT.

Above the age of fifty years, urban men and women had a 2h mean of 9.29 mmol/L and 7.30 mmol/L respectively, indicating that a majority of them were within the IGT range.

Table 4.5: Two hour mean blood glucose per age category

AGE CATEGORY	MEAN (mmol/l)	IGT PREVALENCE
20 – 30 Years	5.26 ^a (n=194)	2.6%
31 – 40 Years	5.43 ^{ab} (n=151)	4.0%
41 – 50 Years	5.91 ^b (n=172)	8.5%
51 – 60 Years	6.55 ^c (n=106)	9.2%

Means for groups in homogeneous subsets are displayed. Means with the same letter superscript are not significantly different.

The high 2h means observed in the age groups above 40 years, especially so among the urban populations of both sexes could be associated with the retirement phase where physical activity tends to reduce drastically.

This study also confirms the Russell-jones *et al* study where two populations of over 40 years of age were compared. The first population was located in a remote rural area and the other in an urban environment. Highly significant differences were observed in mean prevalence of impaired glucose tolerance. The higher value was associated with urban living. Thus urban living is associated with impaired glucose tolerance and diabetes (Russell-Jones *et al*, 1990).

Age and gender were confirmed to be very strongly correlated to impaired glucose tolerance as earlier observed in a study among rural and urban populations in Luzon, Philippines (Baltazar *et al*, 2004).

In the four age groups that were studied, women in all age groups had a higher IGT prevalence than men, except in the age group of 51-60 years, which was the only instant when the men overtook the women.

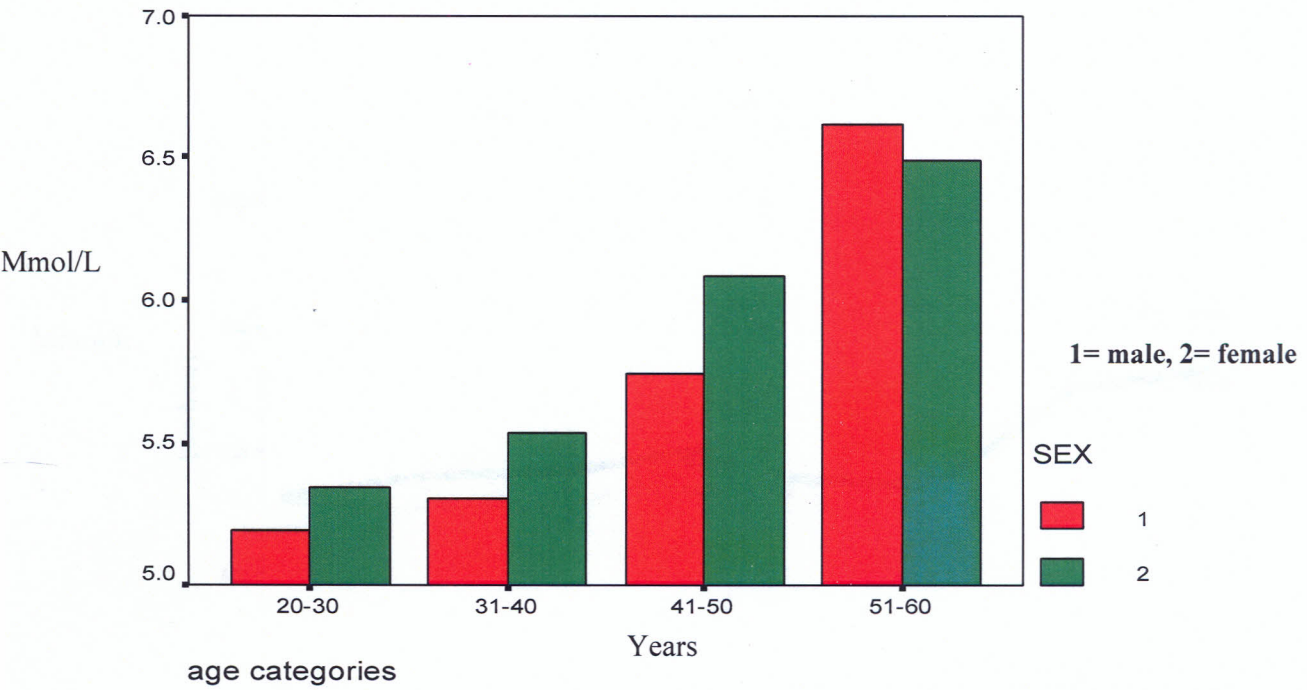


Figure 4.1: Mean 2hr blood glucose reading in mmol/L by age group and sex

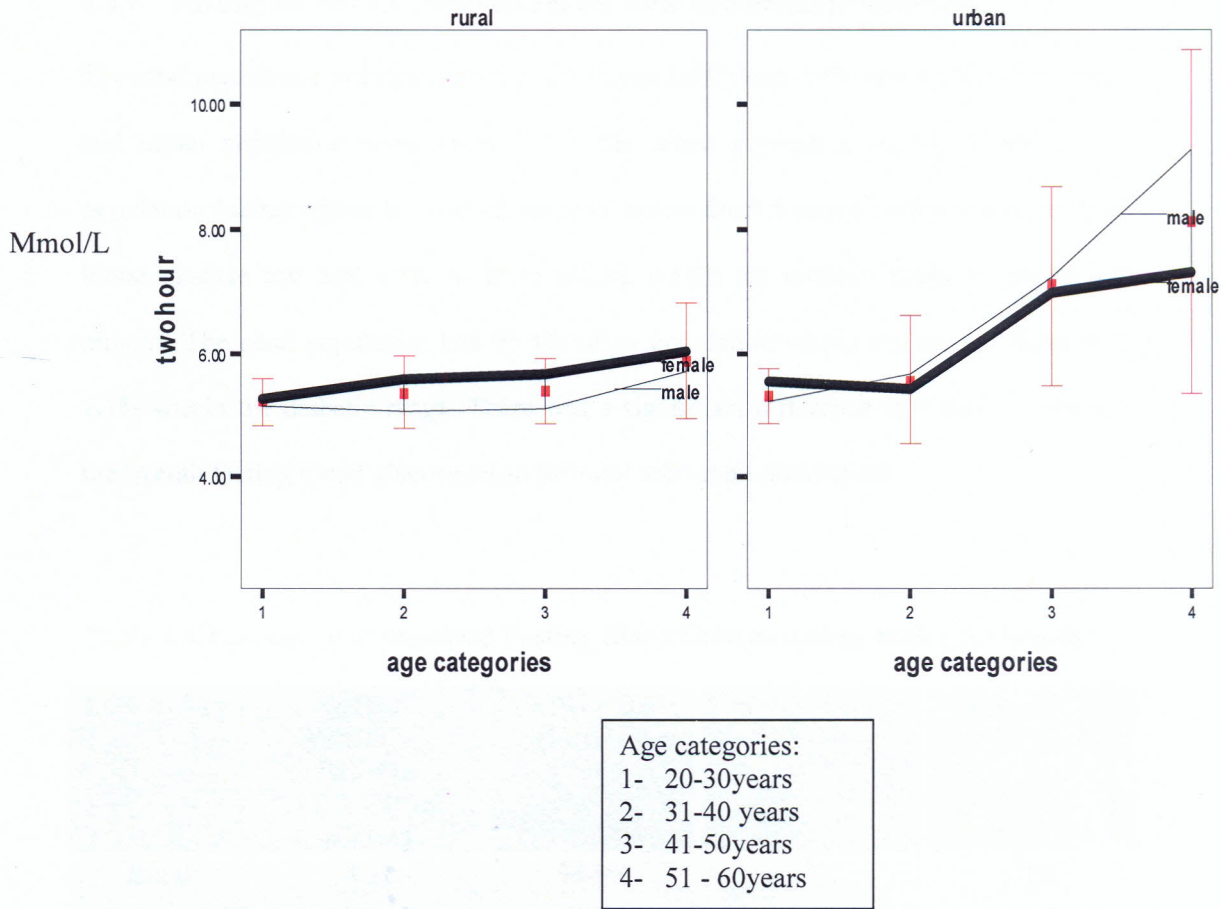


Figure 4.2: Prevalence of Impaired Glucose Tolerance in both populations

4.4. Fasting Blood Glucose levels

4.4.1 Fasting Blood Glucose levels among rural and urban populations

The total prevalence of Impaired Fasting Glucose (IFG) was 3.4% and 4.1% for the rural and urban population respectively. With the urban population having 91.8% of its population falling within the normal range of below the 5.6 mmol/l reading after fasting blood glucose test and 4.1% of them falling within the diabetic range of above 6.9 mmol/l. The rural population had 95.4% of its population within the normal range and 1.1% within the diabetic range. There was a significant difference ($p = 0.004$) between the overall fasting blood glucose mean for rural and urban populations.

Table 4.6: Prevalence of Impaired Fasting Blood Glucose among both populations

LOCALITY	MEAN FASTING BLOOD GLUCOSE Mmol/l	FBG < 5.6 (Normal)	FBG 5.6 TO 6.9 (Impaired Fasting Glucose) IFG	FBG > 6.9 (Diabetics)
Rural	4.41	94.5%	3.4%	1.1%
Urban	4.72	91.8%	4.1%	4.1%

The mean IFG value after the overnight test was therefore higher in urban than in rural populations, at 4.41 ± 0.68 for the rural population and 4.72 ± 1.84 for the urban population.

In a multistage cross sectional population survey undertaken to determine the prevalence of diabetes mellitus (DM) and impaired fasting glycemia/glucose (IFG) in subjects aged 25 years and above in India the age and gender standardized prevalence rate for DM and IFG in the total Indian population was 3.3 and 3.6% respectively ($P < 0.001$). The standardized prevalence of DM and IFG in urban areas was significantly higher than that

for the rural population (urban DM prevalence 4.6% versus rural DM prevalence 1.9%, $P < 0.001$; urban IFG prevalence 4.8% versus rural IFG prevalence 2.5%, $P < 0.001$). There was no statistically significant difference in the prevalence between DM (4.6%) and IFG (4.8%) in the urban population. The rural prevalence of IFG (2.5%) was significantly ($P < 0.001$) more than the rural prevalence of DM (1.9%). Type 2 diabetes is also a major health problem in India (Sadikot *et al*, 2004).

4.4.2 Fasting Blood Glucose levels among males and females

In the overall picture, there was no significant difference between IFG in male and females at P value greater than 0.05. In the urban area, the women demonstrated significantly higher levels of IFG than urban men and also their rural counterparts, with the rural women demonstrating lower levels of the same, than their male counterparts.

Table 4.7: Impaired Fasting Blood Glucose prevalence among males and females

SEX	MEAN FASTING BLOOD GLUCOSE Mmol/l	FBG < 5.6 (Normal)	FBG 5.6 TO 6.9 (Impaired Fasting Glucose) IFG	FBG > 6.9 (Diabetics)
MALE	4.44 ± 1.23	94.5%	3.4%	2.1%
FEMALE	4.53 ± 0.99	94.4%	3.8%	1.7%

Table 4.8: Prevalence and mean of Impaired Fasting Glucose in both sexes for both populations

CATEGORY	MEAN (mmol/l)	IFG PREVALENCE
Rural Men	4.36 ^a	3.9%
Rural Women	4.45 ^a	3.0%
Urban Men	4.60 ^b	2.4%
Urban Women	4.99 ^b	8.1%

Means with the same letter superscript are not significantly different

The mean fasting blood glucose after the overnight fast test was higher for women than for men in both the rural and urban areas, at 4.53 ± 0.99 for women and 4.44 ± 1.23 for men. It was also higher in urban men than rural men and in urban women than in rural women.

In a study in rural Bangladesh, the study population was lean, with a mean body mass index (BMI) of 19.4 but with a low prevalence of type 2 diabetes but relatively high impaired fasting glucose. No relationship between type 2 diabetes and BMI was observed in men, but an overall relationship was observed for women ($P = 0.04$). In that population, low prevalence of type 2 diabetes and relative high impaired fasting blood glucose was observed (Hussain *et al*, 2005). The factors associated with the occurrence of diabetes in this population appeared to differ than its known relations with BMI, unlike in this study where BMI and IFG correlated.

The higher prevalence observed for IFG among women can lead to impairment of their cognitive abilities as found in a study by Yaffe *et al*, 2004, the authors analyzed data from a 4-year study among 7,027 postmenopausal women (mean age, 66.3 years) at 178 sites. A total of 267 (3.8%) women had diabetes and 297 (4.2%) had IFG. Women with IFG had worse baseline cognitive scores compared to women with Normal Glucose but better

scores than diabetics. The study concluded that diabetic as well as pre-diabetic (those with IFG) women have impaired cognitive performance and greater risk of developing cognitive impairment.

4.4.3 Fasting Blood Glucose levels among age groups

The fasting blood glucose mean after an overnight fast test was observed to be high in the 20-30 category as well as in the 51-60 category.

There was a positive correlation with no significance ($r=0.67$, $p=0.146$) between age and the prevalence of FBG.

Above the age of fifty years, urban women had a fasting mean of 7.04 indicating that a majority of them were above the IFG range (5.6-6.9 mmol/L) and well into the diabetic range.

In a 22 year prospective study of non-diabetic men with IFG, Fasting blood glucose values in the upper normal range appeared to be an important independent predictor of cardiovascular death in these men (Bjornholt *et al*, 1999).

In a study to estimate the prevalence of diabetes and impaired fasting glucose (IFG) and their association with risk factors in a Korean population, diabetes prevalence increased with age and peaked in the oldest age-group; however, IFG prevalence did not show the same trend which was displayed among the urban population in the Kenyan study.

Diabetes and IFG in the Korean study was found to be associated with age, BMI, blood pressure, triglyceride, HDL cholesterol, education levels, alcohol consumption, exercise, and a family history of diabetes.

The Korean study indicates that about one-half of diabetes cases remain undiagnosed, as is the case in the Kenyan study where the participants only came to learn of their pre-diabetes status after screening.

Table 4.9: Fasting Blood Glucose Mean and prevalence according to age category

AGE CATEGORY	MEAN (mmol/l)	IFG PREVALENCE
20 – 30 Years	4.39 ^{ab}	3.3%
31 – 40 Years	4.33 ^a	1.7%
41 – 50 Years	4.46 ^{ab}	5.2%
51 – 60 Years	4.60 ^b	4.3%

Means for groups in homogeneous subsets are displayed according to Duncan's Post Hoc Tests. Means with the same letter superscript are not significantly different. Those with different letter superscript are significantly different.

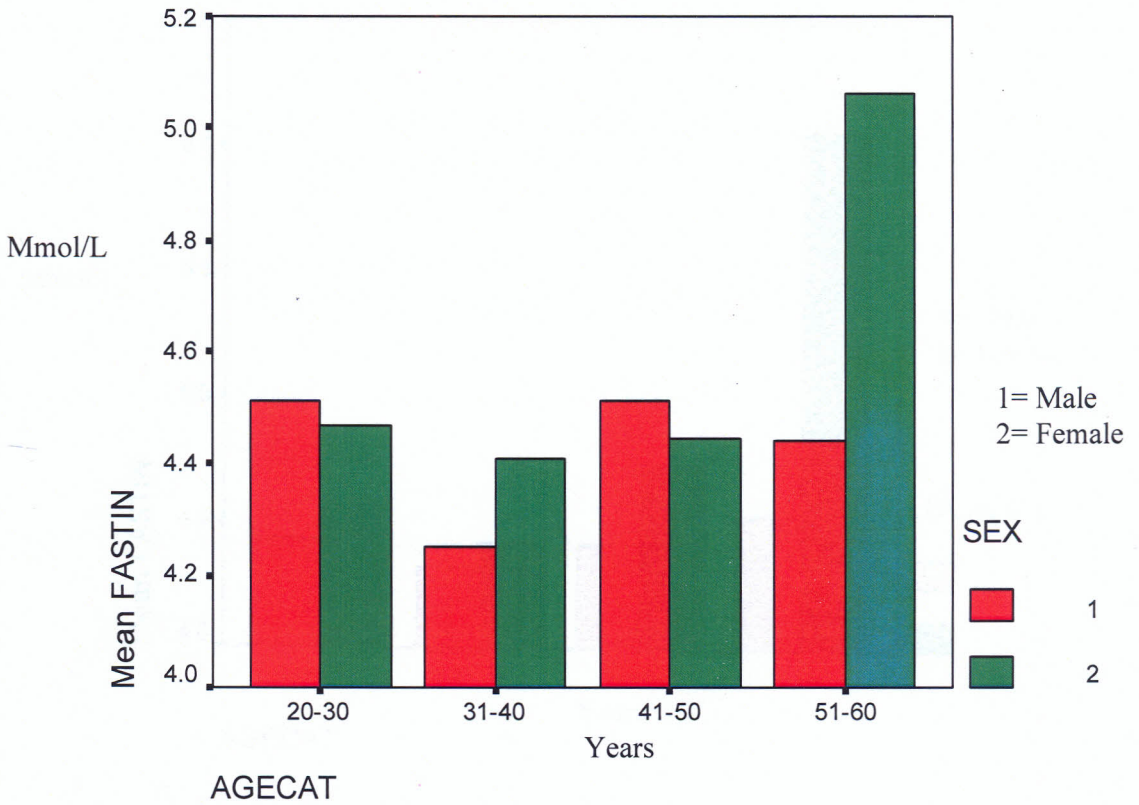


Figure 4.3: Mean Fasting Blood Glucose bar-chart, by sex and age group among rural & urban population.

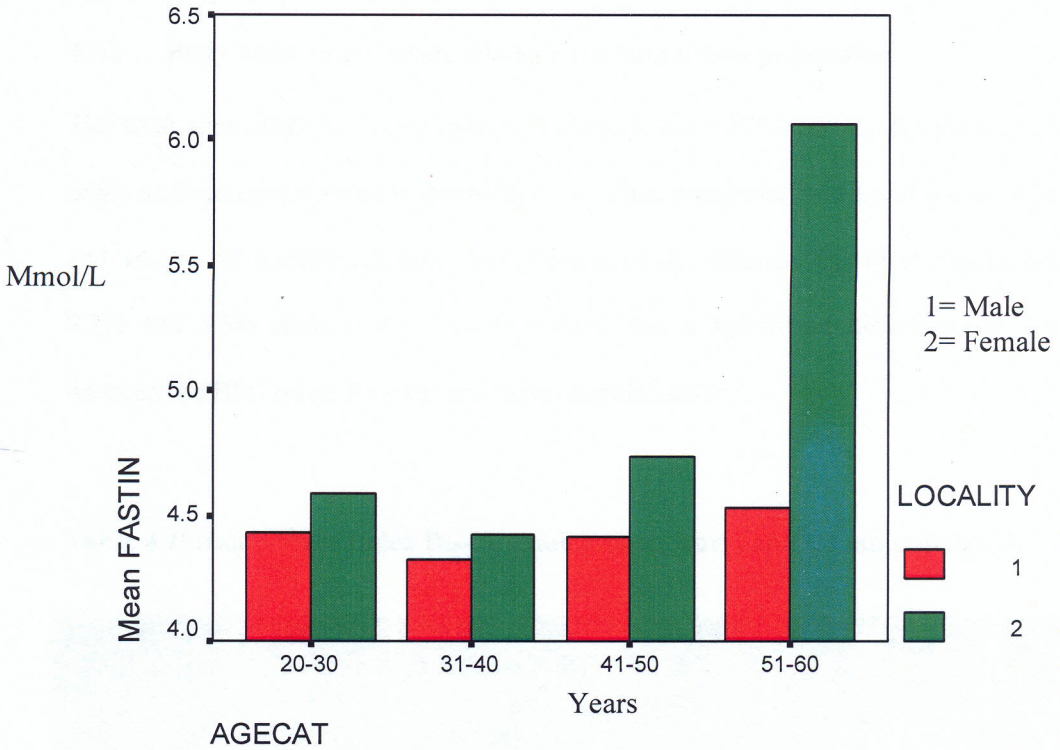


Figure 4.4: Mean Fasting Blood Glucose, by locality and age group

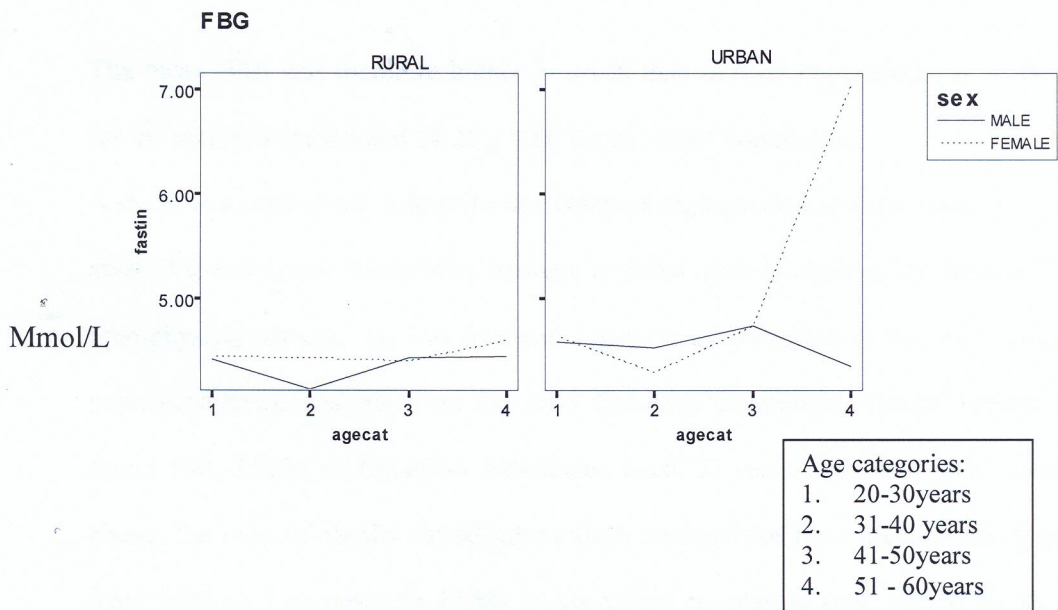


Figure 4.5: Mean Fasting Blood Glucose, among males and females of different age categories in both populations

4.5 Body Mass Index levels

4.5.1 Body Mass Index levels among rural and urban populations

The total prevalence of overweight and obesity was 13.7% and 6.3% respectively for urban and rural populations respectively. The urban population had a prevalence of 25.8% and 14.1% for overweight and obesity respectively, whereas the rural population had 9.2% and 3.5% respectively. However there was a significant difference ($p < 0.05$) between the BMI mean for rural and urban populations.

Table 4.10: Body Mass Index Distribution among Rural and Urban population

LOCALITY	MEAN BODY MASS INDEX Kg/M ²	BMI < 18.5 (Underweight)	BMI 18.5 TO 25 (normal)	BMI 25-30(Overweight)	BMI >30 (Obese)
Rural	21.49 ± 3.48	14.2%	73.1%	9.2%	3.5%
Urban	24.26 ± 4.89	7.8%	52.3%	25.8%	14.1%

The mean BMI was therefore higher in urban than in rural populations, at 21.49 ± 3.48 for the rural population and 24.26 ± 4.89 for the urban population.

A study was carried out to describe and compare regional obesity rates across Canada and assess the ecological relationship between regional rates of obesity, low level of leisure-time physical activity, and low fruit and vegetable consumption. It was a cross-sectional population-based analysis from the 2003 Canadian Community Health Survey. It was found that, 15.2% of Canadian individuals aged 20 years and older were considered obese. The rates of obesity varied substantially between the 106 Canadian health regions: from 6.2% in Vancouver to 47.5% in aboriginal population area. At the health region level, low leisure-time physical activity and low fruit and vegetable consumption are both good predictors of obesity.

There is a strong gradient in obesity prevalence between Canadian health regions. At the regional level, high rates of low level of physical activity, and high rates of low fruit and vegetable consumption were both found good predictors of high rates of obesity. This is the emerging trend between the rural and urban populations that were in the Kenyan study (Vanasse *et al*, 2005)

4.5.2 Body Mass Index levels among males and females

In the overall picture, there was a significance difference between BMI levels in male and females at P value 0.003. In the urban area, the women demonstrated very high levels of BMI, significantly higher levels than urban men and also their rural counterparts, with the rural women demonstrating higher levels of the same, than their male counterparts. This trend is contrary to that which was displayed in a Chinese study (the China Health and Nutrition Survey, 1989–2000) A total of 4527, 4507 and 4046 adults, aged 20–45 years, in 1989, 1997 and 2000, respectively was studied. There was a 13.7% increase in the proportion of men and a 7.9% increase of women who were overweight or obese with a resulting greater change in the prevalence rate for men. This increase in the prevalence of overweight and obesity was far greater than the decrease (2.1% for men; 2.2% for women) in that of underweight. Age–gender-specific percentile curves showed BMI increases mainly among women, aged 35–45 years, and among men at all age groups.

The Chinese BMI dynamics show much greater rates of change among men, aged 20–45 years, than among women, with the increase among women concentrated between ages 35 and 45 years (Wang *et al*, 2006). In China controlling the increasing trends of BMI, especially in men, is an important public health problem facing that country, the same seems to be true with the women in the Kenyan study.

Table 4.11: Mean BMI and OBESITY prevalence comparison for both populations and sexes

CATEGORY	MEAN (BMI)	OBESITY PREVALENCE
Rural Men	21.20 ^a	2.7%
Rural Women	21.69 ^a	4.1%
Urban Men	22.59 ^b	7.1%
Urban Women	27.43 ^b	27.3 %

Means with the same letter superscript are not significantly different

The mean BMI was higher for women than for men in both the rural and urban areas, at 22.75 ± 4.50 for women and 21.70 ± 3.56 for men. It was also higher in urban men than rural men and in urban women than in rural women.

In China between 1992 and 2002 due to an impressive economic growth, the citizens experienced tremendous changes in their lifestyles which is also a trend exhibited here in Kenya mostly via disparities in rural and urban lifestyles. The prevalence of overweight and obesity increased in all gender and age groups and in all geographic areas of China. Using the World Health Organization body mass index cut points, the combined prevalence of overweight and obesity increased from 14.6 to 21.8%. The Chinese obesity standard showed an increase from 20.0% to 29.9%. The annual increase rate were highest in men aged 18–44 years and women aged 45–59 years (approximately 1.6 and 1.0% points, respectively). In general, male subjects, urban residents, and high-income groups had a greater increase. With the increase in overweight and obesity, diet-related chronic diseases (e.g., hypertension, cardiovascular disease (CVD), and type 2 diabetes) also increased over the past decade and became a more important preventable cause of death. Diabetes increased from 1.9 to 5.6% during 1990–2003 (Wang *et al*, 2006).

A population-based cross-sectional survey was also carried out in a rural and an urban Palestinian West Bank community. A total of 549 women and 387 men aged 30–65 y were studied. The prevalence of obesity was 36.8 and 18.1% in rural women and men,

respectively, compared with 49.1 and 30.6% in urban women and men, respectively. This trend though much higher compares with the trend in this study, where the prevalence of females is higher than males for both rural and urban populations. At the household level, the mean energy consumption from 25 selected food items was 13.8 MJ (3310 kcal)/consumption unit/day in the rural community compared to 14.5 MJ (3474 kcal)/consumption unit/day in the urban community ($P=0.021$). BMI was positively associated with age in both men and women and with urban residence in women (Abdul-Rahim *et al*, 2003). Again, it is notable that this compares to our study where urban women recorded very high BMI levels.

4.5.3 Body Mass Index levels among age groups

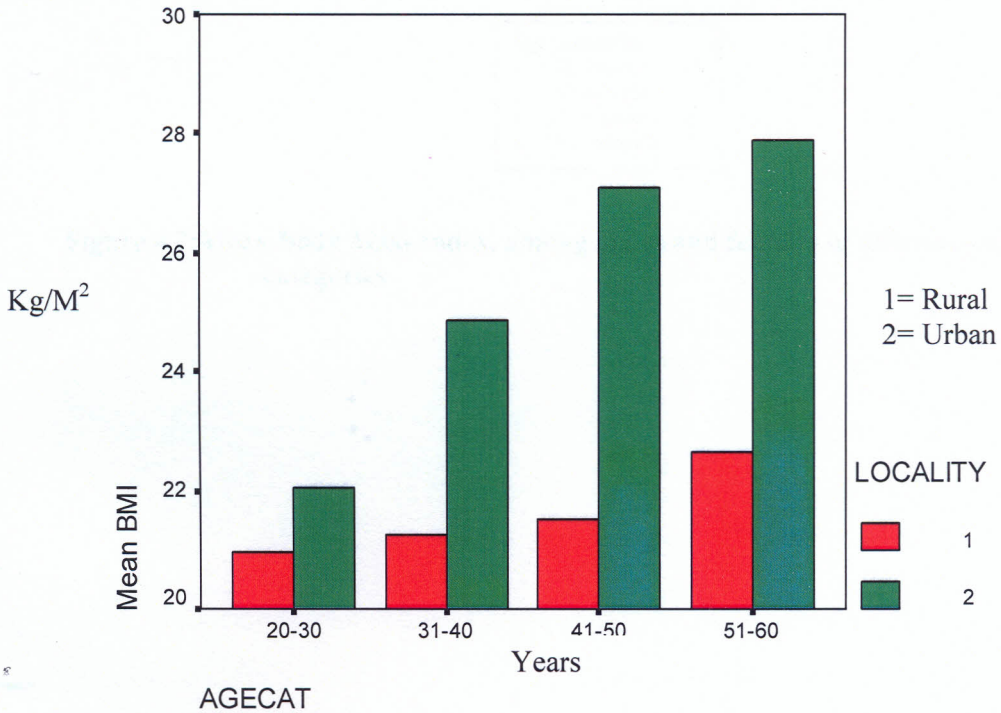
The prevalence of overweight and obesity was observed to increase with age, with the urban population above 40 yrs having a very high means as compared to their rural counterparts. There was a significant Positive correlation ($r=0.174$, $p<0.01$) between age and the prevalence of overweight and obesity.

It is very notable that among urban females of all age categories, the mean BMI was above 25 kg/m². Meaning that a majority of them are above the overweight and obesity levels.

Table 4.12: Body Mass Index mean and Obesity prevalence per age category

AGE CATEGORY	MEAN (Kg/M ²)	Obesity PREVALENCE
20 – 30 Years	21.15 ^a	2.0%
31 – 40 Years	22.99 ^{ab}	5.8%
41 – 50 Years	22.37 ^{bc}	9.1%
51 – 60 Years	23.46 ^c	11.8%

Means for groups in homogeneous subsets are displayed. Means with the same letter superscript are not significantly different. Those with different letter superscript are significantly different.

**Figure 4.6: Mean BMI, by locality and age group**

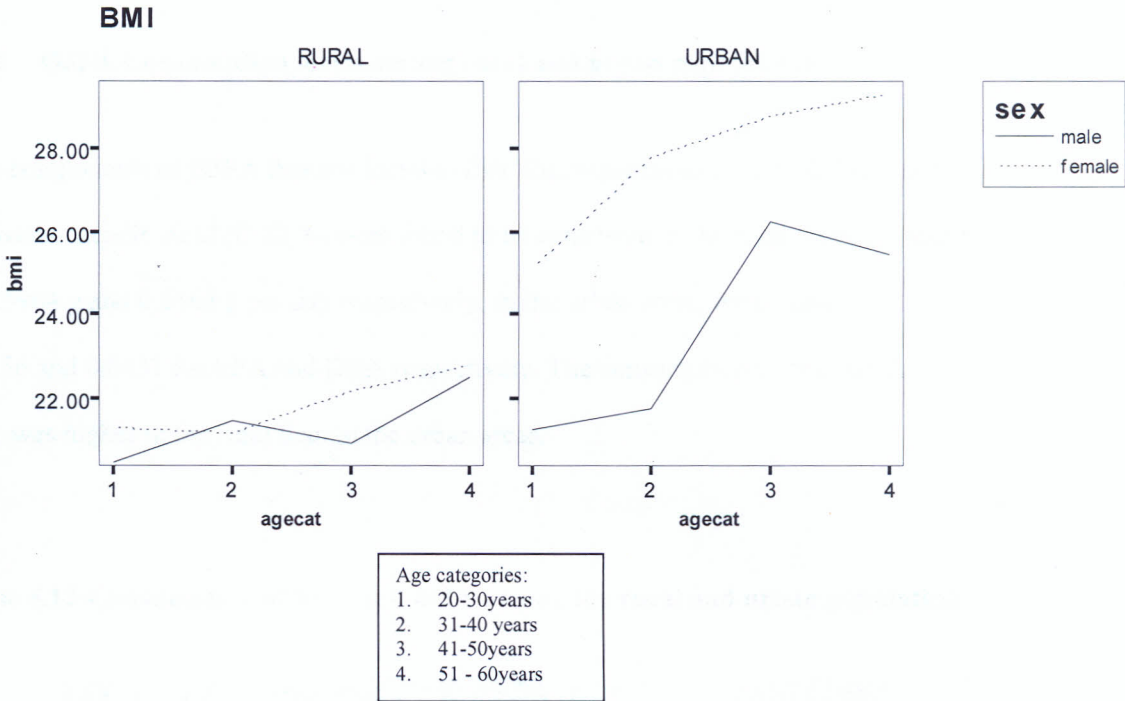


Figure 4.7: Mean Body Mass Index, among males and females of different age categories

4.6 Omega 3 Fatty Acids Consumption levels

4.6.1 O3FA Consumption levels among rural and urban populations

Two components of O3FA that are found in fish, Eicosapentaenoic Acid (C 20, 5) and Docosahexaenoic Acid (C 22, 6) were found to be consumed in the rural areas at a mean of 0.5964 g and 0.0163 g per day respectively. In the urban areas, the consumption was, 0.1156 and 0.0137 for EPA and DHA respectively. The consumption of both DHA and EPA was higher in the rural than in the urban areas.

Table 4.13: Consumption of EPA and DHA among the rural and urban population

LOCALITY		EPA (C 20,5) (g)	DHA(C 22,6) (g)
RURAL	Mean	.5964	.0613
	Std. Deviation	.94299	.12635
URBAN	Mean	.1156	.0137
	Std. Deviation	.39780	.05616
Total	Mean	.4562	.0474
	Std. Deviation	.85035	.11262

There was a significant difference between consumption of EPA in the rural and the urban areas at $P < 0.05$. The difference in DHA consumption between rural and urban areas was also significant at $P < 0.05$.

Typical dietary recommendations for Omega 3 Fatty Acids are 0.3 to 0.5 g/d of EPA+DHA, which is met by the rural population in this study but not so for the urban population. The intake of total omega-3 fatty acids in the United States is approximately 1.6 g/d, and of this, alpha-linolenic acid accounts for approximately 1.4 g/d, and only 0.1 to 0.2 g/d comes from EPA and DHA (Kris-Etherton *et al*, 2002).

Table 4.14: Consumption mean of various nutrients among the rural and urban population.

	ENERGY	PROTEIN	VITAMIN A	IRON
Rural	3435 Kcal	136.4 g	707 µg	116 mg
Urban	2963 Kcal	108g	791 µg	37 mg

The above table portrays the rural community as having a better intake of nutrients than their urban counterparts. It is clear that their unchanged diet is of better value. In an Indian study at the household level, the mean energy consumption from 25 selected food items was 13.8 MJ (3310 kcal)/consumption unit/day in the rural community compared to 14.5 MJ (3474 kcal)/consumption unit/day in the urban community ($P=0.021$) (Abdul-Rahim *et al*, 2003).

It is noteworthy here that despite the rural community having a higher intake of energy foods, believed to be key in Type II Diabetes causation, they displayed a lower risk of the disease than their urban counterparts. The key contributor to the energy intake for the rural community was “*ugali*”.

Table 4.15: Consumption of EPA and DHA among females and males

SEX		EPA (g)	DHA (g)
Male	Mean	.4536	.0443
	Std. Deviation	.78247	.09773
Female	Mean	.4587	.0505
	Std. Deviation	.91503	.12593
Total	Mean	.4562	.0474
	Std. Deviation	.85035	.11262

Eicosapentaenoic Acid (C 20, 5) and Docosahexaenoic Acid (C 22, 6) were found to be consumed by men at a mean of 0.4536 g and 0.0443 g per day respectively. For women, the consumption was, 0.4587 and 0.0505 for EPA and DHA respectively.

There was no significance difference in EPA consumption between the sexes, at $P=0.892$.

There was also no significance difference in DHA consumption between the sexes, at $P=0.257$

Table 4.16:Consumption of EPA among the age categories.

EPA	
AGECAT	EPA (g)
31-40	.4007
51-60	.4339
20-30	.4599
41-50	.5124

Among the age categories, there was no significant difference for the consumption of both EPA and DHA.

Table 4.17:Consumption of DHA among the age categories

AGECAT	DHA (g)
31-40	.0386
51-60	.0389
20-30	.0492
41-50	.0574

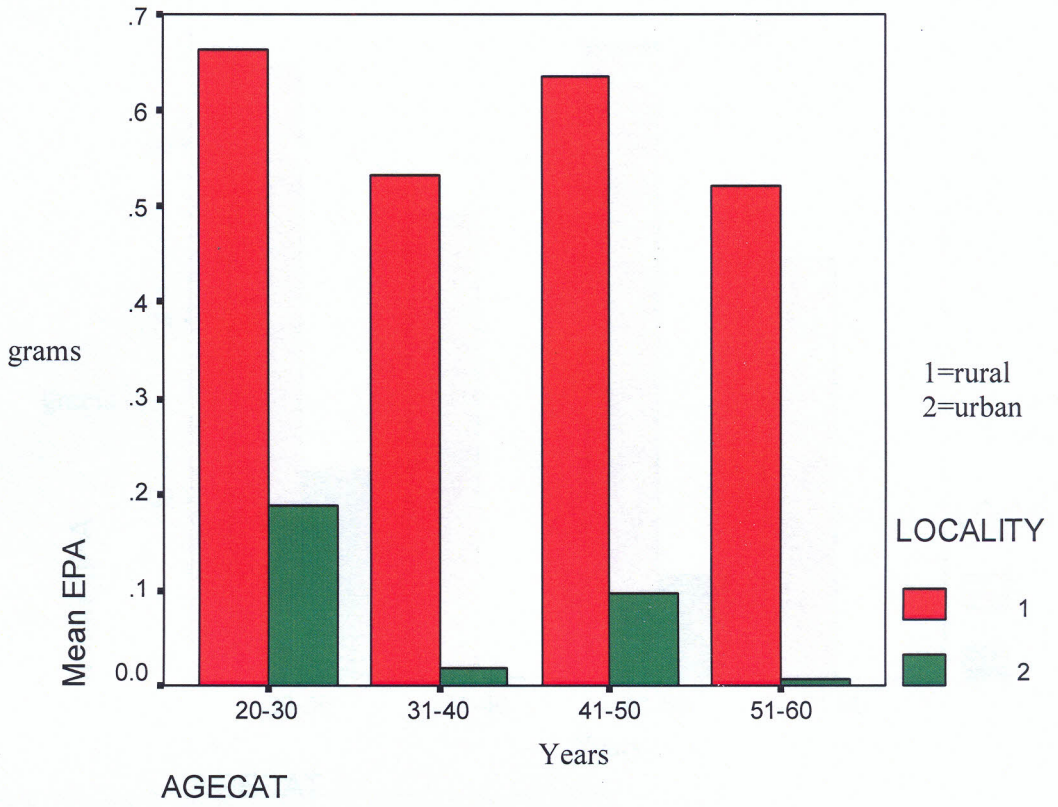


Figure 4.8: Mean consumption of EPA by age category and locality

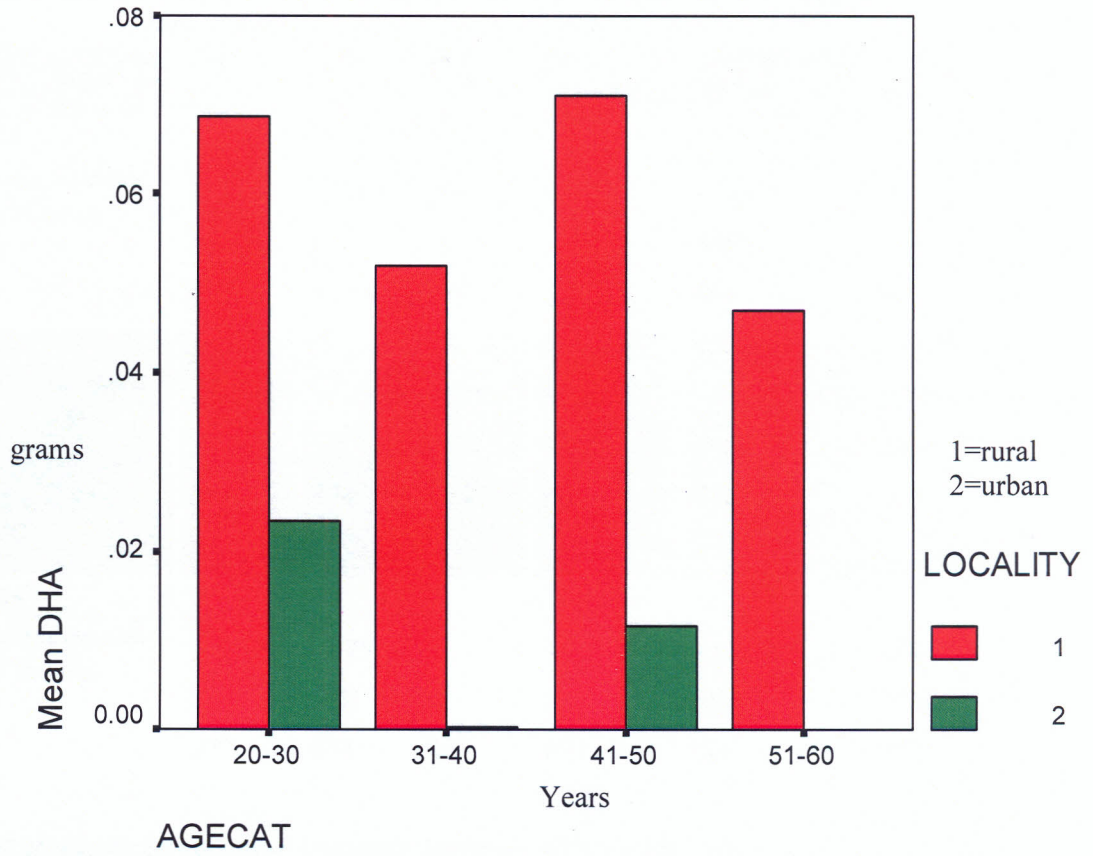


Figure 4.9: Mean consumption of DHA by age category and locality

Table 4.18: Correlations of O3FA consumption levels and Factors of hyperglycemia and obesity.

	EPA	BMI	DHA	FBG VALUE	2 HOUR VALUE	AGE CATEGORY
EPA						
Pearson Correlation	1	-.116*	.886**	-.067	-.124**	.009
Sig. (2- tailed)		0.011	.000	.147	.007	.836
N	497	474	497	471	468	497
BMI						
Pearson Correlation	-.116*	1	-.075	.070	.226**	.174**
Sig. (2- tailed)	.011		.101	.141	.000	.000
N	474	474	474	449	446	474
DHA						
Pearson Correlation	.886**	-.075	1	-.056	-.111*	-.002
Sig. (2- tailed)	.000	.101		.223	.016	.973
N	497	474	497	471	468	497
FBG VALUE						
Pearson Correlation	-.067	.070	-.056	1	.555**	.067
Sig. (2- tailed)	.147	.141	.223		.000	.146
N	471	449	471	471	468	471
2 HOUR VALUE						
Pearson Correlation	-.124**	.226**	-.111*	.555**	1	.157**
Sig. (2- tailed)	.007	.000	.016	.000		.001
N	468	446	468	468	468	468
AGE CATEGORY						
Pearson Correlation	.009	.174**	-.002	.067	.157**	1
Sig. (2- tailed)	.836	.000	.973	.146	.001	
N	497	474	497	471	468	497

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level

4.7 Correlation between O3FA and Risk of T2DM

4.7.1 O3FA consumption and IGT

Using Pearson correlation, it was observed that there was a significant negative correlation between EPA (C 20, 5) consumption and IGT, at $r=-0.124$, $P=0.007$. This indicates that the level of IGT fell with increasing consumption of EPA, at a very significant level.

There was also a significant negative correlation between DHA (C 22, 6) consumption and IGT, at $r=-0.111$, $P=0.016$. This also indicates that the level IGT fell with increasing consumption of DHA, at a very significant level.

4.7.2 O3FA consumption and FBG

Using Pearson correlation, it was also observed that there was a negative correlation between EPA (C 20, 5) consumption and FBG, though not at significant levels, at $r=-0.67$, $p=0.147$. This indicates that the level of FBG fell with increasing EPA consumption, though not at very significant levels.

There was also a negative correlation between DHA (C 22, 6) consumption and FBG though not at significant levels, at $r=-0.056$, $P=0.223$. This also indicates that the level of FBG fell with increasing DHA consumption, though not at very significant levels.

4.7.3 O3FA and BMI

Using Pearson correlation, it was observed that there was a significant negative correlation between EPA (C 20, 5) consumption and BMI, at $r=-0.116$, $P=0.011$. This indicates that the level of BMI appeared to fall with increasing consumption of EPA, at a very significant level. There was also a negative correlation between DHA (C 22, 6) consumption and BMI, though at a level that was not significant at $r=-0.075$, $P=0.101$. This also indicates that the level of BMI appeared to fall with increasing consumption of DHA, though not at a very significant level.

4.7.4 BMI, IGT & FBG

BMI also correlated positively with IGT at very significant levels ($r=0.226$, $P<0.01$). There was also a positive correlation of BMI and FBG though not at significant levels. ($r=0.070$, $P=0.141$).

CHAPTER FIVE

5. CONCLUSION & RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the main findings, conclusion and recommendations of this study.

The objective of the study was to establish the link between the consumption of O3FA, and some risk factors for T2DM, namely IGT, FBG and BMI, among a rural and an urban population, whose main difference was dietary.

5.2 Conclusion

The urban community recorded a higher risk of T2DM, than their rural counterparts.

It was established that the relationship between FBG and O3FA was negative and highly significant in the case of DHA, meaning that increased consumption of O3FA reduced the level of the Fasting blood glucose reading, low consumption correlated with high readings of FBG. The same negative correlation was established for IGT and O3FA, but with IGT, the level of significance was very high for both DHA and EPA, meaning that the IGT levels tended to fall with the consumption of these two O3FA and very significantly at that.

A negative correlation was also observed between BMI and O3FA consumption levels, meaning that the BMI levels fell with increasing consumption of O3FA.

Urbanisation, gender and age were confirmed to be very strongly correlated to the risk of T2DM. The risk of T2DM as measured via IGT, FBG and BMI, was found to be higher in the urban than in the rural areas, which was as a result of the difference in the level of

low-fat and O3FA consumed by the rural population as opposed to the high fat diet that included more saturated fat and cholesterol, by the urbanites.

True to expectations, the prevalence of IGT was higher in the urban than in the rural area, which can be as a result of increased urbanisation and with a modernisation or westernisation of lifestyle. Above the age of fifty years also, a majority of men and women in the urban group were within the IGT range, meaning that they should have their blood sugar tested very frequently to ensure that they do not suffer microvascular or macrovascular damage resulting from asymptomatic glycaemia.

Evidently Impaired Fasting Glucose is attributed to beta cell dysfunction and consequently defective insulin secretion as opposed to Impaired Glucose Tolerance which is more attributable to cellular non-response to insulin or insulin resistance.

The highest prevalence of obesity, BMI>30, was among urban female subjects. It is very notable that among urban females of all age categories, the mean BMI was above 25 kg/m². Meaning that a majority of them are above the overweight and obesity levels.

The increased consumption of more energy-dense, nutrient-poor foods with high levels of sugar and saturated fats, combined with reduced physical activity, have led to very high obesity rates. Obesity and overweight pose a major risk for serious diet-related chronic diseases, like T2DM.

The average consumption of O3FA for the rural population, for EPA and DHA was 0.6127g, while for the urban population, it was 0.1293g. Typical recommendations are 0.3 to 0.5 g/d of EPA+DHA. The rural population being above the RDA for O3FA, did not record as high levels of risk for T2DM as their urban counterparts. Nevertheless they still need to be screened as they exhibited a considerable risk for the T2DM.

5.3 Implications of findings

For T2DM, diet is at the corner stone of contributing to the existence and development of the disease and a diet rich in saturated fats as the one observed to be consumed by the

urban population in this study can contribute significantly to the occurrence of risk factors for diabetes. It was observed that they recorded very high levels of risk factors, namely IGT, IFG and BMI, unlike the rural counterparts whose daily delicacy was the easily accessible fish.

This study strongly lends evidence to the fact that society should move from the harmful and detrimental types of fat, both those found in food as components of food or those used for processing food or addition of flavour to food.

It was observed that the rural community which recorded lower levels of the risk factors for T2DM, ingested the RDA for O3FA.

5.4 Recommendations

Based on the results of this study, the following is recommended:

- There should be development of multi-disciplinary approach of curbing the progression of T2DM, this should include the whole lifestyle spectrum of diet at the centre stage, clinical screening and physical activity. Physicians, Nutritionists, Dieticians and Physical fitness experts should join hands in sensitizing the society and working in unison to combat the debilitating disease.
- Special attention should be paid to female subjects through control of modifiable risk factors such as obesity carried out in gender clinics and given the same emphasis that is given to cancers associated with the female reproductive system like cervical or breast cancer since obesity leads to equally detrimental lifestyle diseases.

- Effective strategies for primary prevention of obesity need to be introduced, especially in urban areas, by institutions partnering with the Diabetes Association of Kenya. This campaign should include promotion of eating more fruit and vegetables, as well as nuts and whole grains, engaging in daily moderate physical activity for at least 30 minutes, cutting the amount of fatty, sugary foods in the diet, moving from saturated animal-based fats to polyunsaturated fats.
- There should also be improvement of glycemic control of the diabetic population, and early identification and treatment of diabetic complications. Effective screening methods should be used at the existing health units to determine IGT and FBG patients and advise them accordingly on lifestyle changes to avoid progression to T2DM.
- Like the “Know your status” campaign that has been adopted for the prevention and check of the spread of HIV. There should be a similar “know your status” campaign for T2DM because most people are unaware of their diabetes status, only coming to know after enrollment to a study. This phenomenon ensures that even those at the borderline stages of IGT and FBG who can be salvaged, are not detected and eventually they progress to diabetes, consequently succumbing to microvascular and macrovascular complications.

5.5 Recommendations for Further Research

- Randomised Controlled Trials should be conducted to indicate the levels of O3FA that will avert the risk of T2DM, and whether they have a protective effect over the disease.

- Longitudinal prospective cohort studies should also be conducted to determine the effect of feeding O3FA to individuals who have already being diagnosed as being at risk of T2DM.
- Investigations should be urgently conducted to establish whether the unbelievable overweight and obesity levels among urban females that caused high levels glucose intolerance are mainly due to improper diet or have other underlying factors.

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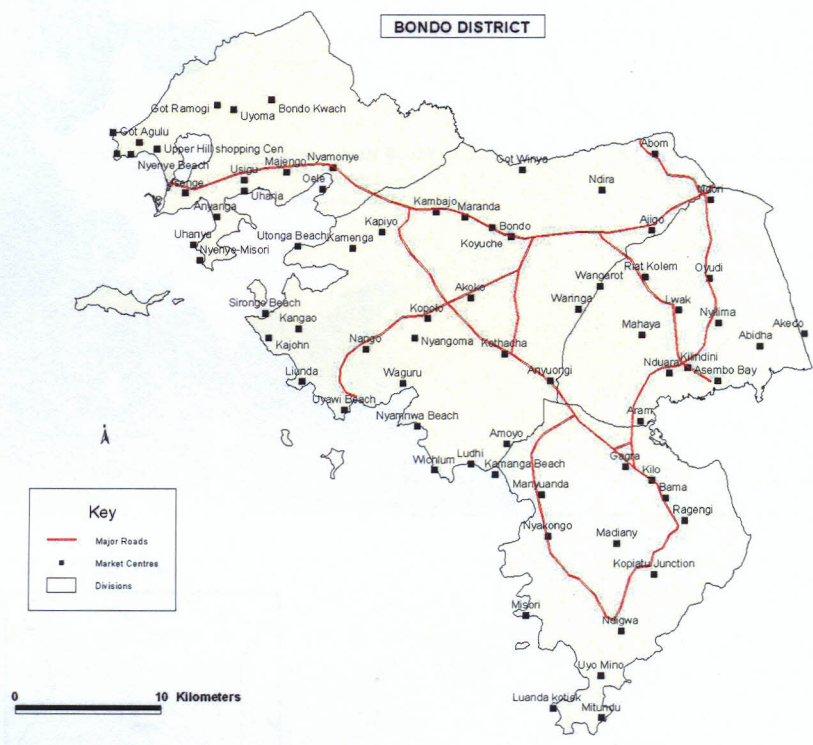
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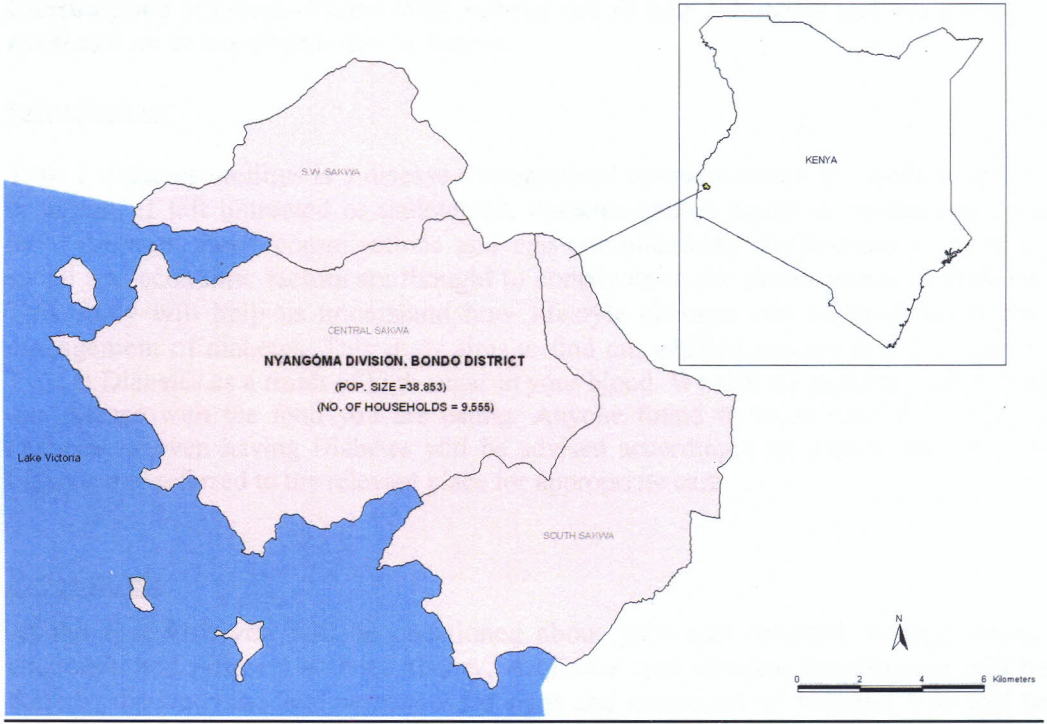
APPENDICES

6.1 Maps

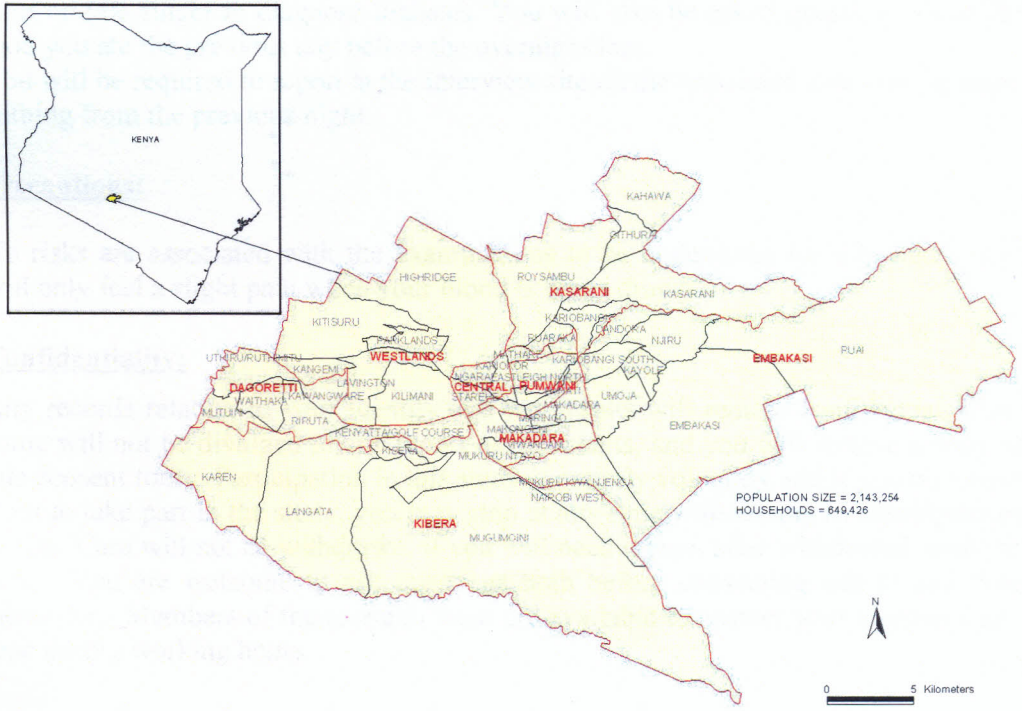
6.1.1 Bondo District



6.1.2 Nyang'oma Division



6.1.3 Nairobi



6.2 Informed Consent Document

Consumption of omega-3 fatty acids and the risk of type 2 diabetes mellitus among a rural and an urban population in Kenya.

Introduction:

Type 2 diabetes mellitus is a disease characterised by malfunction in insulin secretion or action. If left untreated or undetected, diabetes causes health complications such renal diseases, heart complications and eye complications. Differences in cultural, social and economic factors are thought to contribute to the development of diabetes. This study will help us understand how lifestyle changes can be modified during management of diabetes. This study aims to find out whether you are at risk of getting Type II Diabetes as a result of high sugar in your blood. We will try to relate your risk of this disease with the food you are eating. Anyone found to be at risk of developing Diabetes or even having Diabetes will be advised accordingly on how to change their lifestyle and referred to the relevant place for appropriate care.

Procedures:

At the first visit you will be questioned about your past medical, dietary, social, economic and physical activity history. A clinical and physical examination will be done by the study medical personnel for signs and symptoms of diabetes. You will be weighed and measurements for height, arm and waist circumference and skin fold thickness will be determined. A blood sample will be taken by means of pricking your middle finger to diagnose diabetes. You will also be asked questions about the food you ate the previous day before the overnight fast.

You will be required to report at the interview site on the appointed date, having eaten nothing from the previous night.

Precautions:

No risks are associated with the examinations to be undertaken for this study. You will only feel a slight pain when your blood is being drawn.

Confidentiality:

Any records relating to your identity and test results will remain confidential. Your name will not be divulged in any report of the results, and you will receive a copy of this consent form. Participation in this study is entirely voluntary and if you no longer want to take part in the study, you may stop at any time without any ill consequences to you. Care will not be withdrawn, if you will need it even after withdrawal from the study. You are welcome to ask questions both before consenting and at any time thereafter. Members of the research team are available to answer your questions any time during working hours.

Benefits:

By agreeing to participate in this study, you will receive free medical check-up and advice on ways to prevent and/or manage diabetes. Those found ill will be referred to hospitals for further treatment.

Subjects Statement:

I have understood the above information which has been fully explained to me by the investigator, and I voluntarily consent to participate.

Name of district _____

Name of participant _____

Signature of Participant _____

Date _____

6.3 Abstracts presented in conferences and workshops

6.3.1 Prevalence of Impaired Glucose Tolerance in a Rural and an Urban Population in Kenya

VENUE: Kampala, Uganda.
FORUM: The 1st East African Scientific & Health Conference
DATE: 29TH MARCH 2007

Background: Diabetes Mellitus is a metabolic disorder characterized by chronic hyperglycaemia, arising from a defect in insulin secretion, or insensitivity to its action. Type II Diabetes Mellitus, can be aptly named a “bad food disease” in combination with other lifestyle factors and a susceptible genotype. The adaptation of western lifestyles is known to lead to increasing prevalence of type II diabetes mellitus in Africa. Presence of IGT suggests an early stage of a diabetes epidemic and with the predicted increase in Type II Diabetes, approximately by 50% (from 9.4 million to 14.1 million) between 2001 and 2010, it is possible that a large percentage of the populations, in both rural and urban areas may be in the pre-diabetic stage.

Methods: A cross-sectional comparative survey where the prevalence of IGT was determined in a rural and an urban community in Kenya. A total of 663 subjects, 406 rural (185 men, 221 women) and 257 urban (139 men and 118 women) aged 20-60 years were screened for impaired glucose tolerance (IGT) using the 2-h value after 75 g oral glucose values for whole blood venous glucose concentration according to WHO criteria.

Results: The prevalence of Impaired Glucose Tolerance (IGT) was 5.7% and 7.8% for the rural and urban population respectively. Among the rural populations, it was respectively 4.9% and 5.6% for men and women, while among the urban population; it was 6.4% and 10.8% for men and women respectively. There was a significant difference in the prevalence of IGT among the men (5.2%) and women (7.7%) ($P=0.259$), however the trend indicates a significant positive correlation ($CF=0.204$, $p<0.01$, $n=623$) between age and the prevalence of IGT.

Conclusion: These data indicate a high prevalence of IGT in rural and urban areas, which suggests the presence of pre-diabetes risk factors among the populations studied. However the urban population and the elderly are generally at more risk of type II Diabetes.

6.3.2. Comparison of Fasting Blood Glucose (FBG) as a risk factor for Type II Diabetes Mellitus among a Rural and an Urban population in Kenya.

VENUE: Arusha, Tanzania

FORUM: The 2nd East African Scientific & Health Conference

DATE: 26TH MARCH 2008

Background: In Kenya today, changes like rural-urban migration have brought out a shift from a low-fat and largely unprocessed plant food or “natural” diet and high physical activity to an “affluent” high-fat diet that includes more saturated fat and cholesterol and low physical activity.

Presence of Impaired Fasting Glucose (IFG) suggests an early stage of a diabetes epidemic and with the predicted increase in Type II Diabetes, approximately by 50% (from 9.4 million to 14.1 million) between 2001 and 2010, a large percentage of the populations, in both rural and urban areas may be in the pre-diabetic stage.

Methods: A cross-sectional comparative survey. The prevalence of FBG was determined in a rural and an urban community in Kenya. A total of 471 subjects, 349 rural (152 men, 197 women) and 122 urban (79 men and 43 women) aged 20-60 years were screened for Fasting Blood Glucose (FBG) using fasting blood values after an overnight fast for whole blood venous glucose concentration according to WHO criteria.

Results: Prevalence of Impaired Fasting Glucose (IFG) was 3.4% and 4.1% for the rural and urban population respectively. The mean Fasting Blood Glucose (FBG) value was higher in urban (4.72 ± 1.84) than in rural (4.41 ± 0.68) populations. There was a significant difference ($p = 0.004$) between the overall fasting blood glucose mean for rural and urban populations. Among the rural populations, the prevalence of IFG was respectively 3.9% and 3.0% for men and women respectively, while among the urban population; it was 2.4% and 8.1%. There was no significant difference in FBG among the men and women ($P=0.445$), however, there was indication of an insignificant positive correlation ($r=0.67$, $p=0.146$, $N=471$) between age and the prevalence of FBG.

Conclusion: A high prevalence of FBG in rural and urban areas, which suggests the presence of pre-diabetes risk factors among the populations studied. The urban population and especially so, women are generally at more risk of type II Diabetes.

6.4 Questionnaires

6.4.1 Anthropometric measurements recording list:

Participant Name:		
I.D. No. of Participant:		
District:		Division:
Location:		Village:
Age:	Sex:	D.O.B. (dd/mm/yy)
Examiner:		Date of examination: (dd/mm/yy)

	1	2	X
Height (cm)			
Weight (Kg)			

	1	2	3	X
Waist Circumference (cm)				
Hip Circumference (cm)				
Triceps skin fold (mm)				
Arm Circumference (cm)				

Comments:

--

6.4.2 Blood sugar Assessment form

1. Have you ever been diagnosed with diabetes? Yes No

(If No proceed to OGTT)

2. If yes, when were you diagnosed? _____

3. At what age _____

4. Do you take any diabetes medication? Yes No

5. If yes, what kind of medication do you take?

Tablets Injections Traditional Others

6. Where do you get your medicine?

Provincial Hospital District Hospital Health Center

Traditional Doctor Private Clinic Market

7. Does anybody else in your family suffer diabetes?

Yes No

Oral Glucose Tolerance Test

	Fasting	30 Minutes	2 Hours
Blood Glucose (mmol/L)			
(Mg/dl)			

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6.4.5 Dietary Assessment: 24-Hour Recall Form

Recall #: (1) (2)	
Start time:	End Time:

Indicate in the spaces below the types of food described by the interviewee as having been consumed over the last 24 hours. Start the interview by asking: "What did you eat or drink after you woke up yesterday morning? Did you eat that food at home? What did you have next and at what time?" When the end of the day has been reached, go back and ask details about ingredients, preparation method and serving size. Note the ingredients used in the preparation of the dish and the method of preparation. Indicate the amount of the dish/product/food item consumed by the interviewee, based on appropriate household measures such as cups or other appropriate containers such as those for cooking fat, a noted size.

TIME	PLACE EATEN	DISH (Description of food or drink)	INGREDIENTS	PREPARATION METHOD	SERVING SIZE/ AMOUNT (g or ml)	FOOD CODE	AMOUNT CODE
Morning							
Snack							

--	--	--	--	--	--	--	--

1. Was the food intake unusual?

1. Yes
2. No

2. If yes, how was it unusual?

1. Composition (Give Details) _____

2. Quantity (Give details) _____

3. Was the day a feast day?

1. Yes
2. No.

4. Were you sick?

1. Yes
2. No.

5. If yes did it affect your appetite?

1. Yes
2. No.

6. How was the appetite affected?

1. Decreased (Give details)

2. Increased (Give details)
