

**DIFFERENCES IN CARDIOVASCULAR DISEASE, BIOCHEMICAL RISK  
MARKERS, PHYSICAL ACTIVITY AND NUTRITION BETWEEN AN URBAN  
AND PASTORAL SAMPLE IN KENYA**

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**A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE  
AWARD OF DEGREE OF DOCTOR OF PHILOSOPHY IN THE SCHOOL OF  
HEALTH SCIENCES OF KENYATTA UNIVERSITY**

**DECLARATION**

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

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## **DEDICATION**

To my loving parents, whom I lost during this project and to Wangeci, Wanjiru, those to come and all the children of Africa, let's reclaim our place in Science.

## AKNOWLEDGEMENT

This work would have been impossible without the encouragement and guidance from my supervisors, Prof. Boit, Prof Littarru and Dr Kariuki. I am deeply grateful to my late parents, cherished family members and friends; Eng. Gicheru, Dr.W. Gicheru, Donna and Njoki, for their encouragement. The immense support and logistical help from Nyawira, Wairimu, Gemma and Letolwai. I sincerely appreciate the help from F. Lekolol, the social mobilizers and field assistants in Samburu and Nairobi, staff at NCVC and Kenyatta University, to Kiplamai thanks for the camaraderie in the trenches of ‘Twin Towers’ as we worked on our dissertations. To my E-group your prayers were certainly not in vain. To Dirk you are an inspiration. The Lab analysis would never have come to fruition without the generous material support from Prof. Gustav and Tekle in Sweden and grants from the School of Applied Human Sciences, Kenyatta University and last but not least to all the study participants.

## TABLE OF CONTENTS

Declaration.....	ii
Dedication.....	iii
Acknowledgement.....	iv
Table of Contents.....	v
List of Tables.....	ix
List of Figures.....	xiv
Abbreviations and Acronyms.....	xv
Abstract.....	xvi

### CHAPTER ONE: INTRODUCTION

1.1 Background of the Problem.....	1
1.2 Statement of the Problem.....	3
1.3 Purpose of the Study.....	4
1.4 Objectives of the Study.....	4
1.5 Research Hypotheses.....	5
1.6 Significance of the Study.....	5
1.7 Delimitation of the Study.....	6
1.8 Limitations of the Study.....	6
1.9 Assumptions of the Study.....	7
1.10 Theoretical Framework.....	7
1.11 Operational Definition of Terms.....	10

**CHAPTER TWO: LITERATURE REVIEW**

2.1 Introduction.....	12
2.2 Cardiovascular Disease .....	12
2.3 CVD Pathophysiology.....	12
2.4 Cardiovascular Risk Factors.....	14
2.5 CVD Risk Bio-markers.....	14
2.6 CVD Prevalence in SSA.....	17

**CHAPTER THREE: METHODOLOGY**

3.1 Introduction.....	28
3.2 Research Design.....	28
3.3 Research Variables.....	28
3.4 Location of Study.....	29
3.5 Target Sample.....	29
3.6 Sample size and sampling procedures.....	30
3.7 Research instrumentation.....	31
3.8 Laboratory Procedures.....	34
3.9 Pre-testing.....	37
3.10 Validity and Reliability.....	37
3.11 Data Collection.....	37
3.12 Data Analysis.....	38
3.13 Logistical and Ethical Issues.....	38

## CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Introduction.....	40
4.2 Demographics.....	40
4.3 Prevalence of Hypertension Within and Between.....	42
The Urban and Pastoral Sample	
4.4 Differences in Blood Pressure and Biochemical CVD Risk Markers.....	51
4.5 Lifestyle Factors.....	71
4.5.1 Differences in Physical Activity and Haemoglobin.....	71
Within and Between Urban and Pastoral Sample	
4.5.2 Differences in Dietary Intake Within and Between.....	96
the Urban and Pastoral Sample	
4.5.3 Nutrition Status.....	118
4.5.3.1 Malnutrition Prevalence .....	118
4.5.3.2 Differences in Nutrition Status Within and Between.....	126
the Urban and Pastoral Sample	
4.5.4 Body Composition and Anthropometric measures.....	141
4.5.5 Differences in Body Composition and Anthropometric.....	142
Measures Within and Between the Urban and Pastoral Sample	
Urban and Pastoral Sample	
4.6 Identification of Predictive CVD Lifestyle Factors.....	158

**CHAPTER FIVE**

**SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

5.1 Introduction.....160

5.2 Summary.....160

5.3 Implications of findings.....161

5.4 Conclusions.....161

5.5 Policy recommendations.....162

5.6 Recommendations for further research.....163

**REFERENCES.....164**

**APPENDICES.....175**

Appendix A: Informed Consent

Appendix B: Social Demographic Questionnaire

Appendix C: General Health and CVD History Assessment

Appendix D: Anthropometric Questionnaire

Appendix E: Food Frequency Questionnaire

Appendix F: Dietary Recall

Appendix G: IPAQ

Appendix H: Map of study area

Appendix I: Ethical Approval Letter



## LIST OF TABLES

i.	Table 4.1 Background Characteristics By Location.....	41
ii.	Table 4.2 Hypertension Prevalence within the Urban Sample.....	43
iii.	Table 4.3 Hypertension Prevalence within the Pastoral Sample.....	43
iv.	Table 4.4 Differences in Blood Pressure and Biochemical CVD.....	52
	Risk Markers Within The Urban Sample	
v.	Table 4.5 Differences in Blood Pressure and Biochemical CVD.....	54
	Risk Markers Within The Pastoral Sample	
v.	Table 4.6 Differences in Blood Pressure and Biochemical CVD.....	56
	Risk Markers Between the Urban and Pastoral Male Samples	
vi.	Table 4.7 Differences in Blood Pressure and Biochemical CVD.....	58
	Risk Markers Between the Urban and Pastoral Female Samples	
vii.	Table 4.8 Differences in Blood Pressure and Biochemical CVD.....	60
	Risk Markers Between the Urban and Pastoral Samples	
viii.	Table 4.9 Differences in Blood Pressure Between The Urban and.....	65
	Pastoral Sample by Age-categories	
ix.	Table 4.10 Differences in Apolipoproteins Between The Urban.....	68
	and Pastoral Samples By Age Category	
x.	Table 4:11 Differences in Co-Q10 Between the Urban and.....	70
	Pastoral Sample By Age-category	
xi.	Table 4.12 Difference in Physical Activity.....	71
	(MET minutes/week) and Haemoglobin Within The Urban Sample.	

xii.	Table 4.13 Differences in Physical Activity.....	74
	(MET minutes/week) and Haemoglobin Within The Pastoral Sample.	
xiii.	Table 4.14 Differences in Physical Activity.....	78
	(MET minutes/week) and Haemoglobin Between The Urban and Pastoral Male Samples	
xiv.	Table 4.15 Differences in Physical Activity.....	81
	(MET minutes/week) and Haemoglobin Between The Urban and Pastoral Female Samples.	
xv.	Table 4.16 Differences in Physical Activity.....	84
	(MET minutes/week) and Hemoglobin Between The Urban and Pastoral Samples	
xvi.	Table 4.17 Differences in Physical Activity.....	87
	(MET minutes/week) and Hemoglobin Between The Urban and Pastoral Samples in The Age-category 30-40	
xvii.	Table 4.18 Differences in Physical Activity.....	89
	(MET minutes/week) and Hemoglobin Between The Urban and Pastoral Samples in The Age-category 41-50	
xviii.	Table 4.19 Differences in Physical Activity.....	92
	(MET minutes/week) and Hemoglobin Between The Urban and Pastoral Samples By Age-category 51-60	
xix.	Table 4.20 Differences in Dietary Intake Within the.....	96
	Urban Sample	
xx.	Table 4.21 Differences in Dietary Intake Within the.....	98

Pastoral Sample	
xxi. Table 4.22 Differences in Dietary Intake Between.....	100
the Urban and Pastoral Male Samples	
xxii. Table 4.23 Differences in Dietary Intake Between the.....	102
Urban and Pastoral Female Samples	
xxiii. Table 4.24 Differences in Dietary Intake Between the.....	105
Urban and Pastoral Samples	
xxiv. Table 4.25 Differences in Dietary Intake Between.....	108
The Urban and Pastoral Samples By Age-category: 30-40	
xxv. Table 4.26 Differences in Dietary Intake Between.....	110
The Urban and Pastoral Samples By Age-category: 41-50	
xxvi. Table 4.27 Differences in Dietary Intake Between.....	113
The Urban and Pastoral Samples By Age-category: 51-60	
xxvii. Table 4.28 Prevalence of Malnutrition in The Urban and.....	124
Pastoral Samples by Age Categories	
xxviii. Table 4.29 Differences in Nutrition Status within the.....	126
Urban Sample	
xxix. Table 4.30 Differences in Nutrition Status within the.....	128
Pastoral Samples	
xxx. Table 4.31 Differences in Nutrition Status Between.....	129
The Urban and Pastoral Male Samples	
xxxi. Table 4.32 Differences in Nutrition Status Between.....	131
The Urban and Pastoral Female Samples	
xxxii. Table 4.33 Differences in Nutrition Status.....	132

Between The Urban and Pastoral Samples

xxxiii. Table 4.34 Differences in Nutrition Status Between.....133  
 Urban and Pastoral Samples by Age-Category: 30-40

xxxiv. Table 4.35 Differences in Nutrition Status Between.....135  
 Urban and Pastoral Samples By Age-Category: 41-50

xxxv. Table 4.36 Differences in Nutrition Status Between.....136  
 Urban and Pastoral Samples By Age-Category: 51-60

xxxvi. Table 4.37 Differences in Body Composition and.....142  
 Anthropometric Measures Within the Urban Sample

xxxvii. Table 4.38 Differences in Body Composition and.....143  
 Anthropometric Measures Within the Pastoral Sample

xxxviii. Table 4.39 Differences in Body Composition and.....145  
 Anthropometric Measures Between the Urban and  
 Pastoral Male Samples

xxxix. Table 4.40 Differences in Body Composition and.....146  
 Anthropometric Measures Between the Urban and  
 Pastoral Female Samples

xl. Table 4.41 Differences in Body Composition and.....148  
 Anthropometric Measures Between the Urban and  
 Pastoral Samples

xli. Table 4.42 Differences in Body Composition and.....149  
 Anthropometric Measures Between the Urban  
 and Pastoral Samples By Age-Category: 30-40

xlii. Table 4.43 Differences in Body Composition and.....151

Anthropometric Measures Between the Urban  
and Pastoral Samples By Age-Category: 41-50

xliii. Table 4.44 Differences in Body Composition and.....152

Anthropometric Measures Between the Urban  
and Pastoral Samples By Age-Category: 51-60

## LIST OF FIGURES

- i. Figure 1.1 Conceptual framework of Epidemiological transition.....7
- ii. Figure 4.1 Differences in Hypertension Prevalence between.....44  
the Urban and Pastoral male Samples
- iii. Figure 4.2 Differences in Hypertension Prevalence between.....46  
the Urban and Pastoral Female Samples
- iv. Figure 4.3 Differences in Hypertension Prevalence Between the.....47  
Urban and Pastoral Samples
- v. Figure 4.4 Differences in Hypertension Prevalence Between the.....49  
Urban and Pastoral Samples by Age-categories
- vi. Figure 4.5 Prevalence of Malnutrition in the Urban.....118  
Male and Female Sample
- vii. Figure 4.6 Prevalence of Malnutrition in the Pastoral.....119  
Male and Female Sample
- viii. Figure 4.7 Prevalence of Malnutrition in the Urban.....120  
and Pastoral Male Samples
- ix. Figure 4.8 Prevalence of Malnutrition.....121  
in the Urban and Pastoral Female Samples
- x. Figure 4.9 Differences in Malnutrition Prevalence.....122  
Between the Urban and Pastoral Samples

**LIST OF ABBREVIATIONS & ACRONYMS**

ApoA-I	Apolipoprotein A-I
ApoB	Apolipoprotein
ApoB/A-I ratio	The ratio of apolipoprotein B and A-I
BMI	Body Mass Index
CBS	Central Bureau of Statistics
CHD	Coronary Heart Disease
CHF	Congestive Heart Failure
CVD	Cardiovascular Disease
Co-Q10	Ubiquinone
DHA	Docosahexaenoic acid
EPA	Eicosapentaenoic Acid
HC	Hip circumference
IPAQ	International Physical Activity Questionnaire
Kcals	Kilocalories
KDHS	Kenya Demographic and Health Survey
METS	Metabolic equivalents
MUAC	Middle Upper Arm Circumference
RHD	Rheumatic Heart Disease
WC	Waist Circumference
WHO	World Health Organization
WHR	This is the ratio of the waist circumference to the Hip circumference

**ABSTRACT**

The purpose of this study was to determine the differences in blood pressure, cardiovascular disease bio-chemical risk markers, physical activity and nutrition, between an Urban (US) and Pastoral (PS) sample, in the context of the global epidemiological transition taking place globally causing a shift in mortality and morbidity from communicable diseases to non-communicable diseases. A total of 133 adults from both samples meeting the inclusion criteria, were randomly recruited from clusters in sub-locations, villages and homesteads from available demographic data available from Central Bureau of Statistics (CBS) on Kirisia and Kibera divisions in Samburu and Nairobi, in Kenya. Data was collected using questionnaires, venipuncture, blood pressure measurement and anthropometric measurements. Resulting data was stratified and analyzed by locality, gender and age-category using SPSS V 11.5 and computed in terms of percentages and frequencies. Chi-square test was used to test for differences in proportions. Student t-test and ANOVA were used to compare means where applicable and in cases where there were more than two means being compared. The level of significance at 0.05 was used for the statistical tests. In case of significant F-ratio, post-hoc analysis was done using DMRT. Stepwise multiple regression analysis was used to identify predictors of cardiovascular disease, p-values <0.05 were considered significant. There was no difference in proportions between the two groups. Means for SBP, apoB, apoA, apoB/A ratio, Co-Q10, were significantly different at  $p<.019$ ,  $p<.001$ ,  $p<.001$ ,  $p<.001$  and  $p<.001$  respectively, between these two samples. Means for lifestyle factors: MET mins/week (physical activity), Lymphocytes, BMI and MUAC (nutrition status markers) were significantly different at  $p<.001$ ,  $p<.027$ ,  $p<.001$  and  $p<.001$  respectively. Mean nutrient intake was significantly different at  $p<.030$ ,  $p<.039$ ,  $p<.001$ ,  $p<.009$ ,  $p<.025$ ,  $p<.049$  and  $p<.001$ , for protein, carbohydrates, dietary cholesterol, SAFA, MUFA, DHA and Folic acid between the two samples. Mean %B. Fat and WC were significantly different at  $p<.001$  and  $p<.001$  in the two samples respectively. MUAC in both samples could be used to predict Systolic BP. Lymphocytes count could be used to predict Co-Q10 in the US while derived % B. Fat could be used to predict ApoB/A ratio in the PS. The Urban sample had a higher CVD risk than the Pastoral sample therefore perhaps at a more advanced stage of the epidemiological transition.



## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background of the Problem**

Cardiovascular diseases (CVD's) are chronic or acute disorders of the heart and blood vessels and include coronary heart disease, cerebrovascular disease, peripheral artery disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis and pulmonary embolism (WHO, 2002). Majority of these diseases are degenerative and heavily influenced by lifestyle (Gaziano, 2005).

At the beginning of the 20<sup>th</sup> Century, CVD's were responsible for fewer than 10% of all deaths world-wide, but are currently estimated to be responsible for 30% of deaths, with about 80% of these occurring in developing countries (Gaziano, 2005). They were the number one cause of death world-wide for the first time in 2001 (Mathers et al., 2001). CVD's are currently the principal killer in the United States of America (US), Europe and Asia (Breslow, 1997; Brunwald, 1997; Yusuf, Reddy, Ounpuu & Anand, 2001).

Over the past three decades, the US has seen a general decline in mortality rates, although exceptionally high, except in its African American sub-sample (Watkins, 2004). This is particularly so in African American women, with coronary heart disease (CHD) mortality rates 35.3% higher and stroke rates 71.4% higher than in white women (Branford & Ofili, 2000), whose mortality remained constant, despite similar risk factors in both whites and blacks. This is perhaps due to the excess prevalence of diabetes and hypertension (Watkins, 2004).

The incidence of cardiovascular diseases causing an estimated 12 million deaths globally per year, have been noted to occur earlier in life and at a faster rate in developing countries than in industrialized countries (WHO Report, 2002). This has been attributed to a significant increase in consumption especially in middle and low income countries, and termed a "risk transition". This is at great cost because CVD's pose a huge economic burden to these countries in view of their prevailing poverty (Gaziano, 2005), and the high cost of treating communicable diseases compounded by the burden of human immunodeficiency virus/acquired immune deficiency syndrome (NASCO, 2001).

In Africa, the cradle of mankind, hunter-gatherer groups like the Kalahari Bushmen, were documented to have good blood pressures that did not rise with age in 1960 as was the case in Europe and North America. Similar phenomena were also observed among ethnic groups in Kenya in 1929 and in Uganda in 1941 (Opie & Mayosi, 2005). Strong economic forces have however been noted to be propelling previously isolated rural groups into the peri-urban and urban areas and lifestyles, causing an "epidemiological transition" bringing with it an increased burden of cardiovascular disease (Yusuf, Reddy, Ounpuu, Anand, 2001).

According to the World Bank grouping by geographical and economic variation of all the low-and middle-income countries with a gross national income per capita lower than US\$9,200, SSA (SSA) is the only region where CVD is not the leading cause of death, except in those aged over 30 years (Mathers et al., 2001). The stage of transition that each region finds itself varies widely as a result of the epidemiological transition taking place.

Cardiovascular disease in Africa is of immense economic importance because of its frequent under-diagnosis, and the severity of its complications. Hypertension in Africa has now changed from a relative rarity to a major problem, with an estimated 10-20 million hypertensives in SSA alone (Opie, 2005; Seedat, 2000). Hypertension has been identified to be the strongest risk factor for myocardial infarction (MI) in black Africans, with an odds ratio of 6.99 compared with 2.3-3.9 in other ethnic groups in the INTERHEART Africa study, the Africa arm of a global multi-centre case control study of risk factors for acute myocardial infarction (Steyn et al., 2005). However it has been argued that environmental rather than genetic factors may account for observed differences in hypertension between black and white hypertensives (Opie, 2005; Seedat, 2000).

Data on CVD in Kenya is scant or old and therefore not easy to grasp the current prevalence or impact of CVD. Available literature dating back to 1905 (Opie, 2005) show the rarity of CVD, however Urbanisation has since taken root and perhaps altered this. Available literature on the effects of migration from rural to urban settings appears to suggest that environment is an important agent in the rise of CVD, as shown by Poulter, et al., (1990) in a longitudinal study on the determinants of blood pressure changes due to urbanization.

## **1.2 Statement of the Problem**

In view of the rapid epidemiological transition taking place in developing countries, the common occurrence of hypertension and CVD being the leading cause of death in SSA in individuals aged over 30 years (Mathers et al., 2001), there is a need to examine the

occurrence of CVD, biochemical risk markers, and their interaction if any, with lifestyle and socio-economic pressures in different population groups in different socio-economic settings in Kenya, as this will enhance our understanding of the possible environmental factors at play in the rapid increase in CVD.

### **1.3 Purpose of the Study**

This study was designed to determine the differences in blood pressure, biochemical cardiovascular disease risk markers, lifestyle factors: physical activity, dietary habits, nutritional status and body composition, within and between urban Nairobi and pastoral Samburu groups, in Kenya.

### **1.4 Objectives of the Study**

The objectives of the study are to:

- i) Examine the difference in the prevalence of hypertension, a CVD, within and between an Urban and Pastoral sample in Kenya.
- ii) Assess the differences in blood pressure and biochemical CVD risk markers, within and between an Urban and Pastoral group in Kenya.
- iii) Study the differences in lifestyle factors: physical activity, dietary intake, nutritional status, body composition and anthropometric measurements within and between an Urban and Pastoral sample in Kenya in relation to blood pressure and CVD risk markers.
- iv) Identify modifiable lifestyle factors that are predictors of hypertension and biochemical CVD risk markers, in the two groups

### **1.5 Research Hypotheses**

- i.  $H_{01}$  There is no significant difference in the prevalence of high blood pressure within and between Urban Nairobi and Pastoral Samburu samples.
- ii.  $H_{02}$  There is no significant difference in blood pressure and biochemical cardiovascular disease risk markers between an Urban Nairobi and Pastoral Samburu samples, in Kenya.
- iii.  $H_{03}$  There is no significant difference in lifestyle factors: physical activity, dietary intake, nutritional status, body composition and anthropometric measurements within and between Urban and Pastoral samples in Kenya.

### **1.6 Significance of the Study**

The incidence of CVD occurring earlier in life and at a faster rate in developing countries than in industrialised countries, has significant financial, morbidity and mortality implication for these poor countries (WHO, 2002).

As a developing nation, Kenya is no exception and there is therefore, a need for urgent early diagnosis, cost-effective interventions strategies, but much more, the need to understand the underlying factors that may be predisposing the Kenyan sample to CVD's. This will enable the design of sustainable, practical and cost-effective preventive measures and intervention strategies. This will help minimise the economic impact of CVD's viewed in terms of bed costs, loss of man-hours and wages, in addition to minimising the social impact viewed in terms of stress especially given that opportunity cost to society will increase as onset of CVD's continues to occur earlier.

The findings of this study will also provide insight into urban and pastoral samples: their lifestyles, dietary habits and physical activity. Studying subjects from different environments will contribute to our understanding of the environmental mediators of CVD risk factors in SSA.

There is also scarcity of data on CVD risk factors and markers in the Kenyan population despite the alarmingly observed prevalence of CVD or its risk factors in the general as well as in specific sub-populations (Kariuki, 2007 and Christensen, in review). There is need for more studies in this area, as these could potentially provide important new information that will lead to practical preventive strategies to help reduce the incidence of CVD not only in Kenya, but also in SSA. This is important for Kenya as more and more of its populace gradually begins to move to the next stage of the epidemiological transition. The findings of this study will also form the basis for further research on CVD in Kenya.

### **1.7 Delimitations of the Study**

The study was delimited to:-

- i) The use of blood samples to collect biochemical data
- ii) The use of a questionnaire as the instrument for collection of a) demographic b) social c) dietary patterns d) physical activity and e) anthropometric data.

### **1.8 Limitations of the Study**

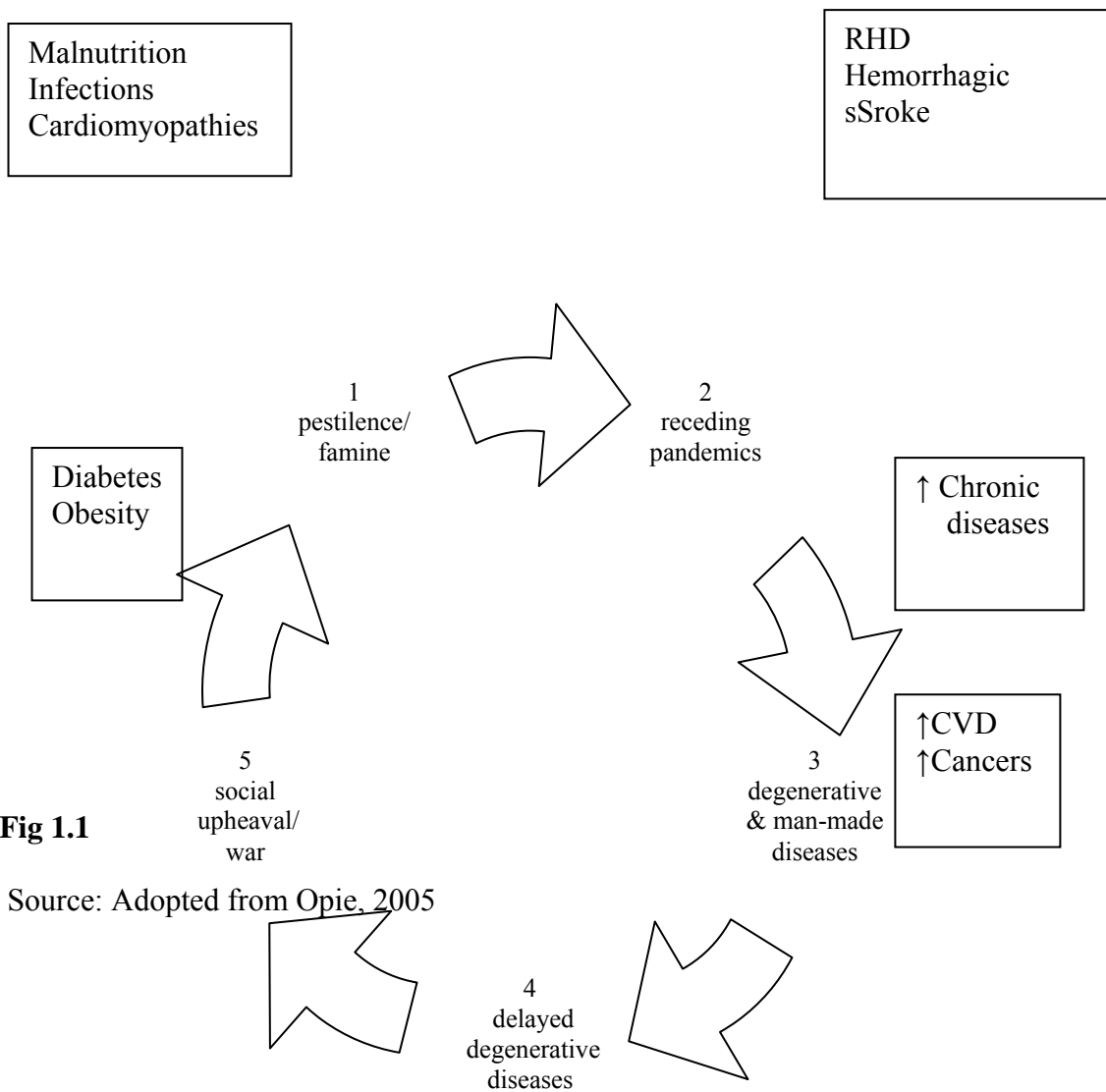
- i) Lack of control over food security with regard to availability of food at the time of the study.

- ii) Lack of control over different levels of food security/availability at the time of the study in the two geographical locations.

### 1.9 Assumptions of the Study

- i) It was assumed that all participants were apparently healthy.
- iii) It was assumed that the subjects responses to questions fielded to them were truthful.

### 1.9 Conceptual Framework



**Fig 1.1**

Source: Adopted from Opie, 2005

A transition model consisting of three basic stages referred to as 'Epidemiological transition' was developed by Omran (1971), to describe the shift in causes of death as a society moves from being a pre-industrial one to a developed one.

He divided this shift into three stages: the age of pestilence and famine, where malnutrition and infectious diseases are the main cause of death, the second stage as the age of receding pandemics in which improvement in nutrition and public health lead to a decrease in death rates because of these improvements accompanied by a steep decline in infant and child mortality rate. The third stage in his construct was the age of degenerative and man-made diseases characterised by increased mortality from chronic non-communicable diseases such as hypertension and atherosclerosis due to increased fat and caloric intake alongside decreased physical activity.

Olshansky and Ault (1986) added a fourth stage, the age of delayed degenerative diseases which is marked by increased efforts to prevent, diagnose and treat ischemic heart disease and stroke, to delay their onset until old age, the major causes of mortality and morbidity are CVD and cancer. A fifth stage was postulated by Yusuf, Reddy, Ounpuu & Anand (2001), the age of social upheaval or war. This stage is marked by a breakdown of existing social and health structures leading to a resurgence of death from diseases found in the first two stages of the epidemiological transition concomitant with diseases of the third and fourth stage. This regressive stage is marked by increasing deaths from CVD, infectious diseases and violence leading to a lowered life-expectancy.



It is important to note that different countries in the world or different parts of a country may be at different stages of this epidemiologic transition due to different rates of acculturation and is particularly common in developing countries. Thus certain regions within a country may be suffering from pestilence, famine and marked by predominance of malnutrition and infectious diseases, while other regions are experiencing a reduction in pandemics, improved nutrition, increased urbanisation, hypertension and adult chronic diseases. Thus variations in CVD rates between different parts of the world reflect interactions between genetic susceptibility and marked environmental changes usually secondary to urbanization, increasing affluence and a range of other influences from early childhood to adulthood (Yussuf et al., 2001).

The present study therefore aimed at determining the differences in cardiovascular disease, biochemical risk markers, physical activity, nutrition and demographics between an urban and pastoral sample in Nairobi and Samburu in Kenya, living in different geographical and socio-economic conditions within the same country to assess the presence if any, of the epidemiological transition and its impact thereof.

### 1.10 Operational Definition of Terms

**Biochemical Risk Markers-** Ubiquinone, Apolipoprotein A-1, Apolipoprotein B-100 and Apolipoprotein B/A-1 ratio are blood tests associated with a higher risk of cardiovascular disease

**Dietary Intake-** Qualitative and Quantitative measurement of the food and fluids consumed by study participants

**Epidemiological Transition-** this is the shift in the major cause of mortality and morbidity from a predominance of nutritional deficiencies and infectious diseases, to chronic degenerative diseases eg. cardiovascular disease, diabetes and cancer in developing nations, previously the preserve of industrialized and more advanced societies.

**Girth Measurements-** Technique to assess body composition, including percent body fat, by measuring circumferences at various body sites.

**Myocardial Infarction -** commonly referred to as a heart attack, is a medical condition that occurs when the blood supply to a part of the heart muscle is interrupted, most commonly due to rupture of a vulnerable plaque causing occlusion.

**Obesity-** A chronic disease characterised by an excessively high amount of body fat in relation to lean body mass.

**Overweight-** An excess amount of weight against a given standard such as height or recommended percent body fat. A Body Mass index greater than  $25-29.9\text{kg/m}^2$  is considered overweight.

**Pastoral sample-** These are people who mainly live off their animals. In this study, this term refers to the Samburu group in Poro and Partuk locations in Kirisia Division, Samburu District in the Rift Valley Province in Kenya, an ethnic group whose lifestyle

is based on keeping of animals for food and economic productivity, they tend to roam from one geographical region to another in search of pasture for their animals.

**Physical Activity-** Bodily movement produced by contraction of skeletal muscles that requires energy expenditure and produces progressive health benefits. It includes activities of daily living, structured leisure time activities and occupational work.

**Urban Nairobi Sample-** this is the diverse ethnic and racial group living in the cosmopolitan capital city of Kenya, Nairobi. In this study, this was the sample drawn from Kibera and Langata locations in Kibera Division in Nairobi Province.

**Urbanization-** this is migration to western environments marked by an increase in consumption of energy rich foods and decreased physical activity

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter reviews literature related to cardiovascular disease, focusing on its prevalence, risk markers, physical activity, diet/nutrition factors in its etiology.

#### **2.2 Cardiovascular Disease**

Cardiovascular diseases (CVD's) include chronic and acute disorders of the heart and blood vessels. These include coronary heart disease, cerebrovascular disease, peripheral artery disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis and pulmonary embolism (WHO, 2002). Majority of these are degenerative and heavily influenced by lifestyle (Gaziano, 2005).

#### **2.3 Pathophysiology**

The precise pathogenesis of atherosclerosis is not fully understood, but generally it is postulated to begin when the endothelium, a thin layer of squamous cells lining the heart and blood vessels to allow the smooth flow of blood and prevention of the formation of thrombi, becomes dysfunctional (endothelial dysfunction) initiated or augmented by elevated and modified LDL cholesterol and reactive oxidative species (ROS). Factors that promote this process include ageing, cigarette smoking, hypertension, diabetes mellitus, genetic alterations, elevated plasma homocysteine concentrations, infectious micro-organisms such as herpes viruses or *Chlamydia pneumoniae*, and combinations of

these or other factors are thought to also have a role in the onset and progression of atherosclerosis, a chronic inflammatory process (Ross, 1999), leading to CVD.

Foam cells attach themselves to the arterial intima to form inflammatory lesions (fatty streaks) in a chronic inflammatory process (Ross, 1999). The inflammatory response itself, specifically mediators of inflammation, such as tumour necrosis factor (TNF  $\alpha$ ), interleukin-1 (IL-1) and macrophage colony-stimulating factor, increases binding of LDL to endothelium and smooth muscle to increase the transcription of the LDL-receptor gene (Stoepck, Nicholson, Mancini & Hajjar, 1993). After binding to scavenger receptors in vitro, modified LDL initiates a series of intracellular events that include the induction of urokinase and inflammatory cytokines such as IL-1. This creates a vicious cycle of inflammation, modification of lipoproteins and further inflammation in the artery as a result of these lipids (Palkama, 1991).

Continuation of chronic inflammation, the hallmark of CVD, leads to formation of fibrous plaque made up of a necrotic core of cellular debris, degenerating foam cells, and cholesterol crystals separated from the arterial lumen by a fibrous cap. Fibrous plaques are more advanced lesions and lead to the clinical manifestations of atherosclerosis. Oxidized LDL is present in lesions of atherosclerosis in humans. Crystallised cholesterol forms sharp tipped crystals that expand and tear biological membranes causing plaque rupture leading to thrombosis and acute myocardial infarction (Abela, Azia & Dejong, 2006). However, adequate levels of or supplementation with antioxidants decreases LDL cholesterol oxidation (Steinberg, 1989; Alleva, Toomasetti, Curatola, Littarru & Folkers, 1995).

Blood flow through an artery is often restricted when arterial plaque calcifies, stiffening the vessel and making it fragile or when arterial plaque ruptures, exposing thrombogenic material leading to formation of a thrombus that may occlude the artery, causing either a heart attack or stroke or its incorporation into the plaque, enlarging its size. A piece of the plaque (atheroma) may also break off and lodge in distal sites (embolization) and manifest itself by causing ischemic change of tissue (Ross, 1999).

#### **2.4 CVD Risk Factors**

Cardiovascular disease is associated with numerous risk factors; however the major coronary artery disease risk factors according to the American College of Sports Medicine, 1996:

##### **Non-Modifiable**

- Age defined for a particular sample
- Gender
- Family history of premature coronary heart disease
- Race or ethnicity

##### **Modifiable**

- Blood lipids and lipoproteins
- Systemic arterial hypertension
- Type II Diabetes
- Tobacco smoking
- Obesity
- Physical inactivity

#### **2.5 CVD Risk Bio-Markers**

Biochemical markers may also be used to determine CVD risk factors, which unmask underlying/sub-clinical states long before symptoms are observed, some of these are:

**Ubiquinone (Co-Q10)**

This is a vitamin-like compound synthesised in all tissue in the human body. It is the cofactor for at least three mitochondrial enzymes (complexes I, II and III) of the oxidative phosphorylation pathway and are essential for the production of adenosine triphosphate (ATP), the functional bedrock of all cells. It is the only lipid-soluble antioxidant that is endogenously synthesized in both unicellular and multicellular organisms (Turunen, Olsson & Dallner, 2004). It also participates in the electron-transport systems of plasma membranes and lysosomes. Co-Q10 levels decrease with age and are low in individuals with some chronic diseases. Deficiency of Co-Q10 affects oxidizability of LDL subfractions (Alleva et al., 1995), and enhances DNA damage in lymphocytes (Tomasetti, Littarru, Stocker & Alleva, 1999). Co-Q10 levels are yet to be determined in a SSS sample to the best of the investigators knowledge.

**Apolipoprotein A-1**

Apolipoprotein A1 is formed in the liver and intestine and secreted into plasma with hepatic HDL particles and chylomicrons. It is quantitatively the most important protein in the HDL fraction and is localized to the HDL particle's surface. It also provides structural integrity to lipoproteins and shields the hydrophobic lipids at their centre. It turns on the necessary activator of the enzyme lecithin-cholesterol acyltransferase (LCAT), which esterifies non-esterified cholesterol in HDL particle surface enzymes that load cholesterol from the tissues into HDL allowing it to be recognized and bound by receptors in the liver at the end of the transport (Florvall, Basu & Larsson, 2006). Apo A-1 concentration tends to rise and fall with HDL levels and its deficiency appears to correlate well with an increased risk of

developing coronary artery disease (CAD) and peripheral vascular disease (Pischon et al., 2005).

### **Apolipoprotein B-100**

This is the protein component of lipoproteins that provides structural integrity to lipoproteins while shielding the hydrophobic lipids at their centre. It is recognized by receptors on the surface of many of the body's cells and helps bind lipoproteins to those cells to allow transfer of cholesterol and triglycerides from the lipoprotein into the cells (Florvall, Basu & Larsson, 2006).

There are two forms of Apolipoprotein B, Apo B-100 and Apo B-48. Apo B-48 is created in the intestines. It is an integral part of the structure of chylomicrons, the larger lipoproteins responsible for the initial transport of lipids to the liver for repackaging and combining with Apo B-100 (made in the liver), to form triglyceride-rich very low-density lipoproteins (VLDL). Lipoprotein in the bloodstream, removes triglycerides from VLDL initially creating intermediate density lipoproteins (IDL) and then low density lipoproteins (LDL). Each VLDL particle contains one molecule of Apo B-100, which is retained as VLDL shrinks to become the more cholesterol-rich, LDL (Florvall, Basu & Larsson, 2006). Apo B-100 levels tend to reflect LDL levels and are measured more precisely than LDL (Pischon et al., 2005).

### **ApoB to ApoA-I ratio (apoB/A-I ratio)**

This is a ratio derived by dividing apoB by apoA-I, it is used to determine CVD risk with a cut off of  $\geq 0.9$ , and is thought to be a better predictor of CVD than serum cholesterol (Pischon et al., 2005).



In Apolipoprotein-related MOrtality RISK (AMORIS) study, a prospective study which followed 175,000 Swedish males and females for 98 months, Apo B/Apo AI ratio had a stronger relationship with CHD risk than any other lipid ratios including total cholesterol to high density lipoprotein cholesterol ratio or Low density lipoprotein cholesterol to high density lipoprotein cholesterol ratio (Walldius et al., 2001). Apob to ApoA-I ratio data in SSA is scant with the exception of the African arm of the INTRHEART study, this study will therefore add to the body of data.

## **2.6 CVD Prevalence in SSA**

SSA is a diverse region with equally diverse ethnic groups with a population of over 500 million, ranging from the Bantu in western, central, eastern and southern Africa, to the Nilo-Hamites in western, eastern and the horn of Africa, with most of this population living in rural set-ups (Akinkugbe, 1990). However urbanisation is fast changing in pockets, with some highly industrialised cities with people living a “western” lifestyle (Steyn et al., 2005). In 1950, an estimated 32 million people lived in urban areas of Africa, by 2025 an estimated 857 million people or 54% of the total African population, will live in urban areas (Sobngwi et al., 2001, WHO, 2003a; WHO, 2003b).

SSA is largely thought to be in the first stage of the epidemiological transition, and is the only World Bank region defined by geographic and economic variation, that does not have CVD as the leading cause of mortality, as HIV/AIDS is the leading cause of death (Mpiko et al, 2005). However, CVD's are the second-leading cause of death and first for those aged above 30 years, while Ischaemic heart disease (IHD), previously considered rare in SSA, now ranks 8th among the leading causes of death

in men and women in the region (Akinboboye, Idris, Akinboboye & Akinkugbe, 2003). High prevalence of CVD and related complications in some quarters is thought to be relatively low in most regions in Africa. However, it is apparent that Africa is experiencing rapid changes in lifestyle and acculturation, with hypertension being the leading form of CVD, followed by rheumatic heart disease and cardiomyopathy (Akinboboye, et al., 2003). The threat of multiplication of CVD risk prevalence in SSA lies in several factors ranging from the ubiquitous *in-utero* malnutrition to HIV/AIDS related CVD that has been noted to uniquely present itself as pericardial disease, tuberculosis or as aneurysms of the large blood vessels (Mpiko & Hakim, 2005).

### **CVD Trends in SSA**

The earliest available documentation of CVD in SSA noted the absence of hypertension in a hospital-based survey of 1800 Kenyan natives admitted to hospital over a two-year period in South Kavirondo in Kenya (Donnison, 1929). Similarly, CVD studies conducted on the Masaai, Samburu, Rendile and Turkana of Kenya in the 1960's and 1970's (Shaper, 1962; Mann, Shaffer, Anderson & Sandstead 1964; Day, Bailey & Robinson 1976) and in the Fulani of West Africa in 2001 (Glew et al., 2001) showed a very low prevalence of CVD in these pastoral samples.

Among the Fulani in Nigeria, a cross-sectional study on the CVD risk factors on 121 subjects, Glew et al, (2001) showed total serum cholesterol concentrations of 3.5mmol/L (136.5mg/L) on the lower end of the reference range. Their low density cholesterol (LDL) concentrations averaged 1.86mmol/L (72.54mg/L) and were lower than the referent range for whites, despite the high-fat (saturated fatty acids) diet

comprising of 20% protein, 33% carbohydrate, 48% fat in the men and 16% protein, 36% carbohydrate and 47% fat in the women. This lead the investigators to debunk the hypothesis that high-fat diets raise serum cholesterol concentrations as these findings were in accord with studies conducted on two other samples in eastern Niger that yielded similar findings (Glew et al., 2001).

However, change in lifestyles and acculturation studies on pastoral groups that have migrated to cities have established certain cardiovascular and biochemical changes occurring in those not living their traditional lifestyle. This has been evidenced by significantly greater average systolic and diastolic blood pressures, skin-fold thickness, body mass index, serum triglycerides and serum cholesterol levels when compared to those living a traditional way of life (Day et al., 1976; Day et al., 1979).

CVD studies done over the past five decades in SSA appear to show an upward trend in CVD with hypertension being the most prevalent (Akinboboye et al., 2003)

### **Hypertension and Stroke**

Hypertension in SSA is described as being widespread and more prevalent in urban areas as compared to rural areas. It is often under-diagnosed and probably under-treated (Seedat et al, 2000). In a multi-centre study on 665 male and female patients in Dakar, Nouakchott, Ouagadougou, N'djamena (Savannah zone) and Abidjan, Libreville, Yaounde (forest zone) to assess the causes, management and outcome of cardiovascular emergencies, severe hypertension and stroke accounted for 52.5 % of all morbidity, followed by Class IV heart failure of the New York Heart Association (NYHA) classification and accounting for 27.5% of all morbidity. Coronary heart

disease only accounted for 6.1%, while the observed mortality was 21.2% without any differences in age groups. Stroke was observed to be the most common emergency resulting in 31.9 % of the deaths (Bertrand et al., 2006). In Nigeria the prevalence of stroke is estimated at 1.14 per 1000 with a 30-day case fatality rate is as high as 40% (Wahab, 2008).

In SSA, despite scant data on CVD's including hypertension, it has been noted that there are differences in the prevalence of hypertension between the urban and the rural sample and that generally blood pressure assumes more importance with age. The exception however, are studies done on the San of Southern Africa and the Maasai of Kenya in whom blood pressures remained relatively flat with age (Kaminer & Lutz, 1960; Day et al., 1976) or declined with age in the Samburu of Kenya (Shaper et al., 1962). Although accurate national prevalence rates of hypertension are lacking, prevalence of hypertension in SSA is estimated at between 10 to 20 million, but with stroke case fatality rates up to threefold greater in SSA than in the developed world (Opie et al., 2005; Steyn et al., 2005).

### **CAD/Dyslipidemia**

Data on CVD risk factors in SSA appears to indicate the growing importance of dyslipidemia, the INTERHEART Africa Study, the African arm of an international, standardized, case-control study conducted in 52 countries, had 9 SSA countries with a total of 578 acute myocardial infarction (AMI) incident cases and 785 age- and sex-matched controls in urban settings during 1999–2003. This study was designed to assess the association of CVD risk factors and AMI for the first time in Africans. It found that the risk for an acute AMI in terms of ApoB/ApoA-1 ratio was higher in

the total African group than in the global INTERHEART group, with the African group having a higher sample attributable risk and that African cases presented with a first AMI for the first time occurring 3.8 years earlier than the overall INTERHEART study participants from other races, perhaps indicating an emerging trend in SSA (Steyn et al., 2005).

In Nigeria, a randomly stratified study to assess the prevalence of dyslipidemia in 100 apparently healthy male and female professionals in South Nigeria with a mean age of  $41.59 \pm 8.22$  years, with a western diet and lifestyle, indicated a low prevalence of hypercholesterolemia of 5%, but a high prevalence of dyslipidemia in this sample with 51% having elevated LDL-cholesterol while 60% had depressed HDL cholesterol levels, with the females recording better overall lipid levels (Osenigbo et al., 2008), further supporting the notion that CVD and its attendant risk factors are no longer the preserve of developed countries but also developing and often poor countries such as those in SSA.

Research by Shaper (1962) found low total cholesterol levels of about 170mg/dl in the Samburu, despite their high fat diets, sometimes as much as 70% of daily caloric intake. Their total cholesterol and blood pressure declined with age despite an increase in the amount of meat consumed. In a study on 400 Maasai men, hypertension and heart disease was found to be rare and remarkably low cholesterol levels averaging 124.6mg/100ml were prevalent, only second to the Ituri pygmies of the Congo (Mann et al., 1964).

**Heart Failure**

Heart failure (HF) in SSA although largely unexplored, is regarded to be emerging as a dominant form of CVD accounting for over 30% of hospital admissions in specialized cardiovascular units and 3-7% of general internal medicine (Kengene et al., 2008). The etiology of which is mainly non-ischemic in nature, with diabetes, hypertension, cardiomyopathy, rheumatic heart disease, pericardial disease and chronic lung disease contributing over 90% of the cases. Hypertensive heart disease complications occur more commonly in Africans particularly in the younger sample who tend to be the backbone of economic productivity in any society thus heart failure in SSA has significant implications for this developing region (Ntusi & Mayosi, 2009).

In a two-dimensional Doppler echocardiographic study on the aetiology of 572 consecutive HF patients referred to a national cardiac referral centre in Ghana over a four year period, the mean age of the patients was 42.3 +/- 0.9 years with a male to female ratio of 1.2:1.0 with the main cause of HF being hypertension 21%, rheumatic heart disease 20.1%, cardiomyopathy 16.8%, Congenital heart disease and coronary artery disease accounted for 9.8 and 10% of the cases respectively (Amoah & Kallen, 2000). The young age at which HF in Africa has been diagnosed at is of great economic and social concern and calls for concerted efforts in monitoring the prevalence and intervention in view of the prevalence of hypertension in SSA.

**Cardiomyopathy**

Cardiomyopathy is a form of irreversible myocardial disease that causes a reduction in the force of contraction, in turn reducing the efficiency of blood circulation, it is

endemic in Africa and the major cause of heart failure in Africa (Sliwa et al., 2005) although its incidence, prevalence and determinants in SSA are largely unknown. The main types found in Africa are dilated cardiomyopathy (DCM), peripartum cardiomyopathy, common with an incidence ranging from 1 in 100 in Nigeria to 1 in 1000 deliveries in South Africa, endomyocardial fibrosis (EMF) mainly found in the tropical regions of East, Central, and West Africa (Sliwa, Damasceno & Mayosi, 2005 ) and HIV-associated cardiomyopathy (Ntsekhe & Mayosi, 2009).

Genetic analysis of DCM in other parts of the world indicate that it is a genetically heterogeneous disorder in which some cases have a Mendelian cause, this heterogeneous pattern of inheritance has been confirmed in small studies that have been conducted so far in Africa (Mayosi et al., 2007). DCM also has other non-genetic or multi-factorial causes such as untreated hypertension, autoimmune mechanisms, haemochromatosis, pregnancy, alcohol, nutritional deficiency, infection and myocarditis. DCM accounts for 10% to 17% of all cardiac conditions encountered at autopsy, in many parts of Africa, and for 17% to 48% of patients who are hospitalized for heart failure (Sliwa et al., 2005).

### **Obesity and Physical Inactivity**

Lack of physical activity may be an important etiological factor in the current epidemiological transition characterized by increasing prevalence of obesity and chronic diseases in SSA. This is probably due to its importance in regulating metabolism in the human body to maintain optimal; blood pressure, serum lipids, blood glucose and preventing accumulation of adipose tissue.

Longitudinal and epidemiological studies on intensity, duration and overall caloric expenditure have shown the importance of physical activity in the prevention and or delay of cardiovascular diseases and a concomitant increase in the incidence of cardiovascular disease associated with low levels of physical activity (Paffenbarger & Wing, 1978; Morris, Heady & Raffle, 1953; Morris, Clave & Adam, 1973).

Studies on the Maasai of Kenya in the 1960's reported high cardiovascular fitness until their mid-40's when the men transitioned from being warriors to elders with significant decrease in the total physical activity engaged in (Mann et al., 1964).

A study in 2003 on 1,430 individuals aged 17–68 years in both rural and urban areas in Kenya and comprising of the Maasai, Kamba and Luo ethnic group, showed a 10-25% decline in cardio-respiratory fitness in the same age group four decades later. Use of an abdominal ultra sound technique to compare visceral obesity among these three samples showed the Maasai to have the greatest amount of abdominal visceral and subcutaneous fat, BMI, arm fat area and waist circumference among 1,430 individuals. The prevalence of overweight (BMI >25) was 39.8% vs 15.8% and obesity (BMI>30) was 15.5% against 5.1% in the urban and rural samples respectively (Christensen et al., 2008).

In SSA, several studies have reported a relationship between physical inactivity and urbanisation with a greater prevalence of cardiovascular disease present in urban samples in comparison to rural samples in the same region. A random study to evaluate and compare physical activity patterns using a questionnaire and their relationship with obesity, diabetes and hypertension in urban (n=1183) and rural



(n=1282) dwellers aged 15 year and above in Cameroon, found urban subjects were characterized by significantly lower physical activity, light occupation, reduced walking and cycling time compared to rural subjects. There were significant associations between both physical inactivity and obesity with high blood pressure, further to this, body mass index, blood pressure and glycaemia were higher in the first compared with the fourth quartiles of energy expenditure (Sobngwi et al., 2004).

In a cross-sectional study designed to verify the hypothesis that there is a positive rural-urban gradient in the overall prevalence of the metabolic syndrome (MetS) and its components and that the differences are associated with socioeconomic status, a sedentary lifestyle and poor diet quality in Benin, West Africa. Data on a random sample of 541 apparently healthy adults selected from rural (n = 170), semi-urban (n = 171), and urban (n = 200) areas was collected using questionnaires in personal interviews. Analysis of data showed a positive rural-urban gradient (rural to semi-urban to urban) for the overall prevalence of the Metabolic Syndrome (4.1%, 6.4%, and 11%, respectively;  $<.035$ ), reflecting that of abdominal obesity (28.2%, 41.5%, 52.5%;  $p < .001$ ). The results also showed diet quality and physical activity were higher in rural and semi-urban compared to urban subjects while physical activity appeared protective for obesity, HBP, and low HDL-C. Micronutrient adequacy was found to be an independent predictor of HDL-C and was associated with a lower likelihood of HBP, while socioeconomic status was positively associated with abdominal obesity only. This was more widespread in women than in men (Ntandou, Delisle, Agueh & Fayomi, 2009).

The results of the Cameroonian and Beninese study are similar and consistent with findings of a national demographic and health survey conducted in Kenya (KDHS 2003), a component of which, examined the prevalence of overweight or obesity in women aged 15-49 years (n= 8,195) and found 23 % were in this category. Women in the age group 45-49 had the highest proportion (41%) of overweight or obese women, the group aged 15-19 had the lowest (8%). However, comparison of overweight or obesity prevalence between urban and rural women showed a prevalence rate of 39% in urban women compared to 18% in rural women. The data also showed a positive relationship between education levels and overweight or obesity levels with 34% of the better educated women being more likely to be overweight or obese compared to 15% in those without education (KDHS, 2003).

Africans seem genetically prone to higher rates of diabetes and hypertension in association with obesity than Caucasians (Prentice & Moore, 2005; Steyn et al., 2005). In essence, obesity in SSA is uncommon but with the epidemiologic transition and urbanization taking place faster in urban compared to rural regions as a result of urban societies being widely exposed to the modernization of lifestyle, sedentary occupations, physical inactivity and to lipid and sugar-rich food, often poor in dietary fibre and micronutrients, the prevalence of cardiovascular disease can only increase and thus compound the burden of disease (Ziraba, Fotos & Ochako, 2009; Prentice et al., 2005).

### **CVD in Kenya**

Beside earlier studies conducted by Shaper, 1962; Mann et al., 1964; Day et al., 1976; Poulter et al., 1990; Poulter 1985 and Christensen et al., 2009, there is a insufficient

data on CVD's, bio-risk markers on Kenyan communities and therefore difficult to draw a conclusion or chart trends on the presence or impact of the epidemiological transition. New data on lifestyle factors, CVD and CVD bio-risk markers would generate additional knowledge on SSA.

### **Conclusion**

The need to determine CVD prevalence, CVD bio-risk markers, physical activity and nutrition habits in two varied sample groups in Kenya cannot be understated, as the findings will shed light on how the epidemiological transition is impacting samples. In addition to this, data generated on the interactions of lifestyle factors and CVD bio-risk markers will generate new knowledge from the general sample on CVD disease and risk that is otherwise scant in Kenya.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Introduction**

This chapter focuses on the description of the procedures that were used in carrying out the study. It covers the location of the research study, research design, target population, sampling procedure, research instruments, data collection and analytical techniques that were used

#### **3.2 Research Design**

A cross-sectional study was conducted in Kibera Division in Nairobi Area in Nairobi Province and in Kirisia Divisions in Samburu District in Rift Valley Province. The samples in these two provinces differ in their cultural and socio-economic practices despite being in the same country. The advantage of this study design is its efficacy in identifying associations and very low risk of drop out in subjects at a single point in time.

#### **3.3 Variables of the Study**

Independent variables studied were gender, locality and age-categories. Dependent variables studied were Systolic Blood Pressure, Diastolic Blood Pressure, and Apolipoprotein B-100 (apoB), Apolipoprotein A-I (apoA-I), Apolipoprotein B/A ratio (apoB/A-1 ratio), Ubiquinone (Co-Q10), Physical Activity Levels (PA), Lymphocyte count (LC), Diet Intake, Body Mass Index (BMI), % Body Fat (%BF) and Anthropometric measurements.

### **3.4 Location of Study**

The data on the urban sample, of the study group, was collected from Lan’gata and Kibera locations in Kibera Division in Nairobi Area, in Nairobi Province (Appendix H) and comprised of diverse ethnicity. This area had a varied social-economic demographic mix, ranging from the low-income earners living in the Kibera slum to the middle to high income earners living in Lan’gata and engaged in industrial and commercial services. It is also important to note that Nairobi lies at an altitude of 1500m above seal level (KNBS, 2009). The findings of this study would only be generalized to Langata and Kibera in Nairobi Province.

The data on the Pastoral sample, of the study group, was collected from Poro and Partuk locations in Kirisia Division in Samburu District in Rift Valley Province (Appendix H), made entirely of the Samburu a nomadic pastoral community living in the northern half of Kenya. The main economic activity in this area is animal husbandry. Samburu District is located about 366km from Nairobi and lies at an altitude of 850m above seal level (KNBS, 2009). The findings of this study would only be generalized to Poro and Partuk locations in Kirisia Division in Samburu District in Rift Valley Province

### **3.5 Target Population**

Male and female adults from the Kibera and Kirisia Divisions meeting the following criteria were eligible for the study.

#### **3.5.1 Inclusion Criteria**

- Aged between 30 and 60 years. Presentation of an identity card or passport was used to determine age of subjects. However in the case of the Samburu many were

illiterate and did not know their age, the local mobilizer and or the local field assistants estimated the subjects age by their age groups or period in time when they underwent rights of passage like circumcision.

- Residence in the area for five years prior to the start of the study for at least 90% of the time.

### **3.5.2 Exclusion Criteria**

- Resident in either area for less than five years for at least 90% of the time prior to the start of the study.
- History of pharmacological therapy for a cardiovascular disease, dyslipidemia or diabetes.
- Current pharmacological therapy for fever or infection
- Pregnancy
- Tobacco smoking within the past 12 months.

## **3.6 Sampling Technique and Sample Size**

### **3.6.1 Sample Size Determination**

The sample size calculations were based on the formula for adequate power to detect differences in proportions. To compare the means of variables determined between the two independent samples, the sample size was calculated using G-power statistical power determination programme Faul, Erdfelder, Lang & Buchner, 2007.

A sample size of 63 individuals, from each area, using a moderately high effect size of 0.6, with  $\alpha = 0.05$  and a confidence level of 95% (Faul et al., 2007) was determined. This sample size was determined to have considerably more power to detect the changes within the variables and differences between the dependent

variables between the urban and the pastoral groups. Similarly, the sample size had considerably more power to detect significant differences (95% confidence level) in other continuous variables, such as physical activity, dietary intake, and nutritional status within and between the two samples.

### **3.6.2 Sampling Procedure**

In the study locations, clusters in sub-locations, villages and homesteads were generated from the demographic data available from the latest surveys by the Central Bureau of Statistics (CBS). Potential participants were pre-screened by social mobilizers to ensure they met the inclusion criteria and were then entered into a list to form a sampling frame. Participants were then randomly drawn using SPSS software version 11.5. Participants were then assigned a day and time to appear at the study sites.

## **3.7 Research Instruments**

A structured questionnaire (Appendix B to H) was used to collect data, components of which are discussed as below:

### **3.7.1 Socio-Demographic Assessment**

Interviews of the Urban sample by the investigator and trained field assistants were conducted to provide general demographic and socio-economic information, including information on subject's place of birth, mother tongue and date of birth, the same was done with the pastoral sample, but with the assistance of Samburu-speaking trained field assistants (Appendix B).

### **3.7.2 General Health and CVD Assessment**

A medical history was taken and family patterns of cardiovascular diseases, risk factors, lifestyle factors including smoking habits and drug prescription use was obtained from each participant in addition to a blood pressure examination (Appendix C).

### **3.7.3 Anthropometric Assessment**

Anthropometric measurements taken included height, weight, mid-upper arm, waist and hip circumference, to assess body mass index and central obesity. This was done using a calibrated clinical scale (Seca, Italy) and a standard non-stretchable measuring tape (Appendix D).

Standard height was measured twice with the subject barefoot to the nearest 0.1 cm using a wall-mounted Stadiometer (Seca, Italy) and the mean of both readings recorded. Body weight was then measured twice, to the nearest 0.1 kg with the subject barefoot and in light clothing on a calibrated clinical scale (Seca, Italy) with the mean of both readings recorded.

The wrist, mid-upper arm, waist and hip circumference were measured twice to the nearest 0.1cm with a non-stretchable tape using a standard protocol and the means recorded. The waist measurements were obtained over light clothing at the abdomen at the narrowest point between the costal margin and iliac crest, this was also used to assess abdominal obesity using cut-points proposed by the International Diabetic Federation (IDF 2005) in recognition of ethnic differences in defining metabolic



syndrome. A waist circumference greater than 94 cm in males or greater than 79 cm in females was considered abnormal.

Hip circumference was measured twice over light clothing at the level of the widest diameter around the buttocks using a non-stretchable measuring tape with the mean recorded. Waist-hip ratio was calculated by dividing the waist measurement in centimetres by the hip measurement in centimetres and was considered abnormal when the value was equal to or greater than 1.0 for men or 0.85 for women. Body Mass Index (BMI) was calculated by dividing the square of the height in meters by kilograms ( $\text{weight/height}^2$  in  $\text{kg/m}^2$ ). A BMI below  $18.5\text{kg/m}^2$  was considered underweight, while a BMI above  $24.9\text{kg/m}^2$  was considered overweight, any BMI above  $29.9\text{kg/m}^2$  was considered as obese.

Mid-upper arm circumference (MUAC) was measured mid-way between the olacranon process and the elbow with the left arm stretched out, the mean of two readings was recorded. Wrist circumference was measured twice at the crease of the left wrist and the mean recorded as part of the girth measurements used to determine body density (Lambson, 1987). Percentage body fat was computed using calculated body density and girth measurements to calculate percentage body fat using the Siri equation (Penrouse et al., 1985).

#### **3.7.4 Dietary Assessment**

Dietary intake was assessed using both a food frequency questionnaire (Appendix E) and a 24-hour recall (Appendix F), with emphasis on establishing dietary patterns and type of cooking oils/fats predominantly used. Specific nutrient intake of foods

consumed between and within groups was estimated using local food composition tables and analysed with NutriSurvey for Windows software (Erhardt, 2004).

### **3.7.5 Physical Activity Assessment**

Daily physical activity patterns were assessed using the validated short International Physical Activity Questionnaire (IPAQ) focusing on the last 7 days or usual week (Appendix G).

### **3.7.6 Blood Pressure**

Blood Pressure was assessed using a digital Omron blood pressure/heart rate monitor (Omron Healthcare Europe BV) with appropriate sized cuff. Blood pressure was obtained from the mean of two blood pressure (BP) measurements performed following the procedure recommended by the British Hypertension Society (Williams et al., 2004) on the right arm of the subjects, in a sitting position, after a minimum 10 minutes, rest as was resting heart rate using a digital Omron blood pressure/heart rate monitor (Omron Healthcare Europe BV) with appropriate sized cuff (Beevers et al., 2001).

## **3.8. Laboratory Procedures**

Subjects were not required to have fasted, each then had 15 mls of venous blood specimens evacuated from the cubital vein into venoject vacuum containers with minimum venous stasis, into two EDTA (purple tops) and one serum clot activator tube (red and yellow top). Total blood count was run to determine lymphocyte count and haemoglobin. Then blood was then centrifuged and the plasma separated, the specimens were then frozen in dry ice at -20°C and batched together for analysis.

### **3.8.1 Co-Q10**

Co-Q10 was determined according to established methods (Bentinger et al., 2003) with slight modification. The plasma stored in  $-20\text{ }^{\circ}\text{C}$  was thawed at room temperature and centrifuged briefly. 0.5 ml plasma was mixed with 5 ml methanol and an internal standard of CoQ6 (1 nmol), respectively) was added. The mixture was then vortexed briefly and 3 ml petroleum ether (boiling point  $40\text{--}60\text{ }^{\circ}\text{C}$ ) was added and shaken by hand for approximately 15seconds (Tekle et al., 2008).

The samples were centrifuged for 2 min and the upper phase of petroleum ether was transferred to a new tube. The rest was re-extracted with another 3 ml petroleum ether. The upper phases were pooled and the samples were dried under gentle stream of nitrogen and finally dissolved in chloroform: methanol (2:1) and analyzed by HPLC. HPLC analyses was performed on a Shimadzu (LC-10AD) using a Hypersil ODS  $4.6\times 60\text{ mm}$ ,  $3.5\text{ }\mu\text{m}$ , C18 (Agilent Technologies) reversed-phase column with a Zorbax SB-C8  $4.6\times 30\text{ mm}$ ,  $3.5\text{ }\mu\text{m}$  (Agilent Technologies) guard column. A linear gradient was used from the initial methanol/water, 9:1, in pump system A to methanol/2-propanol/hexane, 2:1:1, in pump system B, at a flow rate of 1.5 ml/min and with a program time of 20 min. Absorbance was monitored at 275 and 292 nm (Tekle et al., 2008).

### **3.8.2 Apolipoprotein B-100 and apolipoprotein A-I**

Apo B concentration was quantitatively determined by turbidimetry on a Beckman Coulter UniCel DxC 800 Synchron Clinical System. ApoB reagent was combined with specific antibody following automatic dilution and proportioning of a  $20\mu\text{L}$  blood sample and  $200\mu\text{L}$  reagent volume into the cuvette. Change in absorbance was

measured at 340 nanometres and this change in absorbance due to the ensuing antigen-antibody reaction was equated to be directly proportional to the concentration of apoB in the sample and used by the system to calculate apoB concentration in each sample using reference range of 0.51-1.53g/L and 0.51-1.65g/L for males and females respectively.

ApoA-I was similarly run with specific antibody, following automatic dilution of blood sample and proportioning of a 6 $\mu$ L blood sample and 200 $\mu$ L reagent volume into the cuvette, change in absorbance was measured at 340 nanometres and was equated to be directly proportional to the concentration of apolipoprotein A-1 in the sample and used by the SYNCHRO system to calculate apoA-I using reference range of 0.95-1.76g/L and 1.19-2.28g/L for males and females respectively.

### **3.8.3 Lymphocyte Count and Haemoglobin**

Well mixed EDTA whole blood was analysed by immersing sample probe with the aspirate switch pressed on, sample was pulled from the tube into the sample probe and act 5diff analyzer aspirated 30ul of sample in CBC mode, aliquots of which were then distributed into designated baths. The first 3ul sample aliquot at the tip of the probe was discarded into the rinse bath as the exterior of the sample probe was rinsed, ensuring sample integrity. 10ul of sample was then delivered to the first dilution /HB bath for use in preparing the primary RBC/PLT dilution and for measuring the Haemoglobin value. Another 10ul of sample was delivered to the WBC/BASO bath for the WBC/BASO count, Lymphocyte count (LC) was determined from relative differential results computed by dividing absolute number

of the different cells classifications by total WBC count. Remaining sample aliquot was then discarded into the rinse bath.

### **3.9 Pre-testing of Study Instruments**

A pilot study on 20 volunteers randomly drawn from Githurai and Ruiru markets was used to help the researcher to establish the reliability and validity of the research instruments as well as the feasibility of the study using the same research tools and instruments although on a different sample from that of the actual study

### **3.10 Validity and Reliability**

Validity of the instruments and variables was measured using the Pearson correlation, while reliability of the observations in each of the variables for the repeated test measurements were tested using interclass coefficients given by Hopkins (2000). This was done by administering 20 questionnaires from the pilot study, and a correlation in validity and reliability of  $\geq 0.5$  was established.

### **3.11 Data Collection Technique**

The participants were provided with written informed consent (Appendix A), prior to their participation in the study, this had also been translated into Kiswahili, while for the pastoral sample, trained Samburu-speaking field assistants interpreted and then administered the written informed consent, illiterate subjects made an ink impression of their right thumb on the informed consent forms. A personal and family medical history, lifestyle factors including tobacco use and drug intake were obtained.

Other data collected included demographic data, socioeconomic data, and lifestyle factors including history of tobacco use, physical activity (Appendix G) and dietary patterns and food recall with the use of questionnaires (Appendix E and F). Personal and family patterns of cardiovascular disease risk factors were recorded.

### **3.12 Data Presentation and Analysis**

Data was entered into Microsoft Excel, cleaned up and then exported into SPSS Version 11.5 which was used to analyse data. Chi-square test was used to test for differences in proportions in the two samples. Data was then computed in terms of percentages and frequencies. Bar charts and tables were used to present the collected data. Data was analyzed and stratified by sample group (locality), age-category and gender. Student t-test and analysis of variance (ANOVA) were used to compare means where applicable and in cases where there were more than two means being compared, post-hoc analysis was done using Duncans Multiple Range Test (DMRT). Stepwise multiple regression analysis was used to identify predictors of cardiovascular disease, a p-value  $<0.05$  was considered significant. A modified version of NutriSurvey for Windows 2004 was used to quantitatively analyse nutrient content of 24 hour dietary recalls.

### **3.13 Logistical and Ethical Considerations**

Ethical approval from the National Ethical Review Board at Kenya Medical Research Institute (KEMRI) was applied for and granted (Appendix I). Participants were assured about confidentiality of their information and also informed of their right to withdraw from the study at any time if they so chose. Subjects were informed that blood collection would cause some discomfort and that there would be no further

risk associated with any of the tests. The researcher obtained a research permit from the Ministry of Education, Science and Technology.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSIONS**

#### **4.1 Introduction**

This chapter presents the results and discussions of the current study. It compares the findings of this study with related concurring or conflicting findings from other samples done both in SSA and developing countries. The findings are presented in the following order of the outlined objectives of this study:

- Demographics
- Prevalence of hypertension
- Differences in blood pressure and biochemical CVD risk markers
- Differences in physical activity and its relation to BP and CVD risk markers
- Differences in dietary intake and nutrition status and their relation to BP and CVD risk markers
- Differences in body composition and its relation to BP and CVD risk markers
- Differences in anthropometric measurements and their relationship to BP and CVD risk markers
- Identification of modifiable lifestyle factors that were predictors of hypertension and biochemical CVD risk markers in the two groups in this study.

#### **4.2 Demographics**

The demographic characteristics of the groups studied are presented in Table 4.1. The total number of subjects recruited was 133 (64 males and 69 females). 67 of these subjects were from the Urban sample in Nairobi while 66 were from the



Pastoral sample in Samburu. Background characteristics of the two groups and genders are presented in Table 4.1.

The mean age of the subjects recruited to represent the sample was  $41.39 \pm 0.73$  years (30 -60), while the mean age among the genders was  $40.1 \pm 8.2$  years and  $42.6 \pm 8.4$  years for the males and females respectively. Difference in age between the two groups was significant at  $p < .05$  and therefore was potentially confounding in the event of differences between these two samples. The background characteristics of the subjects recruited for this study are presented in Table 4.1

**Table 4.1 Background characteristics by locality**

	Urban (n = 67)	Pastoral (n =66)	Total (n=133)	p-Value
Male	38	26	64	-
Female	29	40	69	-
Age yrs (SD)	39.87 (6.9)	42.94 (9.5)	-	$p < .05$
Age range	30-57	30-60	30-60	-
Age-category				
30-40	(n=42)	(n=33)	(n=75)	-
41-50	(n=18)	(n=17)	(n=35)	-
51-60	(n=7)	(n=16)	(n=23)	-

It was observed that there was a statistically significant difference ( $p < .05$ ) in the ages of the two samples, the mean ages were  $39.87 \pm 6.87$  and  $42.94 \pm 9.46$  for the Urban and Pastoral samples, respectively. It was also observed that there was a decrease in participation with age due to the stringent exclusion criteria particularly in the Urban

sample and therefore the Pastoral sample was particularly better represented in the 51-60 age category.

### **4.3 Prevalence of Hypertension Within and Between the Urban and Pastoral**

#### **Samples**

Prevalence of pre-hypertension and hypertension was determined using the cut-offs 130/85mmHg and 140/90mmHg (at rest) respectively. The overall mean prevalence of pre-hypertension was 15.8% but 17.2% and 16.4% in males and females respectively while prevalence of hypertension was 16.5% in the two samples but 21.9% and 13.1% in males and females respectively, indicating males were more likely to be pre-hypertensive or hypertensive than females.

The overall prevalence of pre-hypertension in the Urban sample in Nairobi was 13.4%, but 15.8% and 10.3% among males and females respectively, while the prevalence of hypertension in the Urban sample was 23.9% but 26.3% and 20.7% in males and females respectively. In the Pastoral sample in Samburu, overall prevalence of pre-hypertension was 18.2%, but 19.2% and 17.5% in the males and females respectively, while the overall prevalence of hypertension was 9.1%, but 15.4% and 5% in the males and females respectively. The prevalence of pre-hypertension and hypertension within and between both samples is presented in Tables 4.2-4.3 and Figures 4.1 -4.4 below.

#### **4.3.1 Differences in Hypertension Prevalence Within the Urban Sample**

Differences in the prevalence of normal blood pressure, pre-hypertension and hypertension within the Urban sample are presented below in Table 4.2 below.

**Table 4.2 Hypertension Prevalence Within the Urban Sample**

Variable	Total	Male	Female	p-Value
N	67	38	29	-
%Normal	62.7 (n=42)	57.9 (n=22)	69 (n=20)	-
%Pre-Hypertensive	13.4 (n=9)	15.8 (n=6)	10.3 (n=3)	-
% Hypertensive	23.9 (n=16)	26.3 (n=10)	20.7 (n=6)	-

From the data collected on the Urban sample, it appears that the prevalence of normal blood pressure was higher in the Urban female sample at 69% than in the Urban male sample at 57.9% respectively. The pattern of pre-hypertension prevalence followed a similar pattern with the Urban female sample having a lower prevalence rate than the Urban male sample at 10.3% and 15.8 % respectively. The Prevalence of hypertension in the Urban female sample was observed to be lower than that of their Urban male counterparts at 20.7% and 26.3% respectively.

#### 4.3.2 Hypertension Prevalence Within the Pastoral Sample

Differences in the prevalence of normal blood pressure, pre-hypertension and hypertension within the Pastoral sample are presented below in Table 4.3

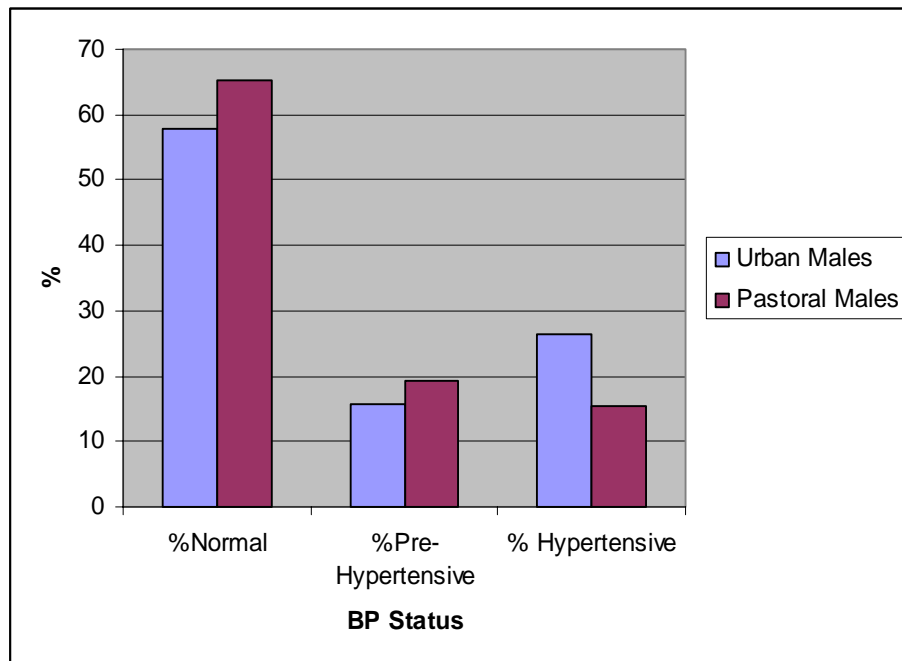
**Table 4.3. Hypertension Prevalence Within the Pastoral Sample**

Variable	Total	Male	Female	p-Value
N	66	26	40	-
%Normal	72.7 (n=48)	65.4 (n=17)	77 (n=31)	-
%Pre-Hypertensive	18.2 (n=12)	19.2 (n=5)	17.5 (n=7)	-
% Hypertensive	9.1 (n=6)	15.4 (n=4)	5 (n=2)	-

From the data collected on the Pastoral sample, it appears that the prevalence of normal blood pressure was higher in the Pastoral female sample at 77% than in the Pastoral male sample at 65.4% respectively. The pattern of pre-hypertension prevalence followed a similar pattern with the Pastoral female sample having a lower prevalence rate than the Pastoral male sample at 17.5% and 19.2 % respectively. The Prevalence of hypertension in the Pastoral female sample was observed to be lower than that of their Pastoral male counterparts at 5% and 15.4% respectively.

#### 4.3.3 Differences in Hypertension Prevalence Between the Urban and Pastoral Male Samples

Differences in the prevalence of normal blood pressure, pre-hypertension and hypertension between the Urban and Pastoral male samples are presented in Fig. 4.1

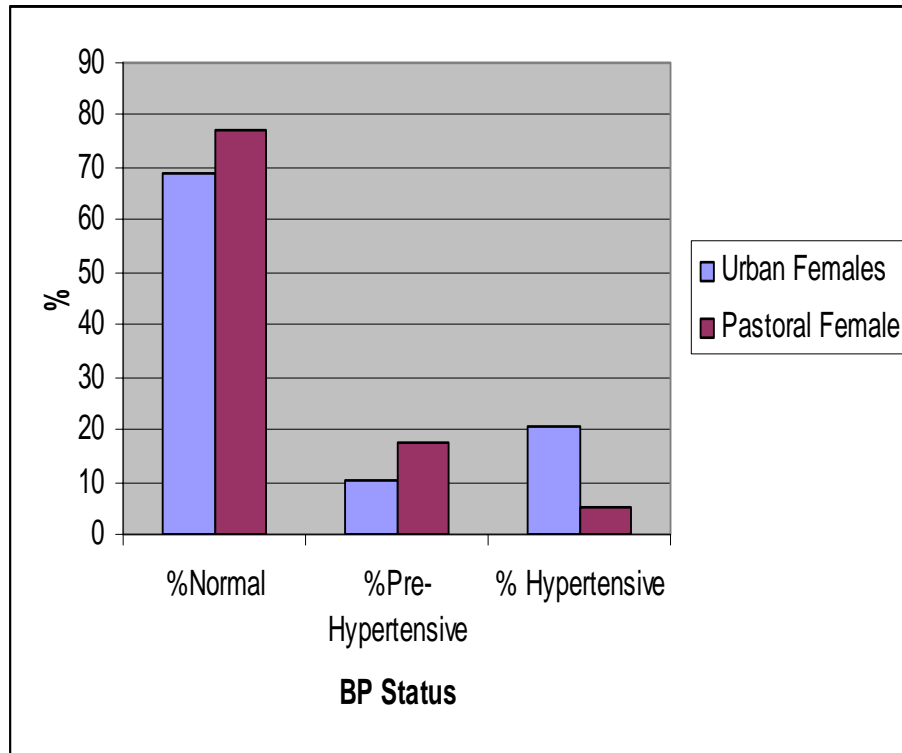


**Fig 4.1 Differences in Hypertension Prevalence Between the Urban and Pastoral Male Samples**

The prevalence of Normo-tension was lower in the Urban male sample than in the Pastoral male sample 57.9% and 65.4% respectively, indicating that the Pastoral male sample had a higher incidence of normal blood pressures. On the other hand, prevalence of Pre-hypertension in the Urban male sample was 15.8%, lower than that of the Pastoral male sample at 19.2%, however the overall prevalence of hypertension in the Urban male sample was 26.3% in contrast to 15.4% in the Pastoral male sample. Chi-square to determine difference in proportions between the different blood pressure categories in the two male samples was not significant.

#### **4.3.4 Differences in Hypertension Prevalence Between the Urban and Pastoral Female Samples**

Differences in the prevalence of normal blood pressure, pre-hypertension and hypertension between the Urban and Pastoral female samples are presented below in Figure 4.2

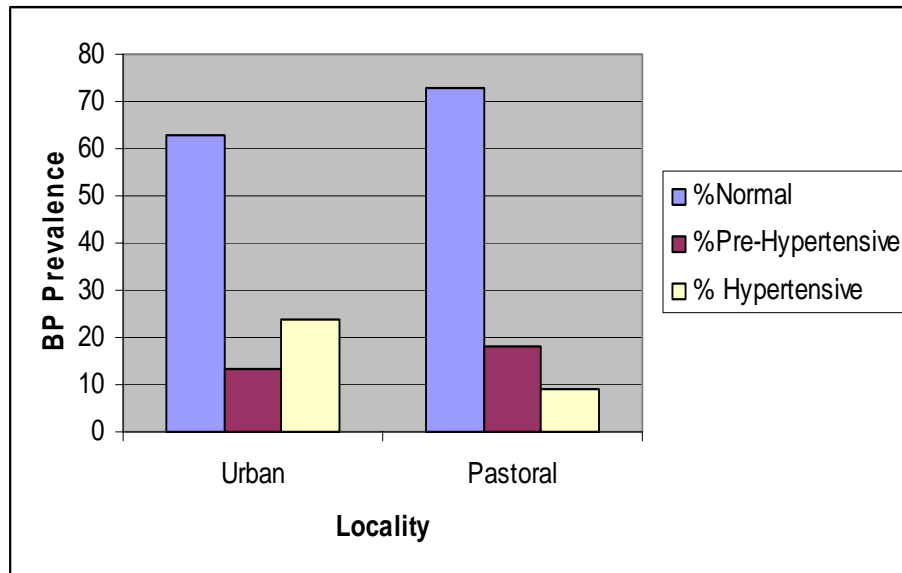


**Fig 4.2 Differences in Hypertension Prevalence Between the Urban and Pastoral Female Samples**

Prevalence of normo-tension, pre-hypertension and hypertension in the Urban and Pastoral female samples were observed to follow a similar pattern as that of the Urban and Pastoral male samples in that, the Urban female sample had a lower prevalence of normo-tension and pre-hypertension at 69% and 10.3% compared to 77% and 17.5% in the Pastoral female sample. However prevalence of hypertension in the Urban female sample was 3.3 times higher at 20.7% against 5% in the Pastoral female sample. Chi-square to determine difference in proportions between the different blood pressure categories in the two female samples was not significant.

#### 4.3.5 Differences in Hypertension Prevalence Between the Urban and Pastoral Samples

Differences in the prevalence of normal blood pressure, pre-hypertension and hypertension between the Urban and Pastoral samples are presented below in Fig 4.3



**Fig 4.3 Differences in Hypertension Prevalence Between the Urban and Pastoral Samples**

Normo-tension and pre-hypertension prevalence were lower in the Urban sample at 62.7% and 13.4% respectively, in contrast to 72.7% and 18.2% respectively in the Pastoral sample. The higher prevalence of pre-hypertension in the Pastoral sample was both interesting and telling, in that it may be indicative of the epidemiological transition sweeping across developing countries even touching previously isolated samples as suggested by Opie, 2005. Chi-square to determine difference in proportions between the different blood pressure categories in the two samples was however not significant. The prevalence of hypertension was however 2.6 times higher in the Urban sample at 23.9% in contrast to 9.1% in the Pastoral sample. This

was consistent with research findings by Njelekela et al (2003), in their study on nutrition variation and CVD risk factors among a Rural Sample (Handeni), Pastoral sample (Monduli) and Urban sample (Dar-es Salaam) in Tanzania, in which they found blood pressure was lowest in the Pastoral sample.

Similarly, Seedat et al (2000) in their review paper on hypertension in developing nations in SSA, reported a difference in the prevalence of hypertension between urban and rural black samples in SSA. A higher prevalence of hypertension in urban dwellers as a result of migration of people from a traditional way of life on the northern shores of Lake Victoria to the urban setting of Nairobi was associated with higher body weight, pulse rates and urinary sodium-potassium ratios than their non-migrant counterparts left behind in the lake area suggesting the effect of acculturation (Poulter et al., 1985). The results of this study were no different from what has generally been the trend in hypertension studies in Africa that have showed lower prevalence of hypertension in the non-industrialized and isolated rural societies (Gaziano, 2005; Opie et al., 2005).

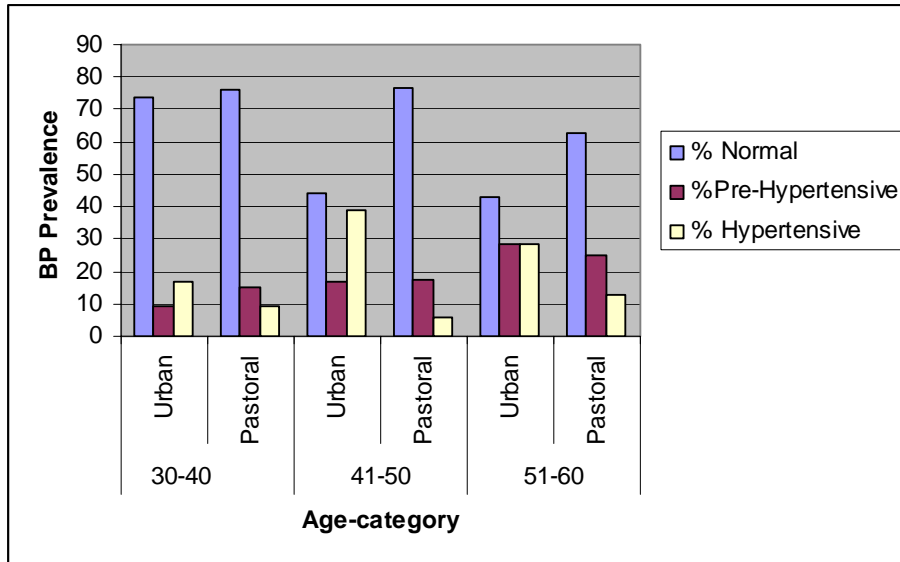
The 23.9% prevalence rate of hypertension in the Urban sample is comparable to the 26.4% worldwide estimated prevalence rate of hypertension in 2000 (Kearney et al., 2005) unlike the 9.1% prevalence rate among the Pastoral sample. This peculiarity is perhaps the result of environment rather than genetics, as urbanization comes with acculturating and adoption of western eating habits and lifestyles.



#### 4.3.6 Differences in Hypertension Prevalence Between the Urban and Pastoral

##### Samples by Age-categories

Differences in prevalence of normal blood pressure, pre-hypertension and hypertension between the Urban and Pastoral samples by age-categories are presented in Fig 4.5 below



**Fig 4.4 Differences in Hypertension Prevalence Between the Urban and Pastoral**

##### Samples by Age-categories

Analysis of prevalence of normo-tension, pre-hypertension and hypertension between the Urban and Pastoral sample by the age-categories 30-40, 41-50 and 51-60 showed the Urban sample having a lower prevalence of normo-tension i.e. the Pastoral sample had a higher prevalence of normal blood pressure in all three age categories. However, the Urban sample had a lower prevalence of pre-hypertension in all but the 51-60 age-category i.e. the Pastoral sample had a higher prevalence of pre-hypertension in all but the age-category 51-60.

Prevalence of hypertension was highest in the Urban sample in all three age-categories. These findings indicate that the age-category 41-50 (38.9%) among the Urban sample had the highest overall prevalence of hypertension, followed by the age-category 51-60 (28.6%) and lastly the age-category 30-40 (16.7%). This was in contrast to studies on hypertension and age which tend to rise with age and therefore the age-category 51-60 should have been more likely to have the highest prevalence of hypertension, however this may also be the effect of the evolving epidemiological transition thus the older generation may have been displaying a lower exposure to hypertension predisposing lifestyle factors in their earlier life than the younger generation.

Among the Pastoral sample, the age category 51-60 had the highest prevalence of hypertension (12.5%), followed by the age-category 30-40 (9.5%) and lastly age-category 41-50 (5.9%), this was in contrast to previous studies on these Pastoral communities in Africa which have shown lower hypertension prevalence in the elderly, in addition, the age-category 30-40 had the second highest prevalence of hypertension in this Pastoral sample and would appear to suggest a non-linear relationship between age and hypertension prevalence in this sample.

The high prevalence of hypertension in the Urban sample is consistent with findings by Agyeman, 2006 in which mean SBP and DBP were lower in both the rural male and female samples than in the urban male and female samples in Ghana. A longitudinal study on the determinants of blood pressure changes due to urbanization, following migration from a traditional rural way of life on the northern shores of Lake Victoria to the urban settings of Nairobi by the Luo, showed an

associated increase in blood pressure, pulse rates, weight and urinary sodium-potassium ratios. This was suggestive of a marked change in diet, potassium intake and caloric intake (Poulter, et al 1985). It has therefore been hypothesized that the higher prevalence of hypertension in urban populations could be the result of acculturation and greater exposure to risk factors for hypertension (Opie, 2005).

#### **4.3.7 Objective Summary**

From the above results it evident that there were significant differences in the prevalence of high blood pressure between the Urban and Pastoral samples and therefore the null hypothesis: There is no significant difference in the prevalence of high blood pressure between the Urban Nairobi and the Pastoral Samburu samples, is rejected.

#### **4.4. Differences in Blood Pressure and Biochemical CVD Risk Markers**

Differences in Blood pressure and biochemical CVD risk markers within and between the two samples were analysed and are discussed below:

##### **4.4.1 Differences in Blood Pressure and Biochemical CVD Risk Markers Within the Urban Sample**

Differences in Blood pressure and biochemical CVD risk markers within the Urban sample are presented below in Table 4.4

**Table 4.4 Differences in Blood Pressure and Biochemical CVD Risk Markers  
Within the Urban Sample**

Variable	Total	Male	Female	p-Value
N	67	38	29	-
Mean SBP(mmHg)	123.3± 19	128.5±17.9	116.5±18.4	p<.009
Mean DBPmmHg	79.7±10.3	81.2± 10.8	77.9±9.5	NS
Apo A (g/L)	1.42±0.32	1.71 ± 0.32	2.04±0.32	p<.001
Apo B (g/L)	1.05±0.28	1.04±0.31	1.06±0.25	NS
ApoB/A-I Ratio	0.51±0.2	0.61±0.19	0.51±0.21	p<.040
CO-Q10 (nmol/ml)	1.13±0.82	1.14±0.6	1.12±1.03	NS

Means compared using T-test

Mean resting Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Urban males was 128.5±17.9mmHg and 81.2± 10.8mmHg respectively, while mean SBP and DBP for the Urban females was 116.5±18.4mmHg and 77.9±9.5mmHg respectively, indicating that the Urban males had a higher mean resting SBP and DBP than the Urban females, however only their mean SBP's were significantly different at p<.009. These findings are consistent with published literature on blood pressure in urban Africans in SSA by Mbanya et al (1998); Njelekela et al (2003) and Ageyman (2006). The higher SBP results in the Urban males are similar to findings on Caucasians (Lopez-Ruiz et al., 2008; Reckelhoff, 2001) and therefore consistent with the generally accepted position that blood pressure is higher in men than in age-matched females.

Mean apolipoprotein B (apoB) and apolipoprotein A (apoA-I) in the Urban males were  $1.04 \pm 0.31$  g/L and  $1.71 \pm 0.32$  g/L respectively, while mean apoB and apoA-I in the Urban females were  $1.06 \pm 0.25$  g/L and  $2.04 \pm 0.32$  g/L indicating Urban females had higher levels of both lipoproteins than the Urban males, however statistical analysis only showed statistical significance between their mean apoA-I levels at  $p < 0.001$ .

The higher mean apoA-I levels in the Urban females are suggestive of a lower risk for cardiovascular disease. In addition, their apo B/A-I ratio was only  $0.51 \pm 0.21$ , lower than the 0.9 cut-off for high risk. This was not only lower than that of the Urban males which was  $0.61 \pm 0.19$ , but was significantly different at  $p < 0.040$ . In this apparently healthy Urban sample, both male and female apo B/A-I ratios were lower than those found in both the controls and cases in the INTERHEART Africa Study cohort that had  $0.76 \pm 0.33$  and  $0.94 \pm 0.32$  g/L respectively, suggesting relatively lower risks for CVD.

Mean Co-Q10 level in the Urban males was  $1.14 \pm 0.6$  nmol/ml while the mean Co-Q10 level in the Urban females was  $1.12 \pm 1.103$  nmol/ml indicating higher levels in the Urban males. However, this difference was not statistically significant. Low Co-Q10 levels are associated with higher CVD risk (Turunen et al., 2004).

#### **4.4.2 Differences in Blood Pressure and Biochemical CVD Risk Markers within the Pastoral Sample**

Differences in Blood pressure and biochemical CVD risk markers within the Pastoral sample were analysed and are presented below in Table 4.5

**Table 4.5 Differences in Blood Pressure and Biochemical CVD Risk Markers  
Within the Pastoral Sample**

Variable	Total	Male	Female	p-Value
N	66	26	40	-
Mean SBP(mmHg)	115.6±18.2	122±18.9	111.5±16.7	p<.020
Mean DBPmmHg	76.8±11.7	79.6± 14	75±9.7	NS
Apo A (g/L)	0.87±0.23	0.79±0.18	0.92±0.25	p<.041
Apo B (g/L)	2.06±0.46	2.21±0.44	1.96±0.45	p<.029
ApoB/A-I Ratio	0.44±0.15	0.38±0.13	0.49±0.16	p<.005
CO-Q10 (nmol/ml)	3.75±1.57	4.2±1.89	3.43±1.23	p<.045

Means compared using a T-test

Mean Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Pastoral male sample was 122±18.9 mmHg and 79.6± 14mmHg respectively, while mean SBP and DBP for the Pastoral females was 111.5±16.7 mmHg and 75±9.7mmHg respectively, indicating that the Pastoral males had a higher mean resting SBP and DBP than the Pastoral females, however only their mean SBP's were significantly different at p<.020.

These findings are consistent with published literature on blood pressure in nomadic pastoralists and hunter-gatherers in SSA by Glew et al (2001); Sever et al (1980); Kaminer et al (1960), in which blood pressure in pastoral females was lower than that of pastoral males. The higher SBP results in the Pastoral males are consistent with the findings of studies on gender differences in blood pressure in Caucasians, (Lopez-Ruiz et al., 2008, Reckelhoff, 2001) and therefore consistent with the

generally accepted position that blood pressure is higher in men than in age-matched females.

Mean apoB and apoA-I in the Pastoral males were  $0.79 \pm 0.18$  g/L and  $2.21 \pm 0.44$  g/L respectively, while mean apoB and apoA-I in the Pastoral females were  $0.92 \pm 0.25$  g/L and  $1.96 \pm 0.45$  g/L indicating Pastoral males had higher levels of apoA-I and a lower level of apo B than the Pastoral females. The differences between their means was significantly different at  $p < .05$ , suggesting a lower CVD risk.

The lower mean apo B and higher apoA-I values in the Pastoral males suggest a relatively lower risk of CVD than in the Pastoral females. The apo B/A-I ratio for the Pastoral males was  $0.38 \pm 0.13$  g/L, while that of the Pastoral females was higher at  $0.49 \pm 0.16$  g/L. The difference between their mean apoB/apoA-I ratios were statistically significant at  $p < 0.005$  level. The apo B and apoA-I ratios of both the male and female Pastoral samples were lower than those found in both the controls and cases in the African INTERHEART study that had  $0.76 \pm 0.33$  and  $0.94 \pm 0.32$  g/L respectively, suggesting these two group had relatively low risks for CVD. Secondly, therefore the lower apoB/ apoA-I ratio in the Pastoral males is probably of little clinical significance.

Mean Co-Q10 levels in the Pastoral males were  $4.2 \pm 1.89$  nmol/ml while the mean Co-Q10 levels in the Pastoral females was  $3.43 \pm 1.23$  nmol/ml, indicating higher levels in the Pastoral males, the difference in their means was statistically significant at  $p < .05$

#### 4.4.3 Differences in Blood Pressure and Biochemical CVD Risk Markers

##### Between the Urban and Pastoral Male Samples

The differences in BP and biochemical CVD risk markers are presented below in Table 4.6.

**Table 4.6 Differences in Blood Pressure and Biochemical CVD Risk Markers**

##### Between the Urban and Pastoral Male Samples

Variable	Total	Male (Urban)	Male (Pastoral)	p-Value
N	64	38	26	-
Mean SBP(mmHg)	125.9±18.5	128.5±17.9	122±18.9	NS
Mean DBPmmHg	80.6±12.1	81.2± 10.8	79.6± 14	NS
Apo A (g/L)		1.71 ± 0.32	2.21±0.44	p<.001
Apo B (g/L)		1.04±0.31	0.79±0.18	p<.001
ApoB/A-I Ratio		0.61±0.19	0.38±0.13	p<.001
CO-Q10 (nmol/ml)		1.14±0.6	4.2±1.89	p<.001

Means compared using a T-test

Mean resting Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Urban male sample was 128.5±17.9mmHg and 81.2± 10.8mmHg respectively, while mean SBP and DBP for the Pastoral male sample was 122±18.9 mmHg and 79.6±14mmHg respectively, indicating that the Urban male sample had an arithmetically higher mean resting SBP and DBP than the Pastoral male sample, however there was no statistically significant difference between their mean SBP and DBP.



The lack of significant difference between their mean SBP may in part be explained by the large standard deviation in the mean SBP's of both the Pastoral and Urban male sample which had a modulation effect on the arithmetical difference in their mean SBP's and lastly perhaps may have been due to the strict inclusion and exclusion criteria.

Mean apoB and apoA-I in the Urban males were  $1.04 \pm 0.31$  g/L and  $1.71 \pm 0.32$  g/L respectively, while mean apo B and apoA-I in the Pastoral males were  $0.79 \pm 0.18$  g/L and  $2.21 \pm 0.44$  g/L indicating Pastoral males had higher levels of apoA-I and lower levels of apo B than the Urban male sample, the difference between their means were significantly different at  $p < .001$  and  $p < .001$  respectively.

The lower mean apoB and higher apoA-I in the Pastoral males indicate a relatively lower risk of CVD than in the Urban males. In addition, the apoB/A-I ratio for the Urban males was  $0.61 \pm 0.19$  g/L, while that of the Pastoral males was lower at  $0.38 \pm 0.13$ . The difference between their mean apo B/A-I ratios was statistically significant at  $p < 0.001$  level. The males in both samples had apo B/A-I ratios that were lower than those found in both the controls and cases in the African INTERHEART study cohort that had  $0.76 \pm 0.33$  g/L and  $0.94 \pm 0.32$  g/L respectively, and were also way below the 0.9 cut-off used in establishing high risk for CVD.

Mean Co-Q10 levels in the Urban males were  $1.14 \pm 0.6$  nmol/ml while the mean levels in the Pastoral males was  $4.22 \pm 1.89$  nmol/ml indicating lower levels in the Urban males, the difference in their means was statistically significant at  $p < .001$ , indicating a significantly lower CVD risk.

#### 4.4.4 Differences in Blood Pressure and Biochemical CVD Risk Markers

##### Between the Urban and Pastoral Female Samples

Differences in Blood pressure and biochemical CVD risk markers between the Urban and Pastoral female samples are presented below in Table 4.7

**Table 4.7 Differences in Blood Pressure and Biochemical CVD Risk Markers**

##### Between the Urban and Pastoral Female Samples

Variable	Total	Female (Urban)	Female (Pastoral)	p-Value
Mean SBP(mmHg)	69	29	40	-
Mean DBPmmHg	113.6±17.5	116.5±18.4	111.5±16.7	NS
Apo A (g/L)	76.2±9.6	77.7±9.5	75± 9.7	NS
Apo B (g/L)		2.04±0.32	1.96±0.45	NS
ApoB/A-I Ratio		1.06±0.25	0.92±0.25	p<.022
CO-Q10 (nmol/ml)		0.51±0.21	0.49±0.16	NS
Mean SBP(mmHg)		1.12±1.03	3.43±1.23	p<.001

Means compared using a T-test

Mean Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Urban female sample was 116.5±18.4 and 77.7±9.5mmHg respectively, while mean SBP and DBP for the Pastoral female sample was 111.5±16.7 mmHg and 75±9.7mmHg respectively, indicating that the Urban female sample had an arithmetically higher mean resting SBP and DBP than the Pastoral female sample. However there was no significant difference between their mean SBP and mean DBP.

These findings though similar to those of urban males in this study and similar to the results of Njelekela et al (2003) support these findings, though their results were significantly different. This result may be as a result of the stringent inclusion and exclusion criteria for subjects in this study. Secondly the systolic blood pressure of the urban females had a large standard deviation and lastly the mean blood pressures in either group were within the normal range.

Mean apoB and apoA-I in the Urban females were  $1.06 \pm 0.25$  g/L and  $2.04 \pm 0.32$ g/L respectively, while mean apoB and apoA-I in the Pastoral females were  $0.92 \pm 0.25$  g/L and  $1.96 \pm 0.45$  g/L indicating Urban females had higher levels of both apoB and apoA-I than the Pastoral female sample, the difference between their means was statistically significant for apoB at  $p < .022$  but not for apoA-I. Thus the Urban female sample had a lower CVD risk in light of their higher mean apoA-I level though statistically insignificant, and a higher mean apoB level than the Pastoral females suggestive of higher CVD risk which was statistically significant at  $p < .05$ .

The higher mean apo B/A-I ratio in the Urban females was  $0.51 \pm 0.21$ g/L, while that of the Pastoral females was lower at  $0.49 \pm 0.16$ g/L. This however was not statistically significant. Both female samples had apo B/A-I ratio that were lower than those found in both the controls and cases in the African INTERHEART study cohort that had  $0.76 \pm 0.33$  and  $0.94 \pm 0.32$ g/L respectively, and were also way below the 0.9 cut-off used in establishing high risk for CVD.

Mean Co-Q10 levels in the Urban females was  $1.12 \pm 1.03$  nmol/ml while the mean levels in the Pastoral females was  $3.43 \pm 1.23$  nmol/ml indicating lower levels and

therefore a relatively high CVD risk than Pastoral females, while the difference between their means was statistically significant at  $p < .001$ .

#### 4.4.5 Differences in Blood Pressure and Biochemical CVD Risk Markers Between the Urban and Pastoral Samples

Differences in Blood pressure and biochemical CVD risk markers between the Urban and Pastoral samples are presented below in Table 4.8

**Table 4.8 Differences in Blood Pressure and Biochemical CVD Risk Markers  
Between the Urban and Pastoral Samples**

Variable	Total	Urban Sample	Pastoral Sample	p-Value
N	133	67	66	-
Mean SBP(mmHg)	119.5±18.9	123.3±19	115.6±18.2	$p < .019$
Mean DBPmmHg	78.3±11.1	79.7±10.3	76.8±11.7	NS
Apo A (g/L)		1.05±0.29	0.87±0.23	$p < .001$
Apo B (g/L)		1.86±0.37	2.06±0.46	$p < .007$
ApoB/A-I Ratio		0.57±0.21	0.44±0.15	$p < .001$
CO-Q10 (nmol/ml)		1.13±0.82	3.75±1.57	$p < .001$

Means compared using a T-test

Mean Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Urban sample was 123.3±19mmHg and 79.7±10.3mmHg respectively, while mean SBP and DBP for the Pastoral sample was 115.6±18.2 mmHg and 76.8±11.7mmHg respectively, indicating that the Urban sample had a higher mean resting SBP and

DBP than the Pastoral sample. However, analysis only showed statistical significance between their mean SBP's at  $p < .019$ , mean DBP's were not significantly different.

These results are similar to those of published studies on differences in blood pressure between urban and rural or pastoral samples in SSA by Mann et al., 1964; Shaper et al., 1962; Day et al., 1979; Sever et al., 1980; Poulter et al., 1985; Njelekela et al., 2003, and Agyemang, et al., 2006 in which they found blood pressure to be significantly different between the rural and pastoral samples.

The Luo (of Kenya) migration study by Poulter et al., 1990 may indicate one possible reason for this difference in SBP to be due to a consistent rise in the urine sodium-to-potassium ratio suggesting a higher dietary sodium intake in Urban migrants. Other reasons postulated for the difference in SBP between rural (isolated samples including Pastoral samples) by Opie et al (2005) include, lower plasma rennin, sodium abnormalities, epithelial sodium channel changes, altered genes regulating the Renin-Angiotensin-Aldosterone System (RAAS), increased peripheral vascular resistance, increasing obesity, socioeconomic stress, increased parasympathetic activity and underweight phenotype.

It is also possible that the difference in SBP observed between these two samples could be as a result of the means of transportation used to get to the testing venues. The Pastoral sample travelled on foot over relatively long distances while the Urban sample travelled either by public or private transport with minimal walking if any, thus the difference could have been due to the result of post-exercise hypotension

caused by the acute effects of the autonomic nervous system response. However, the overall consistency of these results with similar studies, on the Maasai (Day et al., 1976), Samburu (Shaper et al., 1962), and the Koi San (Kaminer et al., 1960), probably negate this notion.

Overall mean difference in physical activity between the Urban and Pastoral sample as shown in Table 4.17 could also be one more reason for the statistically significant difference in the mean SBP's of the two samples studied as increased physical activity is associated with better SBP.

Whereas these results mirror the global picture in which blood pressure in urban samples is higher than that of rural samples, it is critical to look at the occurrence of this phenomenon in the context that hypertension is clearly recognized as a risk factor for coronary heart disease (CHD) and stroke. However, hypertension is the strongest of 6 risk factors for myocardial infarctions in SSA with an astonishing odds ratio of 6.99 (Steyn et al., 2005).

Mean apo B and apoA-I in the Urban sample were  $1.05 \pm 0.29$  g/L and  $1.86 \pm 0.37$  g/L respectively, while mean apoB and apoA-I in the Pastoral sample were  $0.87 \pm 0.23$  g/L and  $2.06 \pm 0.46$  g/L indicating the Pastoral sample had higher levels of apoA-I and a lower level of apo B than the Urban sample, the difference between their means were significantly different at  $p < .007$  and  $p < .001$  respectively. The lower mean apo B and higher apoA-I in the Pastoral sample indicates a relatively lower risk of CVD in this sample compared with the Urban sample.

The mean apo B/apoA-I ratio for the Urban sample was  $0.57 \pm 0.21$  while that of the Pastoral sample was  $0.44 \pm 0.15$ , with a statistically significant mean difference at  $p < .001$ . These results indicated that the Pastoral sample had a relatively lower CVD risk than the Urban sample. Lastly, apo B and apoA-I ratios of both the Urban and Pastoral samples were lower than those found in both the controls and cases in the African INTERHEART study that had  $0.76 \pm 0.33$  and  $0.94 \pm 0.32$  respectively, indicating that these two samples overall, had a relatively low risk for CVD.

Mean Co-Q10 level in the Urban sample at  $1.13 \pm 0.82$  nmol/ml was lower than that of the Pastoral sample  $3.75 \pm 1.57$  nmol/ml and significantly different at  $p < .001$ . While Co-Q10 has not been documented in Africans previously, differences in Co-Q10 levels in samples living in the same country or region but living in different environmental and stress conditions have been noted, with Co-Q10 levels tending to be lower in samples living in polluted or stressful environments Tekle, *et al.*, 2010. It is likely that the lower mean Co-Q10 levels in the Urban sample were a reflection of the stress and pollution associated with urban lifestyles.

Co-Q10's role in reducing oxidative and nitrosative stress in-vivo, by decreasing production of superoxide (SOD) radicals is well documented and has been postulated to contribute to improved vascular function and lower blood pressure via reduced oxidative stress within the arterial wall, leading to reduced vascular tone and blood pressure (West, 2000).

The statistically significant difference in mean Co-Q10 between the Urban and Pastoral sample in this study could be attributed to a combination of differences in

dietary intake and high stress levels associated with Urban lifestyles. This is possible as Co-Q10 in humans is endogenously derived by synthesis from phenylalanine, mevalonic acid and food intake (Hodgson et al., 2003; Hughes et al., 2002). The richest dietary Co-Q10 sources are organ meats that have high-energy requirements such as heart, brain, liver and kidney. These are relatively scarce and perhaps perceived as low value foods in Urban areas in contrast to their near-sacred perception among Pastoral peoples.

The statistically significant difference between the mean systolic blood pressure in the Urban and Pastoral sample in view of the statistically significant difference between their mean Co-Q10 levels is interesting but should be interpreted cautiously as because dietary intake was analysed using a 24 hour dietary recall.

#### **4.4.6 Differences in Pressure and Biochemical CVD Risk Markers**

##### **Between the Urban and Pastoral Samples by Age-categories**

Differences in blood pressure and CVD risk markers between the Urban and Pastoral Sample by age-categories and the results presented below in Tables 4.9-4.11



**Table 4.9 Differences in Blood Pressure and Biochemical CVD Risk Markers  
Between the Urban and Pastoral Samples by Age-categories**

Age-cat	Sample	Total N	Systolic Pressure (mmHg)	Diastolic Pressure (mmHg)
30-40	Urban	42	120.6±15.7	78.4±9.7
	Pastoral	33	116.8±14.5	77.2±9.0
	p-Value	-	NS	NS
41-50	Urban	18	127.7±25.7	83.3±12.3
	Pastoral	17	115.7±12.5	74.1±8
	p-Value	-	NS	p<.014
51-60	Urban	7	128.1±16.1	78.8±7
	Pastoral	16	113.1±28.5	78.9±17.3
	p-Value	-	NS	NS

Means compared using a T-test

Mean SBP and DBP in the Urban sample in the age category 30-40 was 120.6±15.7mmHg and 78.4±9.7 mmHg respectively, while mean resting SBP and DBP for the Pastoral sample in the same age-category was 116.8±14.5mmHg and 77.2±10 mmHg respectively, indicating that the Urban sample had a higher mean resting SBP and DBP than the Pastoral sample, however there was no significant difference between their resting mean SBP and DBP. This may be due to the large standard deviation in the means of the two groups perhaps modulating their arithmetic difference yet on the other hand it could indicate that that blood pressure in the Urban sample does not rise significantly before the fourth decade of life.

Mean SBP and DBP in the Urban sample in the age-category 41-50 was  $127.7 \pm 25.7$  mmHg and  $83.3 \pm 12.3$  mmHg respectively, while mean SBP and DBP for the Pastoral sample in the same age-category was  $115.7 \pm 12.5$  mmHg and  $74.1 \pm 8$  mmHg respectively, indicating that the Urban sample had a higher mean resting SBP and DBP than the Pastoral sample, however statistical analysis of their means only showed a significant difference of  $p < .014$  in their DBP. Mean DBP's of both samples were well within the normal range of a healthy DBP  $< 85$  mmHg and therefore the statistically significant difference in their mean DBP may not be of any clinical significance or CVD risk.

A large standard deviation in the mean SBP in the Urban sample may have contributed a modulation effect on their arithmetic difference. However the mean SBP and DBP of the Urban sample appeared to rise in this age-category in contrast to the mean SBP and DBP of the Pastoral sample that appeared to decline from that of its age-category 30-40.

Mean Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in the Urban sample in the age category 51-60 was  $128.1 \pm 16.1$  mmHg and  $78.8 \pm 7$  mmHg respectively, while mean SBP and DBP for the Pastoral sample in the same age-category was  $113.1 \pm 28.5$  mmHg and  $78.9 \pm 17.3$  mmHg respectively, indicating that the Urban sample had a higher mean resting SBP, but a lower mean DBP than the Pastoral sample. Analysis of their means did not show any significant difference between their resting mean SBP and DBP.

The large standard deviation in the mean SBP of the Pastoral sample appears to have modulated the large arithmetic difference between the two groups mean SBP's. However this age-category of the Pastoral sample registered the lowest mean SBP of its three age-categories. This was in stark contrast to that of the Urban sample which seemed to increase in a progressively linear fashion with each age-category. This finding, though rare with increasing age, is consistent with the relatively flat blood pressure or drop in the same in published literature, on blood pressure in pastoralists and hunter-gatherer samples (Day et al., 1976; Shaper et al., 1962 and Kaminer et al., 1960).

Mean DBP in the Pastoral sample on the other hand showed a slight increase but well within the limits of a normal DBP ( $\leq 85\text{mmHg}$ ) while in the Urban sample, mean DBP dropped by about 10mmHg from that of the 41-50 age category. The 10mmHg drop in DBP in the Urban sample was surprising as this is generally expected to increase with age as a result of intimal thickening, however the mean pulse pressure (difference between mean SBP and mean DBP) in the Urban sample in this age category appeared to increase in a linear manner from the lowest to the highest age-category suggesting an increase in arterial resistance and therefore increasing risk for CVD in contrast to the linearly decreasing mean pulse pressure in the Pastoral sample.

Linear decrease in mean pulse pressure with age in the Pastoral sample may perhaps be explained by the observation made by Mann et al (1972), following examination of 50 hearts and aortae collected '*en block*' from dying Maasai in which he found enlargement of coronary vessels with age so that the lumina were not compromised

by intimal thickening. The increment was greater for the proximal large vessels. He attributed this to high levels of exercise. This could similarly be the case in this Pastoral Samburu sample.

**Table 4.10 Differences in Apolipoproteins Between the Urban and Pastoral Samples by Age-category**

Bio-Marker	Sample	Age-Cat 30-40	Age-Cat 41-50	Age-Cat 51-60
apoB (g/L)	Urban	1.06±0.31	1.04±0.26	1.03±0.2
	Pastoral	0.79±0.19	0.98±0.29	0.92±0.19
	p-Values	p<.001	NS	NS
apoA-I (g/L)	Urban	1.81±0.41	1.91±0.19	1.98±0.37
	Pastoral	1.95±0.44	2.08±0.39	2.26±0.53
	p-Values	NS	NS	NS
apoB/A-I ratio	Urban	0.6±0.22	0.51±0.17	0.51±0.12
	Pastoral	0.42±0.12	0.49±0.21	0.43±0.14
	p-Values	p<.001	NS	NS

Means compared using a T-test

Mean apoB and apoA-I in the Urban sample in the age category 30-40 were 1.06±0.31 g/L and 1.81±0.41 g/L respectively with an apoB/apoA-I ratio of 0.6±0.22. Mean apoB and apoA-I for the Pastoral sample in the same age-category was 0.79±0.19 g/L and 1.95±0.44 g/L respectively with an apoB/apoA-I ratio of 0.42±0.12, indicating that the Urban sample had a higher mean apoB, a lower mean apoA-I and higher apoB/A-I ratio, than the Pastoral sample, suggesting a higher risk for CVD. Differences between their respective means were statistically significant at

$p < .001$  for both the apoB and apoB/A-I ratio only, while the difference between their mean apoA-I was not statistically significant.

Mean apoB and apoA-1 in the Urban sample in the age category 41-50 were  $1.04 \pm 0.26$  g/L and  $1.91 \pm 0.19$  g/L respectively with an apoB/apoA-1 ratio of  $0.51 \pm 0.17$ . Mean apoB and apoA-1 for the Pastoral sample in this same age-category was  $0.98 \pm 0.29$  g/L and  $2.08 \pm 0.39$  g/L respectively with an apoB/apoA-1 ratio of  $0.49 \pm 0.21$ , indicating that the Urban sample in this age-category had a higher mean apoB, a lower mean apoA-I and higher apoB/apoA-1 ratio, than the Pastoral sample, suggesting a higher risk for CVD. The difference between their respective means were however not statistically significant.

Mean apoB and apoA-1 in the Urban sample in the age category 51-60 were  $1.03 \pm 0.2$  g/L and  $1.98 \pm 0.37$  g/L respectively with an apoB/apoA-1 ratio of  $0.51 \pm 0.12$ . Mean apoB and apoA-1 for the Pastoral sample in the same age-category was  $0.92 \pm 0.19$  g/L and  $2.26 \pm 0.53$  g/L respectively with an apoB/apoA-1 ratio of  $0.43 \pm 0.14$ , indicating that the Urban sample in this age-category had a higher mean apoB, a lower mean apoA-I and higher apoB/apoA-1 ratio indicating a relatively higher risk for CVD. However, their means were not statistically significant.

**Table 4.11 Differences in Co-Q10 Between the Urban and Pastoral Sample by Age-category**

Bio-Marker	Sample	Age-Cat 30-40	Age-Cat 41-50	Age-Cat 51-60
Co-Q10 (nmol/ml)	Urban	1.18±0.95	1.02±0.47	1.09±0.66
	Pastoral	3.51±1.44	3.49±1.41	4.48±1.82
	p-Value	p<.001	p<.001	p<.001

Means compared using a T-test

Mean Co-Q10 levels in the Urban and Pastoral samples in the age category 30-40 were 1.18±0.95 nmol/ml and 3.51±1.44 nmol/ml. These results showed that the Urban sample had a lower Co-Q10 level than the Pastoral sample, the difference between their means was statistically significant at p<0.001. Lower Co-Q10 levels in the Urban sample would suggest a higher risk for cardiovascular disease than in the Pastoral sample in view of the free radical scavenging properties of Co-Q10.

Mean Co-Q10 levels in the Urban and Pastoral sample in the age category 41-50 were 1.02±0.47 nmol/ml and 3.49±1.41 nmol/ml respectively. These results showed that the Urban sample had a lower mean Co-Q10 level than the Pastoral sample which was statistically significant at p<.001. Lower Co-Q10 levels in the Urban sample would suggest a higher risk for cardiovascular disease than in the Pastoral sample.

Mean Co-Q10 levels in the Urban and Pastoral sample in the age category 51-60 were 1.09±0.66 nmol/ml and 4.48±1.82nmol/ml respectively. The mean Co-Q10 in

the Urban sample was lower than that of the Pastoral sample and significantly different at  $p < 0.001$  indicating a relatively higher CVD risk than the Pastoral sample.

#### **4.4.7 Objective Summary**

This section sought to assess if there was a difference in blood pressure and biochemical CVD risk markers between the Urban and Pastoral samples. Analysis showed a statistically significant difference in the resting mean SBP, mean apoB, mean apoA-I, mean apoB/A-I ratio and Co-Q10 between the Urban and Pastoral sample, indicating a relatively higher risk for CVD in the Urban sample, and therefore the null hypothesis: There is no significant difference in blood pressure and biochemical cardiovascular disease risk markers between the Urban Nairobi and Pastoral Samburu samples in Kenya, was rejected.

#### **4.5 Lifestyle Factors**

Differences in physical activity, dietary intake, nutrition status, body composition and anthropometric measurements between and within the Urban and Pastoral sample and their relation to Blood Pressure and CVD risk markers were analysed and are discussed as follows:

##### **4.5.1 Differences in physical activity (MET minutes/week) and Haemoglobin**

###### **Within and Between the Urban and Pastoral Samples**

Differences in physical activity (MET mins/week) and haemoglobin within and between the Urban and Pastoral sample were analysed using an independent samples T- Test and are presented in Table 4.12:

**Table 4.12 Difference in Physical Activity (MET minutes/week) and Haemoglobin Within the Urban Sample.**

	Urban (males)	Urban (females)	p –Value
N	38	29	-
Vigorous MET mins	775±733	674.8±501.4	NS
Moderate MET mins	662.3±464.6	649.7±472	NS
Walking Mins	1353±1267.1	1197.8±833.1	NS
Sitting mins	366.1±199.9	305.9±151.2	NS
MET mins/week	2789.8±1948.8	2522.3±1468.2	NS
Hb (g/dL)	15.5±2	13.4±1.4	p<.001

Means compared using a T-test

Data on physical activity was collected using the International Physical Activity Questionnaire (IPAQ). It subjectively measures varying physical activity levels in metabolic equivalents per week. Physical inactivity being a risk factor for CVD, a look at the physical activity of these two samples as part of their global CVD risk was pertinent. Data on haemoglobin was also collected by venipuncture and then processed in the laboratory. Haemoglobin levels reflect oxygen carrying capacity of blood in an individual and when low can limit physical activity, normal or high levels do not impede physical activity.

Vigorous MET minutes are defined by IPAQ as those activities with intensities equivalent to 8 METS. Median Vigorous MET minutes in the Urban males was 775±733 while that of the Urban females was 674.8±501.4, indicating that the males accumulated relatively more minutes of vigorous activities per week than the



females, however the two medians were not significantly different within this sample.

Moderate MET minutes are defined by IPAQ as those activities with intensities equivalent to 4 METS. Median moderate MET minutes per week in the Urban male sample was  $662.3 \pm 464.6$  while that in the Urban female sample was  $649.7 \pm 472$ . These findings indicated that the Urban males accumulated more hours of moderate physical activity per week than the Urban females however the difference between their medians was not statistically significant.

The median time in minutes spent walking per week was also analysed within the Urban sample. Median walking minutes in the Urban males was  $1353 \pm 1267.1$  while median walking minutes in the Urban females was lower at  $1197.8 \pm 833.1$ , however there was no statistically significant difference between the two medians within this sample.

Median time spent sitting per week was analysed within the Urban sample. Median sitting time in the Urban males was  $366.1 \pm 199.9$  while that in their female counterparts was  $305.9 \pm 151.2$ , indicating that the Urban males spent more time than Urban females seated. The difference between their medians was not significantly different.

Median MET minutes per week within the Urban sample was analyzed. Median MET minutes in the Urban males was  $2789.8 \pm 1948.8$  while the Urban females had a mean of  $2522.3 \pm 1468.2$ . The higher median MET minutes in the males suggested the

Urban males engaged in more physical activity than their female counterparts, however the difference between their means was not statistically significant.

Mean Haemoglobin (Hb) in the Urban males was  $15.6 \pm 2$  gm/dL, while mean Hb in the Urban females was  $13.4 \pm 1.4$  gm/dL, indicating that the Urban males had a higher mean Hb than the Urban females and consistent with the established norm in which males have higher Hb levels per 100ml of blood (14-18gm/dL) than females (12-16 gm/dL). The mean Hb's in both the males and females were well within the limits of a normal reference range. The mean Hb's within this group were significantly different at  $p < .001$ .

**Table 4.13 Differences in Physical Activity (MET minutes/week) and Haemoglobin Within the Pastoral Sample.**

	Pastoral (males)	Pastoral (females)	p –Value
N	26	40	-
Vigorous MET mins	$4464.6 \pm 3279.6$	$2494 \pm 2341.9$	$p < .006$
Moderate MET mins	$1550 \pm 1233.7$	$1816.5 \pm 1352.6$	NS
Walking Mins	$2489.7 \pm 1451.1$	$2146.7 \pm 1237.3$	NS
Sitting mins	$259.6 \pm 175.4$	$338.7 \pm 176$	NS
MET mins/week	$8504.3 \pm 4158.4$	$6457.2 \pm 3823.2$	$p < .044$
Hb	$13.1 \pm 1.2$	$12.3 \pm 1.1$	$p < .005$

Means compared using a T-test

The median Vigorous MET minutes/week per week in minutes in the Pastoral males was  $4464.6 \pm 3279.6$  while the mean Vigorous MET minutes/week in the Pastoral

females was lower at  $2494 \pm 2341.9$ , suggesting that the Pastoral males engaged in more vigorous physical activities for a longer duration than the females in the same sample. The difference between their median vigorous MET minutes was statistically significant at  $p < .006$ .

Median moderate MET minutes per week in the Pastoral male sample was  $1550 \pm 1233.7$  while that in the Pastoral female sample was  $1816.5 \pm 1352.6$ . These findings suggested that the Pastoral males accumulated less hours of moderate physical activity per week than the Pastoral females, however the difference between their medians was not statistically significant.

The median time in minutes spent walking per week was also analyzed within the Urban sample. Mean walking minutes in the Pastoral males was  $2489.7 \pm 1451.1$  while mean walking minutes in the Pastoral female sample was lower at  $2146.7 \pm 1237.3$  however there was no statistically significant difference between the two medians within this sample.

Median time spent sitting per day was analyzed within the Pastoral sample. Median sitting time in the Pastoral males was  $259.6 \pm 175.4$  while that in the females was  $338.7 \pm 176$ , indicating that the Pastoral males spent fewer minutes seated per day than Pastoral females, however there was no significant difference between their medians.

Median MET minutes per week within the Pastoral sample was analyzed. Median MET minutes in the Pastoral males was  $8504 \pm 4158.4$  while the Pastoral females had

a mean of  $6457.2 \pm 3823.2$ . The higher median MET minutes in the males would suggest the Pastoral males were more physically active and therefore expended more energy per week than the Pastoral females. The difference between their median MET minutes per week was statistically significant at  $p < .044$ .

Mean Haemoglobin (Hb) in the Pastoral males was  $13.1 \pm 1.2$  gm/dL, while mean Hb in the Pastoral females was  $12.3 \pm 1.1$  gm/dL, indicating that the Pastoral males had a higher mean Hb than the Pastoral females as generally acknowledged. The mean Hb in the males was however slightly below the normal reference range (13.5-17gm/dL), unlike that of the females which was just above the lower limit of the haemoglobin reference range for females (12-16 gm/dL). The mean Hb's within this group were significantly different at  $p < .005$ . This significance however is perhaps a mere reflection of the gender difference in haemoglobin levels.

Possible reasons for the slightly depressed mean Hb values in the Pastoral males samples are:

Lead exposure from munitions- Pastoral samples in Kenya have and use firearms (both legal and illegal) to protect their animal herds from livestock raids. The role of protecting the herds is primarily a male responsibility and may help to explain their slightly depressed mean Hb values while that of their females are within the normal reference range for females, but would not explain why the mean Hb levels in the females are at the lower end of the normal Hb reference range in females and perhaps consistent with literature on lead exposure through handling of ammunition and Hb levels (Johansen et al., 2006).

Other probable reasons for the depressed and borderline Hb levels in the Pastoral male and female samples respectively are high tannin intake from tea. Tannin in tea however, is known to bind non-heme iron and not heme-iron derived from meat which this sample tended to eat in adequate quantities, thereby negating this as a possible reason for the Hb levels in the Pastoral sample. Secondly, if this were the case, the Pastoral females would be more likely of the two genders to have depressed Hb due to menses in addition to the purported serum Fe<sup>+</sup> binding effect of tannin from tea.

Parasitic infestation could be another reason for the slightly depressed or borderline Hb levels in this Pastoral sample but perhaps calls for further investigation in future, to determine if this is the primary reason for the Hb levels in this sample. However, a plausible explanation for their borderline Hb levels may perhaps be related to the well documented exercise induced haemolysis caused by foot-strike particularly in distance running that has been noted to cause higher RBC turnover in runners compared with controls (Telford et al., 2003). While haemolysis caused by foot-strike in distance walkers may not be well documented, it is plausible that daily long distance walking over difficult terrain with nothing more than sandals made from discarded motor vehicle tires could induce haemolysis and explain their relatively high Median MET mins/wk despite their borderline Hb levels.

**Table 4.14 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Male Samples.**

	Urban Males	Pastoral Males	p- Value
N	38	26	-
Vigorous MET mins	775±733	4464.6±3279.6	p<.001
Moderate MET mins	662.3±464.6	1550±1233.7	p<.001
Walking Mins	1353±1267.1	2489.7±1451.1	p<.002
Sitting mins	366.1±199.9	259.6±175.4	p<.032
MET mins/week	2789.8±1948.8	8504.3±4158.4	p<.001
Hb	15.5±2	13.1±1.2	p<.001

Means compared using a T-test

The median Vigorous MET minutes/week, in the Urban males was 775±733 while the median Vigorous MET minutes/week in the Pastoral males was 4464.6±3279.6, suggesting that the Pastoral males engaged in more vigorous physical activities for a longer duration than the Urban male sample. The difference between the median Vigorous MET minutes/week of the two male samples was statistically significant at  $p < .001$ .

Median moderate MET minutes per week in the Urban male sample was 662.3±464.6 while that in the Pastoral male sample was 1550±1233.7. These findings suggested that the Urban male sample accumulated less hours of moderate physical activity per week than the Pastoral male sample, the difference between their medians was statistically significant at  $p < .001$ .

Median time in minutes spent walking per week was also analyzed between the two male samples. Median walking minutes in the Urban males was  $1353 \pm 1267.1$  while mean walking minutes in the Pastoral males was  $2489.7 \pm 1451.1$ , the difference between their medians was statistically significant at  $p < .002$ . This may be explained by difference in distances walked, with the Pastoral sample walking longer distances than the Urban male sample who by virtue of living in an Urban setting probably walked shorter distances.

Median time spent sitting per day, was analyzed between the two male samples. Mean sitting time in the Urban males was  $366.1 \pm 199.9$  while that in Pastoral males was  $259.6 \pm 175.4$ , indicating that the Urban male sample spent more minutes seated per day than Pastoral males reflecting a higher degree of sedentary living. The difference between their median sitting time/day was significantly different at  $p < .032$ .

Median MET minutes per week between the two male samples were analyzed. Median MET minutes were  $2789.8 \pm 1948.8$  and  $8504.3 \pm 4158.4$  in the Urban and Pastoral males respectively. The higher Median MET minutes in the Pastoral male sample would suggest that the Pastoral males were more physically active and therefore expended more energy per week than the Urban male sample. The difference between their medians was statistically significant at  $p < .001$ .

The statistically significant difference between the Median MET mins per week between these two samples, is perhaps due to the different modes of transportation used by either sample and the distances traversed. The Urban sample used

mechanized means of transportation while walking was the means of transport in the Pastoral. Secondly the Urban sample walked short distances unlike the Pastoral sample which walked vast distances. The occupations engaged in by either sample may also add to the total median MET minutes/wk in either group, the Urban sample tended to have more sedentary occupations while the Pastoral sample tended to have active occupations such as herding animals. These results are consistent with literature published on difference in physical activity between urban samples and rural samples still leading a traditional way of life by Sobngwi et al. (2002; 2004).

Interpretation of the median MET minutes/week however needs to be interpreted cautiously given the subjective nature of IPAQ or any other questionnaire to determine physical activity. The use of the International Physical Activity Questionnaire (IPAQ) has individual overestimation as one of its limitations, compared to direct measurement of energy expenditure by use of a calorimeter or water labelling. However, the use of IPAQ helped the researcher to capture the total time spent on physical activity or inactivity in a given week.

Mean haemoglobin (Hb) in the Urban males was  $15.5 \pm 2$  gm/dL, while mean Hb in the Pastoral males was  $13.1 \pm 1.2$  gm/dL, indicating that the Urban males had a higher mean Hb than the Pastoral males. The mean Hb in the Urban male sample was within the normal reference range for males, however mean Hb in the Pastoral males sample was slightly below the normal reference range (13.5-17gm/dL). The mean Hb's between these two samples were significantly different at  $p < .001$ . It is interesting to note the Pastoral sample was able to accumulate a higher and statistically significant



median MET mins/week despite slightly depressed mean Hb values, suggesting that their mean Hb values were not a limiting factor.

Possible reasons for depressed Hb levels are anaemia, bleeding, erythropoietin deficiency, lead poisoning, malnutrition, nutritional deficiencies of iron, folate, vitamin B12, Vitamin B6, over-hydration, red blood cell destruction, parasites or iron binding properties of tannins in tea or perhaps by haemolysis induced by foot-strike during long distance walking. Given the adequate dietary intake in the Pastoral male sample as assessed by a food frequency questionnaire, albeit its subjective nature, it is difficult to explain their depressed mean Hb levels to be related to dietary deficiencies. The excellent mean Systolic and Diastolic blood pressures in this same sample would also rule out erythropoietin deficiency often the result of kidney disease.

**Table 4.15 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Female Samples.**

	Urban Females	Pastoral Females	p- Value
N	29	40	-
Vigorous MET mins	674.8±501.4	2494±2341	p<.001
Moderate MET mins	649.7±472	1816.5±1352.6	p <.001
Walking Mins	1197.8±833.1	2146.7±1237.3	p <.002
Sitting Mins	305.9±151.2	338.7±176	p <.032
MET Mins/week	2522.3±1468.2	6457.2±3823.2	p <.001
Hb (g/dL)	13.4±1.4	12.3±1.2	p <.001

The median Vigorous MET minutes/week, in the Urban females was  $674.8 \pm 501.4$  while the mean Vigorous MET minutes/week in the Pastoral females was  $2494 \pm 2341$ , suggesting that the Pastoral females engaged in more vigorous physical activities for a longer duration than the Urban female sample. The difference between their medians was statistically significant at  $p < .001$ .

Median moderate MET minutes per week in the Urban female sample was  $649.7 \pm 472$  while that in the Pastoral female sample was  $1816.5 \pm 1352.6$ . These findings suggested that the Urban female sample accumulated less hours of moderate physical activity per week than the Pastoral female sample, the difference between their medians was statistically significant at  $p < .001$ .

The median time in minutes spent walking per week was also analyzed between the two female samples. Median walking minutes in the Urban females was  $1197.8 \pm 833.1$  while median walking minutes in the Pastoral females was  $2146.7 \pm 1237.3$ , there was a statistically significant difference between their medians at  $p < .002$ .

Median sitting time per day was analyzed between the two female samples. Median sitting time in the Urban females was  $305.9 \pm 151.1$  while that in Pastoral females was  $338.7 \pm 176$  indicating that the Urban female sample spent fewer minutes seated per day than Pastoral females. There was a statistically significant difference between their medians at  $p < .032$ .

Median MET minutes per week, a measure of physical activity in minutes per week between the two female samples were analyzed. Median MET minutes in the Urban females was  $2522.3 \pm 1468.2$  or 2.5 times lower than the median for Pastoral females which was  $6457.2 \pm 3823.2$ . The higher Median MET minutes in the Pastoral female sample suggested that the Pastoral females were more physically active and therefore expended more energy per week than the Urban female sample. The difference between their medians was statistically significant at  $p < .001$ . This is perhaps due to the mode of transportation used by either sample. The Urban sample used mechanized means of transportation while the Pastoral sample walked long distances. The occupations engaged in by either sample may also have added to their total median MET minutes/wk in either group, the Urban sample tended to have more sedentary occupations while the Pastoral sample tended to have active occupations such as herding animals, trekking long distances to draw water for domestic use. This result was consistent with literature published on difference in physical activity between urban samples and rural samples still leading a traditional way of life by Sobngwi et al, (2002; 2004).

Mean haemoglobin (Hb) in the Urban females was  $13.4 \pm 1.4$  gm/dL, while mean Hb in the Pastoral females was  $12.3 \pm 1.2$  gm/dL, indicating that the Urban females had a higher mean Hb than the Pastoral females. The mean Hb in both the Urban and Pastoral female samples were within the normal reference range for females however (12.1-15gm/dL). The mean Hb's between these two samples were significantly different at  $p < .001$ .

Possible reasons for the significantly lower mean Hb levels in the Pastoral female sample may be malnutrition, however their mean lymphocyte count, shown in Table 4.31 eliminates this as a plausible explanation. Folate deficiency as a possible reason is also discounted as Pastoral females had the highest mean dietary Folic acid intake among the Pastoral males, Urban males and females as shown in Table 4.22. The borderline lower mean Hb levels in the Pastoral females is plausibly the result of haemolysis caused by foot-strike in distance walking over rough terrain in sandals made from discarded motor vehicle tyres.

**Table 4.16 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Samples.**

	Urban	Pastoral	p-Value
N	67	66	-
Vigorous MET mins	731.6±640.6	3270.3±2892.9	p<.001
Moderate MET mins	656.8 ±464.3	1711.5± 1304	p<.001
Walking Mins	1285.9 ±1095.7	2281.8±1325.5	p<.001
Sitting Mins	340±181.6	307.0769±178.6	NS
MET Mins/week	2674.±1749.7	7263.6±4054.2	p<.001
Hb (g/dL)	14.6±2.1	12.6±1.2	p<.001

Means compared using a T-test

The median Vigorous MET minutes/week, in the Urban sample was 731.6±640.6 while the median Vigorous MET minutes/week in the Pastoral sample was 3270.3±2892.9, suggesting that the Pastoral sample engaged in more vigorous

physical activities for a longer duration than the Urban sample. The difference between the means of the two samples was statistically significant at  $p < .001$ .

Median moderate MET minutes per week in the Urban sample was  $656.8 \pm 464.3$  or 2.6 times lower than the mean in the Pastoral sample which was  $1711.5 \pm 1304$ . Suggesting the Pastoral sample accumulated more median moderate MET minutes per week than the Urban sample. The difference between their medians was statistically significant at  $p < .001$ .

The median time in minutes spent walking per week was also analyzed between the two samples. Median walking minutes in the Urban sample was  $1285.9 \pm 1095.7$  while mean walking minutes in the Pastoral sample was  $2281.8 \pm 1325.5$ , the difference between their medians was statistically significant at  $p < .001$ . This result suggests that the Pastoral sample accumulated more minutes a week of walking than did the Urban sample.

Median time spent sitting per day was analyzed between the two samples. Median sitting time in the Urban sample was  $340 \pm 181.6$  while that in Pastoral sample was  $307.0769 \pm 178.6$ , indicating that the Urban sample spent more minutes seated per day than the Pastoral sample. The difference between their medians was however not statistically significant.

Median MET minutes per week a measure of physical activity in minutes per week between the two samples were analyzed. Median MET minutes in the Urban sample

was  $2674. \pm 1749.7$  or 2.7 times lower than the median for the Pastoral sample which was  $7263.6 \pm 4054.2$  despite their significantly lower mean Hb levels.

The higher Median MET minutes per week in the Pastoral sample suggested that they were more physically active and accumulated more minutes a week of physical activity than the Urban sample. The difference between their Median MET minutes per week of the two samples was statistically significant at  $p < .001$ . This was perhaps due to the mode of transportation used by either sample or durations spent walking.

The Urban sample used mechanized means of transportation mainly while the Pastoral sample walked long distances. The occupations engaged in by either sample may also have added to the total MET minutes/wk in either group, the Urban sample tended to have more sedentary occupations while the Pastoral sample tended to have active occupations such as herding animals, trekking long distances to draw water for domestic use. The result was consistent with literature published on difference in physical activity between urban samples and rural samples still leading a traditional way of life by Sobngwi et al, (2002; 2004).

Mean haemoglobin (Hb) in the Urban sample was  $14.6 \pm 2.1$  gm/dL, while mean Hb in the Pastoral sample was  $12.6 \pm 1.2$  gm/dL, indicating that the Urban sample had a higher mean Hb than the Pastoral sample. The mean Hb's between these two samples was significantly different at  $p < .001$ , but of no clinical significance as each sample's mean is a combination of both male and females Hb's and as such do not offer meaningful data. The significantly lower mean Hb levels in the Pastoral sample is plausibly the results of exercise induced haemolysis caused by foot-strike due to

their daily long distance walking over difficult terrain with nothing more than sandals made from discarded motor vehicle tires, possibly causing higher RBC turnover, as has been demonstrated in distance running (Telford et al., 2003).

Differences in physical activity (MET minutes/week), haemoglobin and energy intake between the Urban and Pastoral samples was also analyzed by the following age-categories: 30-40, 41-50 and 51-60.

**Table 4.17 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Samples by Age-category 30-40**

	Urban Sample	Pastoral Sample	p- Value
N	42	33	-
Vigorous MET mins	664.5±634.1	3466.7±3186	p<.001
Moderate MET mins	664.2±491.7	1369.7±1158.2	p<.001
Walking Mins	1332±1224.5	2201.6±1382.4	p<.005
Sitting mins	376.9±198.2	302.2±185.2	NS
MET mins/week	2660.3±1895.9	7037.9±42167	p<.001
Hb (g/dL)	15.1±1.7	12.4±1.4	p<.001

Means compared using a T-test

The median Vigorous MET minutes/week, in the Urban sample, in the age-category 30-40 was 664.5±634.1 while the mean in the Pastoral sample in the same age-category was 3466.7±3186, indicating that the Pastoral sample engaged in more vigorous physical activities for a longer duration than the Urban sample. The

difference between the median Vigorous MET minutes per week in the 30-40 age-category in the two samples was statistically significant at  $p < .001$ .

Median moderate MET minutes per week in the Urban sample, in the age-category 30-40 was  $664.2 \pm 491.7$  or 2.1 times lower than the mean in the Pastoral sample in the same age-category which was  $1369.7 \pm 1158.2$ . These findings indicate that the Urban sample accumulated less hours of moderate physical activity per week than the Pastoral sample in this age-category, the difference between their medians was statistically significant at  $p < .001$ .

The difference in the median walking time in minutes per week, between the two samples in the age category 30-40 was also analyzed. Median walking minutes in the Urban sample was  $1332 \pm 1224.5$  while median walking minutes in the same age-category in the Pastoral sample was  $2201.6 \pm 1382.4$ , the difference between their medians was statistically significant at  $p < .005$ .

The difference in the median sitting time per day was analyzed between the two samples in the age-category 30-40. Median sitting time in the Urban sample was  $376.9 \pm 198.2$ , while that in Pastoral sample was  $302.2 \pm 185.2$ , indicating that the Urban sample spent more minutes seated per day than the Pastoral sample. The difference between the median sitting time per day between these two samples in the age-category 30-40 was however not significantly different.

Median MET minutes per week a measure of physical activity in minutes per week between the two samples in the age-category 30-40 were analyzed. Median MET



minutes in the Urban sample was  $2660.3 \pm 1895.9$  or 2.7 times lower than the mean for the Pastoral sample which was  $7037.9 \pm 42167$ , suggesting that the Pastoral sample in this age-category was more physically active and accumulated more minutes per week of physical activity than the Urban sample in the same age-category.

The difference between their medians was statistically significant at  $p < .001$ . The higher Median MET minutes/week in the Pastoral sample is possibly the result of absence of motorized transportation and physically active lifestyles in contrast to the Urban lifestyles that tended to be sedentary in nature. This result was consistent with literature published on difference in physical activity between urban samples and rural samples still leading a traditional way of life by Sobngwi et al, (2002; 2004).

Mean Hb's were  $15.1 \pm 1.7$  gm/dl and  $12.4 \pm 1.4$  gm/dl for the Urban and Pastoral samples in the age-category 30-40 respectively, the Urban sample in this age category not only had a higher mean Hb, but the difference between the means of these two samples in this age category were statistically significant at  $p < .001$ . The lower mean Hb in the Pastoral sample is as a result of the slightly depressed mean Hb levels in the Pastoral males therefore lowering the mean of the Pastoral sample in this age-category.

**Table 4.18 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Samples by Age-category 41-50**

	Urban Sample	Pastoral Sample	p- Value
N	18	17	-
Vigorous MET mins	782.8 ±624.4	3694.1±2718.6	p<.001
Moderate MET mins	666.7±4845	1977.7±917.6	p<.001
Walking Mins	1347.6±927.6	2439.8±1205.9	p<.005
Sitting mins	281.7±117.8	271.8±95.2	NS
MET mins/week	2797.1±1678.4	8111.6±3321.3	p<.001
Hb (g/dL)	13.9±1.8	12.8±1.3	p<.037

Means compared using a T-test

The median Vigorous MET minutes/week, in the Urban sample, in the age-category 41-50 was 782.8 ±624.4 while the mean in the Pastoral sample in the same age-category was 3694.1±2718.6, indicating that the Pastoral sample engaged in more vigorous physical activities for a longer duration per week than the Urban sample. The difference between their medians was statistically significant at p<.001.

Median moderate MET minutes per week in the Urban sample, in the age-category 41-50 was 666.7±484.5 or about 3 times lower than the median in the Pastoral sample in the same age-category which was 1977.7±917.6. This finding indicated that the Urban sample accumulated less hours of moderate physical activity per week than the Pastoral sample in this age-category, the difference between their means was statistically significant at p<.001.

The difference in the median walking time per week, between the two samples in the age category 41-50 was also analyzed. Mean walking minutes in the Urban sample was  $1347.6 \pm 927.6$  while mean walking minutes in the same age-category in the Pastoral sample was  $2439.8 \pm 1205.9$ , suggesting the Pastoral sample spent more time walking and accumulating physical activity than the Urban sample. The difference between their medians was statistically significant at  $p < .005$ .

The difference in the median time in minutes spent sitting per day was analyzed between the two samples in the age-category 41-50. Median sitting time in the Urban sample was  $281.7 \pm 117.8$  while that in Pastoral sample was  $271.8 \pm 95.2$ , indicating that the Urban sample spent more minutes seated per day than the Pastoral sample. The difference between their medians was however not statistically significant.

Median MET minutes per week a measure of physical activity in minutes per week between the two samples in the age-category 41-50 were analyzed. Median MET minutes in the Urban sample was  $2797.1 \pm 1678.4$  or 2.9 times lower than the median for the Pastoral sample which was  $8111.6 \pm 3321.3$ , suggesting that the Pastoral sample in this age-category were more physically active and accumulated more physical activity per week than the Urban sample in the same age-category. The difference between their medians was statistically significant at  $p < .001$

The higher Median MET minutes/week in the Pastoral sample is possibly the result of their mode of transportation, occupations and physically active lifestyles in contrast to the Urban lifestyles that tended to be sedentary in nature. The result was consistent with literature published on difference in physical activity between urban

samples and rural samples still leading a traditional way of life by Sobngwi et al, (2002; 2004).

Mean Hb's were  $13.9 \pm 1.8$  gm/dl and  $12.8 \pm 1.3$  gm/dl for the Urban and Pastoral samples in the age-category 41-50 respectively. The Urban sample in this age category had a higher mean Hb than that of the Pastoral sample, the difference between the means of the two samples were significantly different at  $p < .037$ . The lower mean Hb in the Pastoral sample is as a result of the slightly depressed mean Hb levels in the Pastoral males therefore lowering the mean of the Pastoral sample in this age-category. However it is interesting to note that the mean Hb of the Urban sample in this age-category was relatively lower than that of the 30-40 age group in the same sample. The mean Hb of the Pastoral sample in this age-category was relatively higher than that in the 30-40 age-category in the same sample.

**Table 4.19 Differences in Physical Activity (MET minutes/week) and Haemoglobin Between the Urban and Pastoral Samples by Age-category 51-60**

	Urban Sample	Pastoral Sample	p- Value
N	7	16	-
Vigorous MET mins	$1002.9 \pm 732.3$	$2415 \pm 2378.6$	NS
Moderate MET mins	$587.1 \pm 218.1$	$2133.8 \pm 1755.1$	$p < .032$
Walking Mins	$850 \pm 523.2$	$2279.4 \pm 1393.9$	$p < .017$
Sitting mins	$268.6 \pm 171.2$	$354.4 \pm 227.6$	NS
MET mins/week	$2440 \pm 1010.8$	$6828.2 \pm 4516.4$	$p < .020$
Hb (g/dL)	$13.1 \pm 3.8$	$12.9 \pm 0.9$	NS

Means compared using a T-test

The median Vigorous MET minutes/week, in the Urban sample, in the age-category 51-60 was  $1002.9 \pm 732.3$  while the median in the Pastoral sample in the same age-category was  $2415 \pm 2378.6$ , suggesting that the Pastoral sample engaged in more vigorous physical activities for a longer duration per week than the Urban sample. The difference between their medians was however not statistically significant.

Median moderate MET minutes per week in the Urban sample, in the age-category 51-60 was  $587.1 \pm 218.1$  or about 3.6 times lower than that of the Pastoral sample in the same age-category that was  $2133.8 \pm 1755.1$ . These findings suggested that the Urban sample accumulated less hours of moderate physical activity per week than the Pastoral sample in this age-category, the difference between their medians was statistically significant at  $p < .032$ .

The difference in the median time in minutes spent walking per week, between the two samples in the age category 51-60 was also analyzed. Median walking minutes in the Urban sample was  $850 \pm 523.2$  while median walking minutes in the same age-category in the Pastoral sample was  $2279.4 \pm 1393.9$ . This suggests the Pastoral sample in this age-category accumulated more minutes per week of physical activity through walking than the Urban sample. The difference between their medians was statistically significant at  $p < .017$ .

The difference in the median time in minutes spent sitting per day was analyzed between the two samples in the age-category 51-60. Median sitting time in the Urban sample was  $268.6 \pm 171.2$  while that of the Pastoral sample was  $354.4 \pm 227.6$ , indicating that the Urban sample spent less time seated per day than the Pastoral

sample. The difference between their medians was however not statistically significant.

Median MET minutes per week in the two samples in the age-category 51-60 were analyzed. Median MET minutes in the Urban sample was  $2440 \pm 1010.8$  or 1.5 times lower than that of the Pastoral sample which was  $6828.2 \pm 4516.4$ , indicating that the Pastoral sample in this age-category were more physically active and accumulated more minutes per week of physical activity than the Urban sample in the same age-category. The difference between their medians was statistically significant at  $p < .020$ .

The higher Median MET minutes/week in the Pastoral sample indicated a fairly active sample in this age-category. This result was consistent with literature published on differences in physical activity between urban samples and rural samples still leading a traditional way of life by Sobngwi et al (2002; 2004).

Mean Hb's were  $13.1 \pm 3.8$  gm/dl and  $12.9 \pm 0.9$  gm/dl for the Urban and Pastoral samples respectively. The Urban sample in this age category had a higher mean Hb than that of the Pastoral sample, however this arithmetic difference in mean Hb between the two sample in this age-category was not statistically significant. It was also noted that the mean Hb in the 51-60 age-category in the Urban sample was relatively the lowest in all three age-categories in the Urban sample. In contrast however, the mean Hb in the 51-60 age-category in the Pastoral sample was relatively the highest at all three age-categories in the Pastoral sample.

#### **4.5.1.1 Relationship Between Physical Activity and BP**

The relationship between Physical Activity and Blood Pressure within the Urban and Pastoral sample was analysed using the Pearson correlation coefficient which showed a significant a weak negative correlation between median walking MET minutes per week and mean SBP ( $r=-.274$ ,  $p<.05$ ) in the Pastoral sample only. This result, indicated an inverse relationship between moderate MET minutes per week in the Pastoral sample and mean SBP; this relationship was however absent in the Urban sample.

The relationship between physical activity and Blood Pressure within the Urban and Pastoral sample was also analysed by age-category using the Pearson correlation coefficient which found a moderate but significant and negative correlation between median walking MET minutes per week and mean SBP ( $r= -.516$ ,  $p< 0.05$ ) in the Pastoral sample's 51-60 age-category only. This result indicates an inverse relationship between minutes spent walking per week and SBP, this relationship was however absent in all age-categories within the Urban sample.

#### **4.5.1.2 Relationship Between Physical Activity and CVD Risk Biomarkers**

The relationship between physical activity and CVD risk biomarkers within the Urban and Pastoral sample were analysed by age-category using the Pearson Correlation coefficient that showed the following significant correlations in the 41-50 age-category in the Urban sample; median moderate MET minutes per week and apoB ( $r=-.498$ ,  $p<.05$ ) suggesting an inverse relationship between median moderate MET minutes per week and apoB. Analysis of the median MET minutes per week in the same sample indicated a negative but significant correlation to apoA

( $r=-.501$ ,  $p<.05$ ), also suggesting an inverse relationship between the median MET minutes per week and apoA in this age-category of the Urban sample. The same age-category in the Pastoral sample did not show any significant relationship between PA and CVD biomarkers.

In the 51-60 age-category there was a significant and positive correlation between median walking MET minutes per week and Co-Q10 ( $r= .858$ ,  $p< .05$ ) in the Urban sample, this result suggests a direct relationship between increasing time spent walking per week and increasing levels of the protective CVD bio risk marker Co-Q10. The same age-category in the Pastoral sample did not show any significant relationship between PA and CVD biomarkers.

#### **4.5.2 Dietary Intake Within and Between the Urban and Pastoral Samples**

Caloric intake, in view of its importance in enabling physical activity, impact on BMI and CVD risk biomarkers, select macro and micronutrients consumed over a 24-hour period were analyzed, using NutriSurvey for Windows 2004 Software, to determine differences in dietary intake within and between the two samples, the results are presented below in Tables 4.20- 4.27



**Table 4.20 Differences in Dietary Intake Within the Urban Sample**

Variable	Male	Female	p-Value
N	38	29	-
Energy (kcal)	1638.1±975.8	1879.6±1026.5	NS
Water (ml)	1391.3±537	1111±476.5	p<.031
Protein (g)	79.9±62.9	73.8±43.5	NS
Fat (g)	49.6±34.4	59.2±54.4	NS
Carbohydrate (g)	240.1±174.8	280±121.1	NS
Cholesterol (mg)	129±100.1	100.1±89.1	NS
SAFA (g)	13.7±12.4	11.2±10.2	NS
PUFA (g)	7.6±5.6	8.7±7.1	NS
MUFA (g)	13.7±11.1	12.4±8.07	NS
EPA (g)	0.03±0.01	0.03±0.02	NS
DHA (g)	0.01±0.012	0.01±0.002	NS
Folic Acid (µg)	105±68.7	85.7±72.9	NS

Means compared using a T-test

The mean energy intake in Kcal were 1638.1±975.8 and 1879.6±1026.5 in the Urban male and females respectively, however the means within this sample were not significantly different. High water intake can have a dilution effect on blood haemoglobin concentration levels, similarly low water intake can raise blood haemoglobin concentration in view of this, water intake therefore measured. Mean water intake was 1391.3 ±537ml and 1111±476.5ml in the Urban male and female respectively, the difference between their means was significantly different at p<.031. Mean protein, fat and carbohydrate intake were 79.9±62.9g, 49.6±34.4g and

240.1±174.8g in the Urban males and 73.8±43.5g, 59.2±54.4g, and 280±121.1g for the Urban females, indicating that the Urban males consumed relatively more protein but less fat and carbohydrates than the Urban females. The means between each of these macronutrients in this sample were not significantly different.

Mean dietary cholesterol and folic acid intake were 129±100.1 mg, and 105±68.7µg in the Urban males and 100.1±89.1mg and 85.7±72.9µg in the Urban females. Mean dietary cholesterol and folic acid within this sample were not significantly different. It was noted that the standard deviation in the mean cholesterol intake was large and therefore perhaps had a dilution effect on the difference.

Mean saturated fat (SAFA), polyunsaturated fat (PUFA), monounsaturated fat (MUFA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) were 13.7±13.4g, 7.6±5.6g, 13.7±11.1g, 0.03±0.01g, and 0.01±0.012g in the Urban males and 11.2±10.2g, 8.7±7.1g, 12.34±8.07g, 0.03±0.02g and 0.01±0.002g in the Urban females. There was no significant difference between the means of any of these fatty acids within this sample.

**Table 4.21 Differences in Dietary Intake Within the Pastoral Sample**

Variable	Male	Female	p-Value
N	26	40	-
Energy (kcal)	1654.4±645.5	2197.5±1098	p<.026
Water (ml)	1341.7±629.6	1592.7±609.1	NS
Protein (g)	76.8±35.7	110.6±54.4	p<.007
Fat (g)	53.5±29.3	68.5±35.3	NS
Carbohydrate (g)	271.9±163.1	362.2±247.4	NS
Cholesterol (mg)	201.6±155.3	199±178	NS
SAFA (g)	16.5±10.6	18.8±9.9	NS
PUFA (g)	6.7±5.1	13.3±10.7	p<.023
MUFA (g)	16.37±11.15	20.8±16.47	NS
EPA (g)	0.02±0.01	0.03±0.25	NS
DHA (g)	0.03±0.01	0.05±0.33	NS
Folic Acid (µg)	178.2±103.5	204.6±152.1	NS

The mean energy intake in Kcals were 1654.4±645.5 and 2197.5±1098 in the Pastoral male and female sample respectively, and was significantly different at p<.026. Mean water intake was 1341.7±629.6ml and 1592.7±609.15ml in the Pastoral male and female respectively, but was not significantly different.

Mean protein, fat and carbohydrate intake were 76.8±35.7g, 53.5±29.3g and 271.9±163.1g respectively in the Pastoral males and 110.6±54.4g, 68.5±35.3g, and 362.2±247.4g for the Pastoral females, suggesting that the Pastoral males consumed relatively less protein, fat and carbohydrates than the Pastoral females. The

difference between the means of each of these macronutrients in this sample were significant for Protein at  $p < .007$ , but not for Fat and Carbohydrates. It is important to note that Pastoral females diet included beans which were seldom reported as eaten by the Pastoral male sample, perhaps increasing the females overall protein intake upwards.

Mean dietary cholesterol and folic acid intake were  $201.6 \pm 155.3$ mg, and  $178.2 \pm 103.5$ µg in the Pastoral males and  $199 \pm 178$ mg and  $204.6 \pm 152.1$ µg in the Pastoral females. The means between dietary cholesterol and folic acid in this sample were not significantly different.

Mean SAFA, PUFA, MUFA, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) were  $16.5 \pm 10.6$ g,  $6.7 \pm 5.1$ g,  $16.37 \pm 11.15$ g,  $0.02 \pm 0.01$ g, and  $0.03 \pm 0.01$ g in the Pastoral males and  $18.8 \pm 9.9$ g,  $13.3 \pm 10.7$ g,  $20.8 \pm 16.47$ g,  $0.03 \pm 0.25$ g and  $0.05 \pm 0.33$ g in the Pastoral females respectively. The difference between the means of each of these fatty acids, in this sample, were significant for PUFA at  $p < .023$  but not for SAFA, MUFA, EPA and DHA. PUFA is usually present in the diet from processed foods or oils, the higher PUFA intake in the females could suggest higher intake of processed foods or oils by the females in this sample, however given this data was obtained using a 24- hour recall, this finding should be interpreted with caution and therefore cannot be generalised.

**Table 4.22 Differences in Dietary Intake Between the Urban and Pastoral Male Samples**

Variable	Urban Male	Pastoral Male	p-Value
N	38	26	-
Energy (kcal)	1638.1±975.8	1654.4±645.5	NS
Water (ml)	1391.3±537	1341.7±629.6	NS
Protein (g)	79.9±62.9	76.8±35.7	NS
Fat (g)	49.6±34.4	53.5±29.3	NS
Carbohydrate (g)	240.1±174.8	271.9±163.1	NS
Cholesterol (mg)	129±100.1	201.6±155.3	NS
SAFA (g)	13.7±13.4	16.5±10.6	NS
PUFA (g)	7.6±5.7	6.7±6.1	NS
MUFA (g)	14.73±11.1	16.37±11.15	NS
EPA (g)	0.03±0.01	0.02±0.001	NS
DHA (g)	0.003±0.012	0.03±0.01	p<.001
Folic Acid (µg)	105±68.7	178.2±103.5	p<.001

Means compared using a T-test

The mean energy intake in Kcal were 1638.1±975.8 and 1654.4±645.5 in the Urban and Pastoral male samples respectively, however there was no significant difference between their means. Mean water intake was 1391.3±537ml and 1341.7±629.6ml in the Urban and Pastoral male samples respectively. The difference between their mean water intake was not significant. This suggested that the difference in their mean haemoglobin levels was not due to the dilution or concentration effect of water. Mean protein, fat and carbohydrate intake were 79.9±62.9g, 49.6±34.4g and

240.1±174.8g in the Urban males and 76.8±35.7g, 53.5±29.3g and 271.9±163.1g in the Pastoral males, suggesting that the Urban males consumed relatively more Protein but less fat and carbohydrates than the Pastoral males. The difference between the means, of each of these macronutrients, in the two samples were not significant.

Mean dietary cholesterol and folic acid intake were 129±100.1 mg, and 105±66.7µg in the Urban males and 201.6±155.3 mg, and 178.2±103.5µg in the Pastoral males. The means between dietary cholesterol were not significant, however the difference between the means of their folic acid intake was significant at  $p < .001$ . The large standard deviation around the mean cholesterol intake in the Urban male sample appeared to have a dilution effect on the relatively large arithmetic difference in the means of the two samples.

Mean saturated fat (SAFA), polyunsaturated fat (PUFA), monounsaturated fat (MUFA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) were 13.7±13.4g, 7.6±5.7g, 14.73±15.11g, 0.03±0.01g, and 0.003±0.012g in the Urban males and 16.5±10.6g, 6.7±5.1g, 16.37±11.15g, 0.02±0.01g and 0.03±0.01 in the Pastoral males. The difference between the means of each of these fatty acids, in these two samples, were significant for DHA at  $p < .001$  but not for SAFA, PUFA, MUFA and EPA. However from this analysis it was difficult to conclude whether this was a reflection of differences in diet (habitual) or merely a reflection of food consumed in the 24 hours preceding administration of the 24 hour dietary recall.

**Table 4.23 Differences in Dietary Intake Between the Urban and Pastoral Female Samples**

Variable	Urban Female	Pastoral Female	P-Value
N	29	40	-
Energy (kcal)	1879.6±1026.5	2197.5±1098	NS
Water (ml)	1111±476.5	1592.7±609.1	p<.001
Protein (g)	73.8±43.5	110.6±54.4	p<.004
Fat (g)	59.2±54.4	68.5±35.3	NS
Carbohydrate (g)	280±121.1	362.2±247.4	NS
Cholesterol (mg)	100.1±89.1	199±178	p<.001
SAFA (g)	11.2±10.2	18.8±9.9	p<.004
PUFA (g)	8.7±7.1	13.3±10.7	NS
MUFA (g)	12.34±8.07	20.08±16.47	NS
EPA (g)	0.03±0.02	0.03±0.25	NS
DHA (g)	0.01±0.002	0.05±0.33	NS
Folic Acid (µg)	85.7±72.9	204.6±152.1	p<.001

Means compared using a T-test

The mean energy intake in Kcal were 1879.6±1026.5 and 2197.5±1098 in the Urban and Pastoral female samples respectively, however the means between these two groups were not significantly different. Mean water intake was 1111±476.5ml and 1592.7±609.5ml in the Urban and Pastoral female samples respectively, the difference between their mean water intake was significant at p<.001, this would possible suggest any differences in mean haemoglobin may have been due to a dilution effect on haemoglobin levels, in the Pastoral female sample. Mean protein,

fat and carbohydrate intake were  $73.8\pm 43.5\text{g}$ ,  $59.2\pm 54.4\text{g}$  and  $280\pm 121.1\text{g}$  in the Urban female sample and  $110.6\pm 54.4\text{g}$ ,  $68.5\pm 35.3\text{g}$ , and  $362.2\pm 247.4\text{g}$  for the Pastoral females, suggesting that the Urban females consumed relatively less protein, fat and carbohydrates than the Pastoral females. The difference between the means of each of these macronutrients in these two samples were significant for protein at  $p<.004$ , but not for fat and carbohydrates. The large standard deviations around the means for fat and carbohydrates in the Urban sample were large and therefore may have had a dilution effect on the difference on the means between the two samples.

Mean dietary cholesterol and folic acid intake were  $100.1\pm 89.1\text{mg}$ , and  $85.7\pm 72.9\mu\text{g}$  in the Urban females and  $199.9\pm 178\text{mg}$  and  $204.6\pm 152.1\mu\text{g}$  in the Pastoral females. The means between dietary cholesterol and folic acid intake in these two samples were significantly different at  $p<.001$  and  $p<.001$  respectively. The high dietary cholesterol intake in the Pastoral female sample was not surprising as pastoral samples are reputed to have high dietary cholesterol intakes (Day et al 1976; Day et al., 1979; Mann et al., 1964; Shaper et al., 1962; Shaper, et al., 1963; Biss et al., 1971) however their higher intake of folic acid was surprising as folic acid is usually found in leafy greens which are traditionally not eaten by Pastoral samples, however the high folic acid intake may have been from consumption of organ meats which are relatively high in folic acid.

Mean SAFA, PUFA, MUFA, EPA, DHA were  $11.2\pm 10.2\text{g}$ ,  $8.7\pm 7.1\text{g}$ ,  $12.34\pm 8.07\text{g}$ ,  $0.03\pm 0.02\text{g}$ , and  $0.01\pm 0.002\text{g}$  in the Urban females and  $18.8\pm 9.9\text{g}$ ,  $13.3\pm 10.7\text{g}$ ,  $20.08\pm 16.47\text{g}$ ,  $0.03\pm 0.25\text{g}$  and  $0.05\pm 0.33\text{g}$  in the Pastoral females respectively. The difference between the means of each of these fatty acids, in these two samples, were



significant for SAFA at  $p < .004$ , but not for PUFA, MUFA, EPA and DHA. The significantly higher SAFA intake in the Pastoral female sample was not surprising as pastoralists are reputed for high intake of SAFA's ( Njelekela et al., 2001; Glew et al., 2003). However, their relatively higher intake of PUFA was surprising as pastoral samples have in the past, been associated with animal fats and not processed plant fats or oils, this perhaps is a reflection of the epidemiological and nutrition transition taking place even in otherwise isolated populations leading a traditional life. However this finding must be interpreted with caution as the data was collected from a 24-hour dietary recall thus limiting generalisations.

**Table 4.24 Differences in Dietary Intake between the Urban and Pastoral Samples**

Variable	Urban Sample	Pastoral Sample	p-Value
N	67	66	-
Energy (kcal)	1744.2±998	1983.5±977.3	NS
Water (ml)	1268.1±526.5	1493.8±624.7	p<.027
Protein (g)	77.2±54.9	97.3±50.4	p<.030
Fat (g)	53.8±44.2	68.5±35.3	NS
Carbohydrate (g)	257.6±153.8	326.7±221.2	p<.039
Cholesterol (mg)	114.5±95.1	200.6±168.2	p<.001
SAFA (g)	12.6±11.8	17.9±10.2	p<.009
PUFA (g)	8.1±6.3	10.7±8.7	NS
MUFA (g)	13.68±12.49	19.05±14.67	p<.025
EPA (g)	0.02±0.04	0.06±0.2	NS
DHA (g)	0.04±0.02	0.07±0.26	p<.049
Folic Acid (µg)	96.5±70.7	194.2±134.8	p<.001

Means compared using a T-test

The mean energy intake in Kcal were 1744.2±998 and 1983.5±977.3 in the Urban and Pastoral samples respectively. The means between these two groups were not significantly different. Mean water intake was 1268.1±526.5ml and 1493.8±624.7ml in the Urban and Pastoral samples respectively. The difference between their mean water intake was significant at p<.027. Mean protein, fat and carbohydrate intake were 77.2±54.9g, 53.8±44.2g and 257.6±153.8g in the Urban sample and 97.3±50.4g, 62.6±33.7g, and 326.7±221.2g in the Pastoral sample, indicating that the

Urban sample consumed relatively less protein and carbohydrates than the Pastoral sample. The difference between the means of each of these macronutrients in these two samples were significantly different for protein at  $p < .030$  and carbohydrates at  $p < .039$ , but not for dietary fat. The standard deviation in the means for dietary fat in the Urban sample was large and therefore may have had a dilution effect on the difference between the means of the two samples.

Pastoral samples in SSA are known to mainly live off protein rich diets that are also high in total fat content (Biss et al., 1971; Mann et al., 1964, Mann et al., 1972; and Shaper et al., 1962) and therefore the significantly different mean protein intake was not surprising, however the significant difference between the mean carbohydrate intake was surprising as Pastoral communities in Kenya have been traditionally known to exclude carbohydrate (Shaper et al., 1962). The lack of significant difference in the overall fat intake between the two samples may be explained by modification of the Pastoral sample's diet by inclusion of carbohydrates thus lowering overall fat intake, it is important to note that the area had also suffered three years of inadequate rain at the time of data collection and therefore interpretation of this data should be done cautiously.

Mean dietary cholesterol and folic acid intake were  $114.5 \pm 95.1$  mg, and  $96.5 \pm 70.7$   $\mu$ g in the Urban sample and  $200.6 \pm 168.2$  mg and  $194.2 \pm 134.8$   $\mu$ g in the Pastoral sample. The means between dietary cholesterol and folic acid intake in these two samples were significantly different at  $p < .039$  and  $p < .001$  respectively. The high dietary cholesterol intake in the Pastoral sample was consistent with studies on the Pastoral Fulani of West Africa or Maasai in Tanzania (Glew et al., 2001 and Njelekela et al.,

2003). The Pastoral sample also tend to consume large quantities of organ meats such as liver, heart, and tripe which are relatively high in cholesterol and folic acid are may thus be reflected in this data.

Mean saturated fat (SAFA), polyunsaturated fat (PUFA), monounsaturated fat (MUFA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) were  $12.6\pm 11.8\text{g}$ ,  $8.1\pm 6.3\text{g}$ ,  $13.68\pm 12.49\text{g}$ ,  $0.02\pm 0.04\text{g}$  and  $0.04\pm 0.02\text{g}$  in the Urban sample and  $17.9\pm 10.2\text{g}$ ,  $10.7\pm 8.7\text{g}$ ,  $19.05\pm 14.67\text{g}$ ,  $0.06\pm 0.2\text{g}$  and  $0.07\pm 0.26\text{g}$  in the Pastoral sample. The difference between the means of each of these fatty acids, in these two samples, were significant for SAFA at  $p<.009$  and DHA at  $p<.049$ , but not for PUFA, MUFA and EPA.

The significantly higher SAFA intake in the Pastoral sample was consistent with that of pastoral samples such as the Maasai, Samburu and Rendile of Kenya who tend to have high intakes of SAFA's and therefore not surprising (Day et al., 1979, and Shaper et al., 1963). However their relatively higher intake of PUFA was surprising and probably a reflection of the epidemiological and nutrition transitions taking place even in otherwise isolated communities leading a traditional life. This finding however, must also be interpreted with caution as the data was collected from a 24-hour dietary recall which may not be entirely representative of one's dietary habits. Secondly, this could also be a reflection of the types of foods available during a particular season, this is in contrast to the year-round availability of food in the urban setting.

**Table 4.25 Differences in Dietary Intake Between the Urban and Pastoral Samples by Age-category: 30-40**

Variable	Urban Sample	Pastoral Sample	p-Value
N	42	33	-
Energy (kcal)	1787±1072.3	1997.3±1014.3	NS
Water (ml)	1283.5±581.5	1346±578.3	NS
Protein (g)	83.6±58.9	100±54.2	NS
Fat (g)	56.7±49.2	59.4±28.2	NS
Carbohydrate (g)	257±164.7	337.3±244	NS
Cholesterol (mg)	120.6±109.5	199.6±160.3	p<.038
SAFA (g)	13.8±11.2	17.2±9.8	NS
PUFA (g)	8.6±7.1	9.1±8	NS
MUFA (g)	15.37±13.52	17.39±9.93	NS
EPA (g)	0.04±0.03	0.04±0.01	NS
DHA (g)	0.003±0.01	0.04±0.01	p<.004
Folic Acid (µg)	101.7±77.3	150.5±79.3	p<.009

Means compared by a T-test

The mean energy intake in this age category was Kcal was 1787±1072.3 and 1997.3±1014.3 in the Urban and Pastoral samples respectively. The difference between their means was not significant. Mean water intake was 1283.5±581.5ml and 1346±578.3ml in the Urban and Pastoral samples respectively, the difference between mean water intake in either sample was not statistically significant. Mean protein, fat and carbohydrate intake were 83.6±58.9g, 56.7±49.2g and 257±164.7g in the Urban sample and 100±54.2g, 59.4±28.2g, and 337.3±244g for the Pastoral

sample in this age-category. The Urban sample appeared to have a relatively lower intake of all three macro-nutrients than the Pastoral sample, however the difference between the means of each of these macronutrients were not statistically significant. The standard deviation, in the means of macronutrient in both samples, were large and thus may have diluted the arithmetic differences and therefore indicated a relatively similar energy and macronutrient intake.

Mean dietary cholesterol and folic acid intake were  $120.6 \pm 109.5$  mg, and  $101.7 \pm 77.3$   $\mu$ g in the Urban sample and  $199.6 \pm 160.3$  mg and  $150.5 \pm 79.3$   $\mu$ g in the Pastoral sample. The means between dietary cholesterol and folic acid intake in these two samples were significantly different at  $p < .038$  and  $p < .009$  respectively. The lack of a statistically significant difference in the mean protein intake in grams between these two samples in this age-category and a statistically significant difference in their mean cholesterol and folic acid intake would suggest a relatively higher intake of a food or foods rich in both cholesterol and folic acid by the Pastoral sample. Organ meats such as kidney, liver and the heart are popular with Pastoral samples and are also a rich source of both cholesterol and folic acid Shaper et al. (1962).

Mean SAFA, PUFA, MUFA, EPA, DHA were  $13.8 \pm 11.2$ g,  $8.6 \pm 7.1$ g,  $5.37 \pm 13.52$ g,  $0.04 \pm 0.03$ g and  $0.003 \pm 0.01$ g in the Urban sample and  $17.2 \pm 9.8$ g,  $9.1 \pm 8$ g,  $17.39 \pm 9.93$ g,  $0.04 \pm 0.01$ g and  $0.04 \pm 0.01$ g in the Pastoral sample. The difference between the means of each of these fatty acids, in these two samples, were significant for DHA at  $p < .004$ , but not for SAFA, PUFA, MUFA and EPA. The significantly higher DHA but not EPA in the Pastoral sample is difficult to explain and perhaps highlights the shortcomings of a 24-hour dietary recall.

The lack of a statistically significant difference between the means of the SAFA, PUFA, MUFA and EPA in these two samples may on one hand suggest similar dietary intake in the 24-hour period data was collected or signify the nutrition transition taking place in this age-category in the Pastoral sample particularly intake of PUFA which is found in processed vegetable or plant oils and fats.

**Table 4.26 Differences in Dietary Intake between the Urban and Pastoral Samples by Age-category: 41-50**

Variable	Urban Sample	Pastoral Sample	p-Value
N	18	17	-
Energy (kcal)	1753.4±970.8	2069.3±1083.6	NS
Water (ml)	1199.6±414.4	1658.8±580.6	p<.011
Protein (g)	71.2±51.5	93.8±41.6	NS
Fat (g)	50.1±39.4	64.1±37.3	NS
Carbohydrate (g)	268.2±148.2	302.4±229.4	NS
Cholesterol (mg)	171.8±95.3	202.5±163.3	NS
SAFA (g)	12.5±11.3	16.2±11.8	NS
PUFA (g)	13.4±8.2	14.2±12.8	NS
MUFA (g)	15.9±11.41	19.43±14.20	NS
EPA (g)	0.01±0.001	0.01±0.04	NS
DHA (g)	0.01±0.02	0.02±0.01	NS
Folic Acid (µg)	84.9±48.5	226±133.9	p<.001

Means compared by a T-test

The mean energy intake in this age category was Kcal was 1753.4±970.8 and

2069.3±1083.6 in the Urban and Pastoral samples respectively. The difference between their means was not statistically significant. Mean water intake was 1199.6±414.4ml and 1658.8±580.6ml in the Urban and Pastoral samples respectively, the difference between their mean water intake in was statistically significant at  $p<.011$ , indicating lower water intake in the Urban sample.

Mean protein, fat and carbohydrate intake were 71.2±51.5g, 50.1±39.4g and 268.2±148.2g in the Urban group and 93.8±41.6g, 64.1±37.3g, and 302.4±229.4g for the Pastoral group in this age-category. The Urban group appeared to have a relatively lower intake of all three macro-nutrients than the Pastoral group, however the difference between the means of each of these macronutrients were not statistically significant. The standard deviation around the means of each macronutrient in both samples were large and may thus have diluted the arithmetic differences indicating a relatively similar energy and macronutrient intake.

Mean dietary cholesterol and folic acid intake were 171.8±95.3mg, and 84.9±48.5µg in the Urban sample and 202.5±163.3mg and 226±133.9µg in the Pastoral sample. The difference between mean dietary cholesterol intake between these two samples was not significantly different, however the difference between mean folic acid intake between these two samples was statistically significant at  $p<.001$ . While interpretation of this finding in absolute terms was difficult to explain, the large standard deviation around the mean cholesterol intake in the Urban sample was large and may have masked the difference in cholesterol intake and therefore explain the statistically significant difference between the mean folic acid intake between the two samples.



Mean SAFA, PUFA, MUFA, EPA, DHA were 12.5±11.3g, 13.4±8.2g, 15.9±11.41g, 0.01±0.001mg and 0.01±0.02mg in the Urban sample and 16.2±11.8g, 14.2±12.8g, 19.43±14.20g, 0.01±0.004mg and 0.02±0.01mg in the Pastoral sample. The difference between the means of each of these fatty acids, in these two samples, were not statistically significant, perhaps suggesting a similar fatty acid intake in the 41-50 age-category in the two samples, in the 24-hour period captured in the dietary recall.

**Table 4.27 Differences in Dietary Intake between the Urban and Pastoral Samples by age-category: 51-60**

Variable	Urban Sample	Pastoral Sample	p-Value
N	7	16	-
Energy (kcal)	1470.2±593.7	1864±817.1	NS
Water (ml)	1354.5±487.1	1623.4±722.1	NS
Protein (g)	55.2±33	95.4±53.5	NS
Fat (g)	46.5±21.8	67.5±41	NS
Carbohydrate (g)	234.3±109.7	330.5±167	NS
Cholesterol (mg)	186.7±86.3	200.5±128.5	NS
SAFA (g)	9±7.5	17.9±9.5	p<.040
PUFA (g)	5.6±3.7	11.8±10	NS
MUFA (g)	10.76±7.0	22.09±20.16	NS
EPA (g)	0.01±0.004	0.03±0.01	p<.014
DHA (g)	0.01±0.002	0.02±0.01	NS
Folic Acid (µg)	196.2±83.9	250.4±173.5	NS

Means compared using a T-test

The mean energy intake in this age category was Kcals was  $1470.2 \pm 593.7$  and  $1864 \pm 817.1$  in the Urban and Pastoral samples respectively. The difference between their means was not statistically significant. Mean water intake was  $1354.5 \pm 487.1$  ml and  $1623.4 \pm 722.1$  ml in the Urban and Pastoral samples respectively, the difference between their mean water intake in was not statistically significant, suggesting similar water intake in the two samples.

Mean protein, fat and carbohydrate intake were  $55.2 \pm 33$ g,  $46.5 \pm 21.8$ g and  $234.3 \pm 109.7$ g in the Urban sample and  $95.4 \pm 53.5$ g,  $67.5 \pm 41$ g, and  $330.5 \pm 167$ g for the Pastoral sample in this age-category. The Urban sample appeared to have a relatively lower intake of all three macro-nutrients than the Pastoral sample, however the difference between the means of each of these macronutrients were not statistically significant. The standard deviation around the means of each macronutrient in the Pastoral sample were large and appear to have diluted the apparent arithmetic difference.

Mean dietary cholesterol and folic acid intake were  $186.7 \pm 86.3$ mg and  $196.2 \pm 83.9$ µg in the Urban sample and  $200.5 \pm 128.5$ mg and  $250.4 \pm 173.5$ µg in the Pastoral sample. The difference between the means of dietary cholesterol and folic acid between these two samples was not significantly different. The difference between mean folic acid intake approached significance at  $p < .058$ . The mean dietary cholesterol and folic acid in Pastoral sample had very large standard deviations not only masking the difference between the means of the two samples, but may also be suggestive of a relatively low intake of the two, in a subset of this age-category in the Pastoral sample in this age-category.

Mean SAFA, PUFA, MUFA, EPA, DHA were  $9\pm 7.5\text{g}$ ,  $5.6\pm 3.7\text{g}$ ,  $10.76\pm 7.0\text{g}$ ,  $0.1\pm 0.004\text{mg}$  and  $0.1\pm 0.002\text{mg}$  in the Urban sample and  $17.9\pm 9.5\text{g}$ ,  $11.8\pm 10\text{g}$ ,  $22.09\pm 20.16\text{g}$ ,  $0.03\pm 0.01\text{mg}$  and  $0.02\pm 0.01\text{mg}$  in the Pastoral sample. The difference between the means of SAFA and EPA between this age-category in the two samples were statistically significant at  $p < .040$  and  $p < .014$  respectively, but there was no significant difference between the means of PUFA, MUFA and DHA fatty acids in these two groups in the 51-60 age-category. These findings indicate a higher intake of SAFA and EPA in the Pastoral sample, but a similar intake of PUFA and DHA in both samples in the period preceding the 24-hour dietary recall.

#### **4.5.2.1 Relationship Between Dietary Intake and Blood Pressure**

The relationship between dietary intake and Blood Pressure within the Urban and Pastoral Sample was analysed by age-category using the Pearson Correlation coefficient which found a significant and positive correlation between PUFA and SBP ( $r = .434$ ,  $p < 0.05$ ) and PUFA and DBP ( $r = .486$ ,  $p < 0.05$ ) in the Pastoral group's 30-40 age-category only. These results indicate a direct relationship between quantity of PUFA intake and blood pressure, this relationship was however absent in the same age-category in the Urban sample.

In the age-category 41-50 in the Pastoral sample, the Pearson Correlation coefficient found a significant and positive correlation between CHO and SBP ( $r = .609$ ,  $p < 0.01$ ), this was not observed in the Urban sample in this age-category. However, the 51-60 age-category in the Urban sample showed the following significant correlations: Water intake and SBP ( $r = .784$ ,  $p < 0.05$ ), SAFA and SBP ( $r = .757$ ,  $p < 0.05$ ), PUFA and SBP ( $r = .867$ ,  $p < 0.05$ ) and MUFA and SBP ( $r = .829$ ,

$p < 0.05$ ). These results indicate a direct relationship or association with systolic blood pressure in this age-category in the Urban sample. The Pastoral sample in the age 51-60 age-category on the other hand showed a significant but negative correlation between SAFA and DBP ( $r = -.505$ ,  $p < 0.05$ ) thus an increase in SAFA was associated with a decrease in diastolic blood pressure and vice-versa in contrast to the Urban sample in this age-category which showed a rise in blood pressure associated with increased SAFA consumption.

#### **4.5.2.2 Relationship Between Dietary Intake and CVD Risk Biomarkers**

The relationship between dietary intake and CVD Risk Biomarkers within the Urban and Pastoral Sample was analysed by age-category using the Pearson Correlation coefficient which found a significant and positive correlation between Folic acid intake and Co-Q10 ( $r = .336$ ,  $p < 0.01$ ) in the Urban sample only. The Pastoral sample had the following significant correlations: EPA and apo B ( $r = .481$ ,  $p < 0.01$ ), EPA and apoB/A-I ratio ( $r = .571$ ,  $p < 0.01$ ), DHA and apoB ( $r = .472$ ,  $p < 0.01$ ) and DHA and apoB/A ratio ( $r = .574$ ,  $p < 0.01$ ). These results indicate a direct relationship between intake of Folic acid and Co-Q10 levels in the Urban sample or CVD risk lowering effect, but an increased EPA and DHA intake in the Pastoral sample being associated with higher levels of apoB and apoB/A-I ratio thus an increased CVD risk.

The relationship between dietary intake and CVD risk biomarkers was analysed between the Urban and Pastoral sample by age-category and found a significant and positive correlation between Folic acid intake and Co-Q10 ( $r = .336$ ,  $p < 0.01$ ) in the 30-40 age-category of the Urban sample only, while folic acid was significantly and negatively correlated with apoA-I ( $r = -.348$ ,  $p < 0.05$ ) in the 30-40 age-category in the

Pastoral sample only. These results indicate a direct relationship between Folic acid and Co-Q10 in the Urban sample but an inverse relationship with apoA-I in the Pastoral sample.

In the 41-50 age-category in the Urban sample, the following significant correlations were seen: energy and Co-Q10 ( $r=-.533$ ,  $p<0.05$ ), Protein intake and Co-Q10 ( $r=-.509$ ,  $p<0.05$ ), dietary cholesterol and apoA-I ( $r=.516$ ,  $p<0.05$ ), dietary cholesterol and apoB/A ratio ( $r=-.564$ ,  $p<0.05$ ), DHA intake and apoA-I ( $r=.800$ ,  $p<0.01$ ), DHA intake and apoB/A-I ratio ( $r=-.632$ ,  $p<0.01$ ), Folic acid intake and apoB ( $r=-.513$ ,  $p<0.05$ ), Folic acid intake and apoB/A-I ratio ( $r=-.503$ ,  $p<0.05$ ) and Folic acid intake and Co-Q10 ( $r=.526$ ,  $p<0.05$ ). These results indicate a negative relationship between increasing energy and protein intake with Co-Q10, dietary cholesterol intake and apoB/A-I ratio, dietary DHA and apoB/A-I ratio and Folic acid intake and apoB while indicating positive relationships between dietary cholesterol intake and apoA-I, DHA and apoA-I and dietary Folic acid intake and Co-Q10 in this age-category of the Urban sample.

In the age-category 41-50 in the Pastoral sample, the Pearson Correlation coefficient found significant and positive correlations between: energy intake and apoB ( $r=.618$ ,  $p<0.05$ ), energy and apoB/A-I ratio ( $r=.561$ ,  $p<0.05$ ), EPA and apoB ( $r=.672$ ,  $p<0.01$ ), EPA and apoB/A-I ratio ( $r=.791$ ,  $p<0.01$ ), DHA and apoB ( $r=.685$ ,  $p<0.01$ ), DHA and apoB/A-I ratio ( $r=.800$ ,  $p<0.01$ ) in the Pastoral sample only, however SAFA and Co-Q10 were significantly but negatively correlated at ( $r=-.530$ ,  $p<0.05$ ). These results indicated increasing CVD risks with increased intake

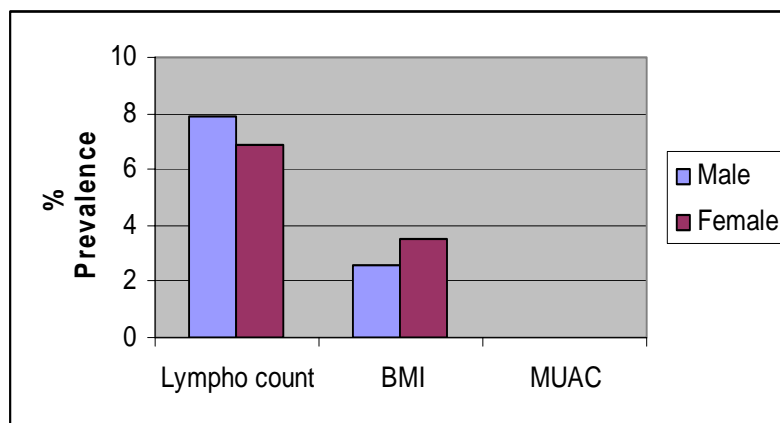
of total energy, EPA and DHA but an inverse relationship between SAFA and CO-Q10 in the Pastoral sample in the 41-50 age-category only.

The 51-60 age category in the both the Urban and Pastoral samples did not show any significant relationships between dietary intake and CVD risk biomarkers.

#### 4.5.3 Nutrition Status

##### 4.5.3.1 Malnutrition Prevalence

Malnutrition affects functional capacity and negatively affects protective CVD bio-risk markers (Barendregt, Soeters, Allison & Kondrup, 2004). Prevalence of Malnutrition or chronic malnutrition in the two samples was therefore assessed using three different methods; Lymphocyte Count (LC)  $<1500$  cells/mm<sup>3</sup>, Body Mass Index (BMI)  $< 18\text{kg/m}^2$  and Mid-upper arm circumference (MUAC)  $<21\text{cm}$ . The results were then analyzed within and between the two samples and are presented in Tables 4.28 and Figures 4.5-4.9

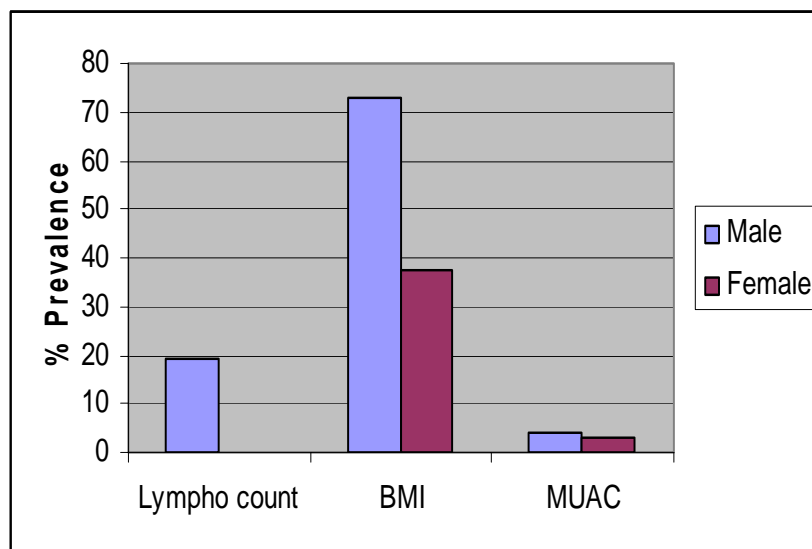


**Fig 4.5 Prevalence of Malnutrition in the Urban Male and Female Sample**

Prevalence of Malnutrition in the Urban sample using a lymphocyte count of  $< 1500$  cells/mm<sup>3</sup> was 7.9% and 6.9% in the Urban males and females respectively. Urban males had a higher prevalence of malnutrition than the Urban females, using lymphocyte count as an assessment tool. Chi-square results to test for difference in proportions using lymphocytes in the three categories: normal, moderate and severe malnutrition was not significant.

A BMI cut-off of 18kg/m<sup>2</sup> to determine malnutrition prevalence, showed 2.6% and 3.5% in the Urban males and females respectively, indicating a higher prevalence of malnutrition in the Urban females in contrast to the results of the lymphocyte count.

Prevalence of malnutrition using mid-upper arm circumference (MUAC) yielded 0% in both the Urban males and females. This was in contrast to the results yielded by both the lymphocyte count and BMI.

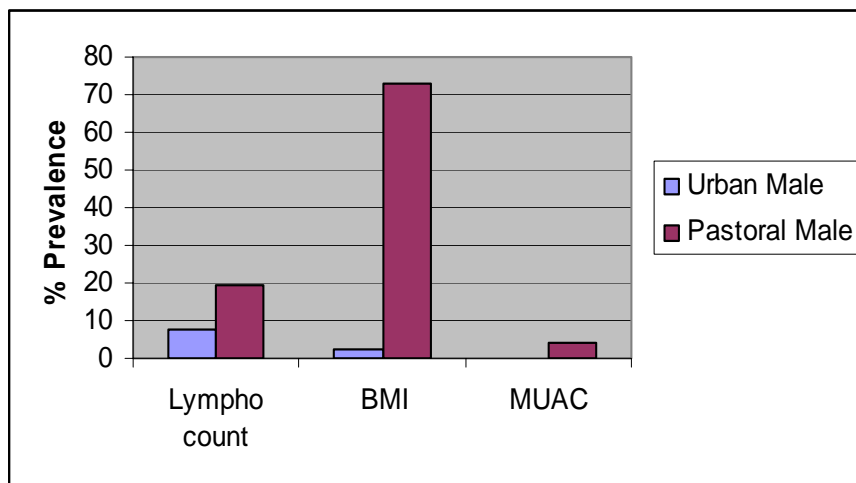


**Fig 4.6 Prevalence of Malnutrition in the Pastoral Male and Female Sample**

Prevalence of Malnutrition in the Pastoral sample using a lymphocyte count of  $< 1500 \text{ cells/mm}^3$  as a nutrition assessment tool was 19.2% and 0% in the Pastoral males and females respectively. Pastoral males had a higher prevalence of malnutrition than the Pastoral females.

Use of a BMI cut-off of  $18\text{kg/m}^2$ , to determine malnutrition prevalence showed 73.1% and 37.5% in the Pastoral males and females respectively, indicating that Pastoral males had a higher prevalence of malnutrition than the Pastoral females, as was the case with the use of lymphocyte count.

Prevalence of malnutrition using mid-upper arm circumference (MUAC) yielded 3.9% and 7.5% respectively in the Pastoral males and females. This was in contrast to the results yielded by both the lymphocyte count and BMI, in that it showed a lower prevalence of malnutrition in the Pastoral males and females overall.



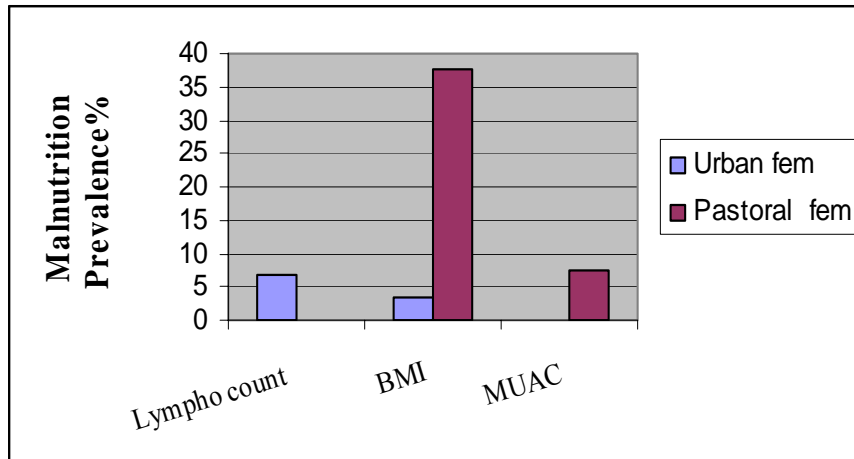
**Fig 4.7 Prevalence of Malnutrition in the Urban and Pastoral Male Samples**



The overall prevalence of malnutrition in the Male sample, determined by a lymphocyte count of  $< 1500 \text{ cells/mm}^3$ , was 12.5%, but was 7.9% and 19.2% among the Urban and Pastoral male sample respectively. This was an indication of a higher prevalence of malnutrition among Pastoral males than among Urban males, using lymphocyte count as a nutrition assessment tool. Chi square to test for difference in the proportions in the nutrition status categories between the Urban and Pastoral male genders samples was not significantly different.

The overall prevalence of malnutrition as determined by use of a BMI cut-off of  $18\text{kg/m}^2$  was 31.3%, however in the Urban male sample, prevalence was 2.6% but 73.1% in the Pastoral male samples. The Pastoral male sample had a much higher prevalence of malnutrition than the Urban male sample using BMI as a nutrition assessment tool, as was the case with lymphocyte count.

Overall prevalence of malnutrition in the two male samples using MUAC was 1.6%, but 0% and 3.9% in the Urban and Pastoral male samples respectively. This result suggested the Urban sample were better nourished than the Pastoral one as the former did not appear to have any incidence of malnutrition when using MUAC, while that in the Pastoral male sample was low.

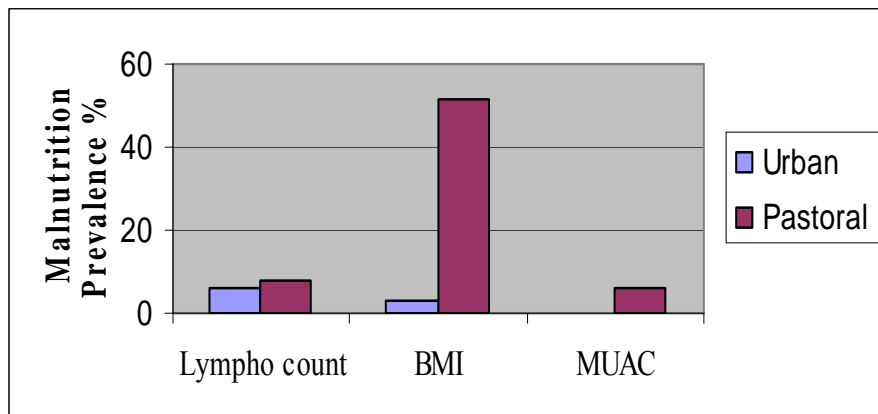


**Fig 4.8 Prevalence of Malnutrition in the Urban and Pastoral Female Samples**

The overall prevalence of malnutrition in the Female sample, determined by a lymphocyte count of  $< 1500 \text{ cells/mm}^3$ , was 10.5% but was 6.9% and 0% among the Urban and Pastoral female samples respectively. These results indicated a higher prevalence of malnutrition among Urban females than among Pastoral females. This was a little surprising as the Urban sample would generally be thought to have a lower prevalence of malnutrition than a Pastoral sample. Chi square to test for difference in the proportions in the nutrition status categories between the Urban and Pastoral female gender sample's was not significantly different.

The overall prevalence of malnutrition as determined by use of a BMI cut-off of  $18 \text{kg/m}^2$  was 24.2%, however in the Urban female sample, prevalence was 3.5% but 37.5% in the Pastoral female sample. The Pastoral female sample had a higher prevalence of malnutrition than the Urban female sample when using the BMI as a nutrition assessment tool.

Overall prevalence of malnutrition in the two female samples using MUAC, as a nutrition assessment tool, was 4.6%, but 0% and 7.5% in the Urban and Pastoral female samples respectively. The Urban female sample did not have any incidence of malnutrition when assessed by MUAC unlike the Pastoral female sample. These results mirror those of the Urban and Pastoral male sample.



**Fig 4.9 Differences in Malnutrition Prevalence Between the Urban and Pastoral Samples**

The overall prevalence of malnutrition in the two samples, determined by a lymphocyte count of  $< 1500 \text{ cells/mm}^3$ , was 6.8% but was 6% and 7.6% among the Urban and Pastoral samples respectively. These results indicated a higher prevalence of malnutrition among the Pastoral sample.

The overall prevalence of malnutrition as determined by use of a BMI cut-off of  $18 \text{ kg/m}^2$  was 27.7%. However, in the Urban sample, prevalence was 3% but 51.5% in the Pastoral sample. The Pastoral sample had a prevalence rate that was 17 times higher than that of the Urban sample, it is important to note that the Pastoral sample's Median MET values were 2.8 times greater than those of the Urban sample. These results therefore suggest that though clinically the Pastoral sample had a

higher prevalence of malnutrition, they were functionally superior to the Urban sample as they accumulated more minutes per week of physical activity. Thus it would appear to suggest that the BMI cut-off in this sample exaggerated the malnutrition prevalence and calls for determination of a valid BMI cut-off for determining malnutrition in this sample.

Overall prevalence of malnutrition in the two samples using MUAC was 3%, but 0% and 4% in the Urban and Pastoral samples respectively. The Urban sample did not have any incidence of malnutrition when assessed by MUAC unlike the Pastoral sample. Despite this, the prevalence of malnutrition in the Pastoral sample was low enough to validate this sample's high Median MET values, a reflection of functional capacity that would otherwise be compromised by malnutrition, as malnutrition is associated with reduced muscle function and higher mortality (ESPEN, 2006), which was not the case in this sample.

**Table 4.28 Prevalence of Malnutrition in the Urban and Pastoral Samples by Age-categories**

Age Cat	Group	% Lymphocyte	%BMI	% MUAC
30-40	Urban	4.8 (n=2)	2.4 (n=1)	0 (n=0)
	Pastoral	6.1 (n=2)	48.5(n=16)	6.1(n=2)
41-50	Urban	10.3 (n=2)	5.6 (n=1)	0 (n=0)
	Pastoral	17.7 (n=3)	47.1(n=8)	5.9 (n=1)
51-60	Urban	0 (n=0)	0 (n=0)	0 (n=0)
	Pastoral	18.8 (n=3)	62.5 (n=10)	6.3 (n=1)

Analysis of prevalence of malnutrition or chronic hunger using three methods; lymphocyte count, BMI and MUAC, among the Urban and Pastoral sample by the age-categories 30-40, 41-50 and 51-60 showed the Urban sample having a lower prevalence of malnutrition than the Pastoral sample in all three age-categories. The findings in Table 4.29 indicate that the age-category 41-50 (10.3%) among the Urban sample had the highest overall prevalence of malnutrition as measured by the lymphocyte count, followed by the age-category 30-40 (4.8%) and lastly the age-category 51-60 (0%). The Prevalence of malnutrition in this sample did not follow a linear pattern when examined by age-category.

Among the Pastoral sample, the age category 51-60 had the highest prevalence of malnutrition as measured by a lymphocyte count (18.8%), followed by the age-category 41-50 (17.7%) and lastly age-category 30-40 (6.1%). The prevalence in malnutrition followed a linear path and therefore increased with age, in this group.

The highest prevalence of malnutrition as measured by a BMI cut-off of  $18\text{kg/m}^2$  in the Urban sample was the age-category 41-50 (5.6%), followed by the age-category 30-40 (2.4%) and lastly the age-category 51-60 (0%). Malnutrition prevalence using a BMI cut-off of  $18\text{kg/m}^2$  in the Pastoral group was highest in the age-category 51-60 (62.5%), followed by age-category 30-40 at (48.5%) and lastly the age-category 41-50 at (47.1%) in contrast to the Urban group. Neither of the two group had a linear relationship between age and malnutrition as measured by BMI

The prevalence of malnutrition as measured by MUAC in the Urban sample in all age-categories was zero, but in the Pastoral sample, the highest prevalence of

malnutrition was in the age-category 51-60 (6.3%), followed by the age-category 30-40 (6.1%) and lastly the age-category 41-50 (5.9%). The malnutrition prevalence results as measured by MUAC in the Pastoral sample did not follow a linear path when analysed by age-category.

The Pastoral sample in the age-category 30-40 had malnutrition prevalence rates that were 1.3, 20.2 and 6.1 times greater than those of the Urban sample when using lymphocyte count, BMI and MUAC respectively. However, its Median MET/mins per week values were 2.6 times greater than those of the Urban sample, while the Pastoral sample's age-category 41-50 had malnutrition prevalence rates that were 1.7, 8.4 and 5.9 times greater than those of the Urban sample when using lymphocyte count, BMI and MUAC but its Median MET/mins per week values were 3.1 times greater than those of the Urban sample. Similarly, the Pastoral sample's age-category 51-60 had malnutrition prevalence rates that were 18.8, 62.5 and 6.3 times greater than those of the Urban sample when using lymphocyte count, BMI and MUAC respectively but its Median MET/mins per week values were 2.8 times greater than those of the Urban sample.

The results on prevalence of malnutrition in these two samples using LC, BMI and MUAC in Urban and Pastoral groups were varied, with BMI indicating the highest prevalence of malnutrition, followed by lymphocyte count and MUAC indicating the lowest prevalence in all three age-categories. The high and statistically significant difference in Median MET/mins per week values in the Pastoral sample would suggest superior muscle function and negate the high malnutrition prevalence indicated by the BMI cut-off and perhaps that of the lymphocyte count or indicate

that the malnutrition cut-offs of these two measures may not be appropriate in this sample and perhaps calls for validation of these clinical tools in Africans.

#### 4.5.3.2 Differences in Nutrition Status Within and Between the Urban and Pastoral Sample

Differences in Nutrition Status Within and Between The Urban and Pastoral samples were analysed and presented in Tables 4.29 – 4.36 below.

**Table 4.29 Differences in Nutrition Status Within the Urban Sample**

Variable	Male	Female	p-Value
N	38	29	-
Lymphocytes	2168.8±617	2557.6±715.7	p<.020
BMI	25.9±3.7	26.3±4.6	NS
MUAC	31.3±2.7	30.4± 4	NS

Means compared using a T-test

Difference in nutrition status between the Urban sample was determined by assessing, lymphocyte count, body mass index (BMI) and mid-upper arm circumference (MUAC). The means were 2168.8±617, 25.9±3.7, 31.3±2.7 and 2557.6±715.7, 26.3±4.6, 30.4± 4 for the Urban male and females respectively. The difference between their means were statistically significant for lymphocytes only, at p<.020, but not for BMI and MUAC within the Urban sample.

Mean lymphocyte count, as a nutrition assessment tool, in both the Urban male and female sample were above a lymphocyte count 900-1500 cells/mm<sup>3</sup> the cut off for

moderate malnutrition or  $<900/\text{mm}^3$  the cut off for severe malnutrition (Barendregt et al., 2004.) The mean lymphocyte count in the Urban male and female sample suggested a normal nutrition status in this sample when using this tool.

Mean BMI, as a nutrition assessment tool, in the Urban male and female sample were within the BMI reference range for overweight ( $25\text{-}29.9\text{kg}/\text{m}^2$ ). This is reflective of the global epidemiological transition taking place particularly in urban settings (Yusuf et al., 2001). The mean BMI would suggest hypercaloric dietary habits in the Urban sample accompanied by low physical activity hence their overweight status. Malnutrition in this sample was therefore more likely to be as a result of over-nutrition/excess energy intake rather than under-nutrition, when examined using BMI.

Mid upper arm circumference (MUAC) means in the Urban male and female sample were above the 21cm cut-off used in detection of malnutrition by the Mini Nutritional Assessment tool by Nestle (1994). Malnutrition (under-nutrition) using the MUAC measure was not detected within the Urban male and female sample.

**Table 4.30 Differences in Nutrition Status within the Pastoral sample**

Variable	Male	Female	p-Value
N	26	40	-
Lymphocytes	1882±441.8	2260.2±412.8	p< .001
BMI	17.5±4.3	20.1±4.6	p <.029
MUAC	25.1±3.5	26.7±4.9	NS

Means compared using a T-test



Mean differences between lymphocyte count, body mass index (BMI) and mid-upper arm circumference (MUAC) within the Pastoral sample were used to determine its nutrition status (malnutrition). The means were  $1882 \pm 441.8 \text{mm}^3$ ,  $17.5 \pm 4.318 \text{kg/m}^2$ ,  $25.1 \pm 3.5 \text{cm}$  and  $2260.2 \pm 412.8 \text{mm}^3$ ,  $20.1 \pm 4.6 \text{kg/m}^2$ ,  $26.7 \pm 4.9 \text{cm}$  for the Pastoral Male and Females respectively. Difference between their means were statistically significant for lymphocytes and BMI at  $p < .001$  and  $p < .029$ , respectively, but not for MUAC within the Pastoral sample.

Mean lymphocyte count in both the Pastoral male and female sample were well above cut off for severe and moderate malnutrition (Barendregt et al., 2004.) The mean lymphocyte count in the Urban male and female sample suggested a normal nutrition status in this sample.

Mean BMI in the Pastoral male sample was within the  $< 18 \text{kg/m}^2$  cut-off for under-nutrition, while the mean BMI in the Pastoral female sample was just within the  $20-24.9 \text{kg/m}^2$  cut-off for a normal BMI (normal/healthy weight). The mean BMI of the Pastoral male sample would suggest that they were under-nourished going by the BMI cut-off for malnutrition, however in view of their mean lymphocyte count, this results must be interpreted in light of their functional capacity and clinical symptoms which they did not exhibit.

Mid upper arm circumference (MUAC) means in both the Pastoral male and female sample were above the 21cm cut-off used in detection of malnutrition by the Mini Nutritional Assessment tool by Nestle (1994), suggesting a normal nutrition status in this Pastoral sample.

**Table 4.31 Differences in Nutrition Status Between the Urban and Pastoral Male Samples**

Variable	Urban Male	Pastoral Male	p-Value
N	38	26	
Lymphocytes	2168.8±617	1882±441.8	p<.046
BMI	25.9±3.7	17.5±4.3	p<.001
MUAC	31.3±2.7	25.1±3.5	p<.001

Means compared using a T-test

Mean differences between lymphocyte count, body mass index (BMI) and mid-upper arm circumference (MUAC) within the Urban and Pastoral male samples were used to determine their nutrition status (under/over nutrition). The means were 2168.8±617mm<sup>3</sup>, 25.9±3.7kg/m<sup>2</sup>, 31.3±2.7cm and 1882±441.8mm<sup>3</sup>, 17.5±4.3kg/m<sup>2</sup>, 25.1±3.5cm for the Urban and Pastoral Male samples respectively. The difference between their means were statistically significant for lymphocyte count, BMI and MUAC at p<.046, p<.001 and p<.001 respectively.

Mean lymphocyte count in both the Urban and Pastoral male samples were well above the cut off for severe and moderate malnutrition (Barendregt et al., 2004.) The mean lymphocyte count in the Urban and Pastoral male samples suggested normal nutrition status in both of these samples.

Mean BMI in the Urban male sample was within the 25-29.9kg/m<sup>2</sup> cut-off for overweight while the mean BMI for the Pastoral male sample was below the <18kg/m<sup>2</sup> cut-off for under-nutrition. The Urban male sample's BMI indicated

malnutrition by over-nutrition, while the Pastoral male sample's BMI suggested malnutrition by under-nutrition at face value. However, consideration of their lymphocyte count, MUAC and median MET mins/wk values appear to negate this, precluding the possibility of malnutrition in the male Pastoral sample.

Mid upper arm circumference (MUAC) means in both the Urban and Pastoral male samples were above the 21cm cut-off used in detection of malnutrition by the Mini Nutritional Assessment tool by Nestle (1994). This suggested a normal nutrition status within both the Urban and Pastoral male samples.

**Table 4.32 Differences in Nutrition Status Between the Urban and Pastoral Female Samples**

Variable	Urban Female	Pastoral Female	p-Value
N	29	40	
Lymphocytes	2557.6±715.7	2260.2±412.8	p<.033
BMI	26.3±4.6	20.1±4.6	p<.001
MUAC	30.4± 4	26.7±4.9	p<.001

Means compared using a T-test

Mean differences between lymphocyte count, body mass index (BMI) and mid-upper arm circumference (MUAC) between the Urban and Pastoral female samples were used to determine their nutrition status (malnourishment). The means were 2557.6±715.7mm<sup>3</sup>, 26.3±4.6kg/m<sup>2</sup>, 30.4±4cm and 2260.2±412.8mm<sup>3</sup>, 20.1±4.6kg/m<sup>2</sup>, 26.7±4.9cm for the Urban and Pastoral female samples respectively.

Differences between their means were significant for lymphocytes, BMI and MUAC at  $p < .033$ ,  $p < .001$  and  $p < .001$  respectively.

Mean lymphocyte count in both the Urban and Pastoral female sample were well above the cut off for severe or moderate malnutrition (Barendregt et al., 2004), suggesting a normal nutrition status in either of the two female samples.

Mean BMI in the Urban female sample was within the BMI cut-off for overweight ( $25-29.9 \text{ kg/m}^2$ ) indicating this sample was overweight, not undernourished and possibly over-nourished hence their BMI status. The mean BMI in the Pastoral female sample was within the BMI cut-off for normal weight ( $20-24.9 \text{ kg/m}^2$ ), indicating they were neither under-nourished nor over-nourished assuming standard BMI cut-offs are valid in the African sample.

Mean mid-upper arm circumference (MUAC) in both the Urban and Pastoral female samples were above the 21cm cut-off used in detection of malnutrition by the Mini Nutritional Assessment tool by Nestle (1994), suggesting a normal nutrition status in either of the two female samples.

**Table 4.33 Differences in Nutrition Status Between The Urban and Pastoral Samples**

Variable	Total	Urban	Pastoral	p-Value
N		67	66	
Lymphocytes		2337.1±684.4	2111.2±460.4	p<.027
BMI		26±4.1	19.1±4.6	p<.001
MUAC		30.9±3.3	26±4.5	p<.001

Means compared using a T-test

Mean differences between lymphocyte count, body mass index (BMI) and mid-upper arm circumference (MUAC) between the Urban and Pastoral samples were used to determine their nutrition status (malnourishment). The means were 2337.1±684.4mm<sup>3</sup>, 26±4.1kg/m<sup>2</sup>, 30.9±3.3cm and 2111.2±460.4mm<sup>3</sup>, 19.1±4.6kg/m<sup>2</sup>, 26±4.5cm for the Urban and Pastoral samples respectively. Differences between their means were statistically significant for lymphocyte count, BMI and MUAC at p<.027, p<.001 and p<.001 respectively.

Mean LC in both the Urban and Pastoral sample were above the cut off for severe or moderate malnutrition (Barendregt et al., 2004.) Thus malnutrition (under-nutrition), using LC, was not detected in either of these two samples.

Mean BMI in the Urban sample was within the BMI cut-off for overweight (25-29.9kg/m<sup>2</sup>) indicating this sample was overweight, not undernourished and possibly over-nourished hence their overweight BMI status. The mean BMI in the Pastoral sample was above the >18kg/m<sup>2</sup> for malnutrition but below the 20kg/m<sup>2</sup> BMI cut-off

for possible malnutrition. However, its normal mean LC and mean MUAC appear to exclude the conclusion that the Pastoral sample was by and large malnourished (undernourished).

Mean MUAC in both the Urban and Pastoral sample were above the 21cm cut-off for malnutrition when using the Mini Nutritional Assessment tool by Nestle (1994), suggesting a normal nutrition status in either of the two samples.

**Table 4.34 Differences in Nutrition Status between Urban and Pastoral Samples by Age-Category: 30-40**

Variable	Urban	Pastoral	p –Value
N	42	33	-
Lymphocytes	2307.6±557.9	2031.1±392.3	p <.020
BMI	25.1±3.5	20.1±5.5	p <.001
MUAC	30±2.9	26.8±5	p<.001

Means compared using a T-test

Mean differences between LC, BM and MUAC between the Urban and Pastoral samples in the age-category 30-40 were used to determine their nutrition status (malnourishment). The means were 2307.6±557.9mm<sup>3</sup>, 25.1±3.5kg/m<sup>2</sup>, 30±2.9cm and 2031.1±392.3mm<sup>3</sup>, 20.1±5.5kg/m<sup>2</sup>, 26.8±5cm for the Urban and Pastoral sample's in the 30-40 age-category respectively. Differences between their means were statistically significant for lymphocyte count, BMI and MUAC at p<.020, p<.001 and p<.001 respectively.

Mean lymphocyte count in both the Urban and Pastoral sample in the 30-40 age-category were above the cut off for severe or moderate malnutrition (Barendregt et al., 2004.) Thus malnutrition (under-nutrition), using the lymphocyte count, was not detected in either of these two samples in the 30-40 age-category.

Mean BMI in the Urban sample in the 30-40 age-category was within the BMI cut-off for overweight ( $25-29.9\text{kg/m}^2$ ) indicating this sample was overweight, not undernourished and possibly over-nourished hence their overweight BMI status. The mean BMI in the Pastoral sample was above both the  $18\text{kg/m}^2$  BMI cut-off for malnutrition and just above the  $20\text{kg/m}^2$  BMI cut-off for possible malnutrition.

Mean MUAC in both the Urban and Pastoral sample in the 30-40 age-category were above the 21cm cut-off for malnutrition when using the Mini Nutritional Assessment tool by Nestle, 1994, indicating an apparently normal nutrition status in either of these samples in the 30-40 age-category.

**Table 4.35 Differences in Nutrition Status Between Urban and Pastoral Samples by Age-Category: 41-50**

Variable	Urban	Pastoral	p-Value
N	7	16	-
Lymphocytes	2172.9±7817	2224.9±476.2	NS
BMI	27.9±5.1	18.4±3.3	p<.001
MUAC	32.4±3.7	25.6±3.8	p<.001

Means compared using a T-test

Mean differences between LC, BMI and MUAC between the Urban and Pastoral samples in the age-category 41-50 were used to determine their nutrition status (malnourishment). The means were  $2172.9 \pm 7817 \text{mm}^3$ ,  $27.9 \pm 5.1 \text{kg/m}^2$ ,  $32.4 \pm 3.7 \text{cm}$  and  $2224.9 \pm 476.2 \text{mm}^3$ ,  $18.4 \pm 3.3 \text{kg/m}^2$ ,  $25.6 \pm 3.8 \text{cm}$  for the Urban and Pastoral sample's in the 41-50 age-category respectively. Differences between their means were significant for lymphocyte count, BMI and MUAC at  $p < .020$ ,  $p < .001$  and  $p < .001$  respectively.

Mean lymphocyte count in both the Urban and Pastoral sample in the 41-50 age-category were above the cut off for severe or moderate malnutrition (Barendregt et al., 2004), indicating an apparently normal nutrition status in either of these samples, in this age-category.

Mean BMI in the Urban sample in the 41-50 age-category was within the BMI cut-off for overweight ( $25-29.9 \text{kg/m}^2$ ) indicating this sample was overweight, not undernourished and more likely over-nourished hence their BMI status. The mean BMI in the Pastoral sample was just above the  $< 18 \text{kg/m}^2$  BMI cut-off for malnutrition, but below the  $20 \text{kg/m}^2$  BMI cut-off for possible malnutrition.

Mean mid-upper arm circumference (MUAC) in both the Urban and Pastoral sample in the 41-50 age-category were above the 21cm cut-off for malnutrition when using the Mini Nutritional Assessment tool by Nestle (1994). Each of these two samples therefore had an apparently normal nutrition status.



**Table 4.36 Differences in Nutrition Status Between Urban and Pastoral Samples by Age-Category: 51-60**

Variable	Urban	Pastoral	p-Value
N	7	16	-
Lymphocytes	2960.3±867	2155.7±563.6	p<.014
BMI	27±3.2	17.7±3.4	p<.001
MUAC	32.3±3	24.9±3.9	p<.001

Means compared using a T-test

Mean differences between LC, BMI and MUAC between the Urban and Pastoral samples in the age-category 41-50 were used to determine their nutrition status (malnourishment). The means were 2960.3±867mm<sup>3</sup>, 27±3.2kg/m<sup>2</sup>, 32.3±3cm and 2155.7±563.6mm<sup>3</sup>, 17.7±3.4kg/m<sup>2</sup>, 24.9±3.9cm for the Urban and Pastoral sample's in the 51-60 age-category respectively. Differences between their means were significant for lymphocyte count, BMI and MUAC at p<.014, p<.001 and p<.001 respectively.

Mean LC in both the Urban and Pastoral sample in the 51-60 age-category were above the 900-1500 cells/mm<sup>3</sup> cut off for moderate malnutrition or <900/mm<sup>3</sup> cut off for severe malnutrition (Barendregt et al., 2004.) Thus the nutrition status of either of these two groups using the lymphocyte count, was apparently normal.

Mean BMI in the Urban sample in the 51-60 age-category was within the BMI cut-off for overweight (25-29.9kg/m<sup>2</sup>) indicating this sample was overweight and more likely over-nourished hence their BMI status. The mean BMI in the Pastoral sample

was just below the  $<18\text{kg/m}^2$  BMI cut-off for malnutrition. The BMI data on the Pastoral sample in this age-category appears to have established clinical malnutrition in this sample, however its mean lymphocyte count and mean MUAC were within the normal reference range.

Interpretation of the BMI results in the Pastoral sample in this age-category therefore must take into account the fact that only one of the three clinical assessment tools for malnutrition assessment used, suggested malnutrition in this Pastoral group. However, its mean MUAC values were above the cut-off for malnutrition suggesting presence of good upper body muscle mass. Secondly, this Pastoral sample was physically more active than the over-nourished Urban sample in the same age-category when its Median MET mins/wk values are considered, to add a global perspective. It may therefore be safe to conclude that this sample was lean, had adequate muscle mass sufficient to undertake the levels of physical activity recorded and was apparently not undernourished as established by its normal MUAC and LC.

Mean MUAC in both the Urban and Pastoral sample in the 51-60 age-category were above the 21cm cut-off for malnutrition when using the Mini Nutritional Assessment tool by Nestle (1994). These results therefore suggest a normal nutrition status in either of the two groups in this age-category.

#### **4.5.3.3 Relationship Between Nutrition Status and Blood Pressure in the Urban and Pastoral Samples**

The relationship between nutrition status and Blood Pressure within the Urban and Pastoral sample was analysed using the Pearson Correlation coefficient which

found low but significant and positive correlation between, BMI and SBP ( $r=.273$ ,  $p<0.05$ ), BMI and DBP ( $r=.283$ ,  $p<0.05$ ), MUAC and SBP ( $r=.355$ ,  $p<0.01$ ) and MUAC and DBP ( $r=.347$ ,  $p<0.01$ ) in the Urban sample. These results indicate a direct relationship between over-nutrition and increasing blood pressure in the Urban sample. While in the Pastoral sample, only MUAC and DBP ( $r=.299$ ,  $p<0.05$ ) showed a low but significant and positive correlation, indicating that increasing MUAC levels, a surrogate indicator of nutrition status, were associated with increased diastolic blood pressure in this sample.

The relationship between nutrition status and Blood Pressure within the Urban and Pastoral Sample was analysed by age-category using the Pearson Correlation coefficient which found low but significant and positive correlations in the 30-40 age-category between BMI and SBP ( $r=.333$ ,  $p<0.05$ ), BMI and DBP ( $r=.312$ ,  $p<0.05$ ) and a moderate but significant and positive correlation between MUAC and SBP ( $r=.406$ ,  $p<0.05$ ) in the Pastoral sample only. This could be an indication that increasing blood pressure levels in the Urban sample in the 30-40 age-category is associated with factors other than weight status and calls for further research.

In the 41-50 age-category, the Pearson Correlation coefficient found moderate but significant and positive correlations between BMI and SBP ( $r=.500$ ,  $p<0.05$ ), MUAC and SBP ( $r=.559$ ,  $p<0.05$ ) and MUAC and DBP ( $r=.529$ ,  $p<0.05$ ) in the Urban sample, while the Pastoral sample in this age-category did not show any significant correlations between its nutrition status and blood pressure. This was also the case in both sample's in their age-category 51-60. Thus while overweight status in the Urban

sample was more likely to be related to increasing blood pressure levels, increasing blood pressure in the Pastoral sample could not be accounted for by the same.

#### **4.5.3.4 Relationship Between Nutrition Status and CVD Risk Biomarkers in the Urban and Pastoral Samples**

The relationship between nutrition status and CVD risk biomarkers between the Urban and Pastoral Sample was analysed using the Pearson Correlation coefficient which found a low but significant and positive correlation between, LC and apoA-I ( $r=.335$ ,  $p<0.05$ ), LC and Co-Q10 ( $r=.302$ ,  $p<0.05$ ), BMI and apoB ( $r=.272$ ,  $p<0.05$ ) in the Urban sample. These results indicate a direct relationship between over-nutrition and rising CVD risk biomarkers in the Urban sample.

In the Pastoral sample LC and apoA-I ( $r=-.248$ ,  $p<0.05$ ), BMI and apoA-I ( $r=-.364$ ,  $p<0.01$ ), ( $r=-.385$ ,  $p<0.01$ ), BMI and apoB/A-I ratio ( $r=-.385$ ,  $p<0.01$ ) and MUAC and apoA-I ( $r=-.324$ ,  $p<0.01$ ) showed negative but low correlations, while LC and apoB/A-I ratio ( $r=.309$ ,  $p<0.05$ ), BMI and apoB ( $r=.255$ ,  $p<0.05$ ) and MUAC and apoB ( $r=.322$ ,  $p<.001$ ) showed positive but low correlations, while MUAC and apoB/A-I ratio ( $r=.407$ ,  $p<0.01$ ) showed a positive but moderate correlation. These results indicated both inverse and direct relationships between increasing nutrition status markers and CVD risk biomarkers in the Pastoral sample.

The relationship between nutrition status and CVD risk biomarkers within the Urban and Pastoral sample was analysed by age-category using the Pearson Correlation coefficient which found a significant and positive correlation but with a low relationship in 30-40 age-category between BMI and apoA-I ( $r=-.377$ ,  $p<0.05$ ). In

this same age-category, BMI and apoB ( $r=.371$ ,  $p<0.05$ ), BMI and apoB/A-I ratio ( $r=.547$ ,  $p<0.01$ ), MUAC and apoB ( $r=.444$ ,  $p<0.01$ ), MUAC and apoB/A-I ratio ( $r=.529$ ,  $p<0.01$ ) in the Urban sample, had positive and significant correlations that had a low to medium relationship. These results suggested a linear association between increasing nutrition status markers, suggestive of over-nutrition and increasing CVD risk biomarkers and an inverse relationship between increasing BMI and decreasing apoA-I levels in the Urban sample, suggestive of increasing CVD risk.

While in the Pastoral sample, the Pearson correlation coefficient showed a low but significant and negative correlation between LC and apoA-I ( $r=-.312$ ,  $p<0.05$ ). LC and Co-Q10 ( $r=.388$ ,  $p<0.05$ ), BMI and apoB/A-I ratio ( $r=.395$ ,  $p<0.05$ ) in the same Pastoral sample showed low but significant and positive correlations. These results suggest improved nutrition status on one hand as being associated with positive CVD risk biomarker levels but on the other, an increase in nutrition status markers, representing over-nutrition, being associated with an increase in the level of CVD risk biomarkers.

In the 41-50 age-category only the Pastoral sample showed moderate but significant and positive correlations between BMI and apoB ( $r=.586$ ,  $p<0.05$ ), MUAC and Co-Q10 ( $r=.501$ ,  $p<0.05$ ) indicating BMI was associated with higher apoB levels but increasing MUAC was associated with an increase in Co-Q10 in the Pastoral sample and therefore perhaps beneficial because of Co-Q10's role as an antioxidant and mitochondrial electron transporter therefore lowering CVD risk.

In the 51-60 age-category, moderate but significant and positive correlations between BMI and apoB/A ratio ( $r=.552$ ,  $p<0.05$ ) in the Urban sample, while the Pastoral sample showed a high, significant and positive correlation between MUAC and apoB ( $r=.762$ ,  $p<0.05$ ). These results indicate that increasing BMI in the Urban sample was associated with an increase in apoB/A-I ratio meaning an increase CVD risk while in the Pastoral sample in this age-category, increasing MUAC levels were inversely associated with the atherogenic apoB levels.

#### **4.5.4 Body Composition and Anthropometric Measurements**

Differences in Body Composition and Anthropometric Measures within and between the Urban and Pastoral Samples are presented in below in Tables 4.37-4.44

**Table 4.37 Differences in Body Composition and Anthropometric Measures  
Within the Urban Sample**

Variable	Male	Female	p-Value
N	38	29	-
% BF	24.9± 8.1	35.3±8.7	p<.001
Waist Circumference	94.6±10.1	87.6±11	p<.008
Hip Circumference	102.83±7.4	107.13±9.3	p<.039
WHR	0.92±0.07	0.82±0.07	p<.001

Means compared using a T-test

The means within the Urban sample were 24.9±8.1%, 94.6±10.1cm, 102.83±7.4 and 0.92±0.07 for the Urban males and 35.3±8.7%, 87.6±11cm, 107.13±9.3 and 0.82±0.07 for %BF, WC, HC and WHR in the Urban females respectively. The difference between their means was significant for %BF at p<.001, WC at p<.001, HC at p <.039 and WHR at <.001 respectively. The Urban males had a lower mean %BF and hip circumference, but higher mean waist circumference and WHR than the Urban females.

Mean % BF, a measure of percentage body fat, were above 24.9% and 30% in the Urban male and female sample respectively. These means indicated that the Urban sample was mainly overweight in the males, while the females were mainly obese. Although males have lower essential body fat requirements than females, the mean

male and female % BF in this sample was above what is healthy and therefore a risk factor for cardiovascular diseases.

Mean WC in the Urban male was  $94.6 \pm 10.1$  cm and 0.6 cm above the IDF cut-off for abdominal obesity in African and European males, indicating borderline abdominal obesity/adiposity. While mean WC in the Urban female was  $87.6 \pm 11$  cm and above the 79 cm cut-off for abdominal obesity in African and European females. Mean WC in the Urban male and female samples support the % BF findings in this sample and suggested that this sample was at least overweight.

Mean WHR in the Urban males was higher than that of the Urban females, mean WHR in both the Urban males and females were  $<1$  and  $<.85$  in the males and females respectively and were within the threshold for android obesity thus positively modifying their CVD risk profiles.

**Table 4.38 Differences in Body Composition and Anthropometric Measures Within the Pastoral Sample**

Variable	Male	Female	P-Value
N	26	40	-
%BF	$10.2 \pm 10$	$23.7 \pm 9.3$	$p < .001$
Waist Circ.	$76 \pm 11.8$	$79.1 \pm 12.1$	NS
Hip Circ.	$88.09 \pm 10.2$	$93.31 \pm 12.1$	NS
WHR	$0.86 \pm 0.06$	$0.85 \pm 0.07$	NS

Means compared using a T-test



The means within the Pastoral group were  $10.2\pm 10\%$ ,  $76\pm 11.8\text{cm}$ ,  $88.09\pm 10.2\text{cm}$ ,  $0.86\pm 0.06$  and  $23.7\pm 9.3\%$ ,  $79.1\pm 12.1\text{cm}$ ,  $93.31\pm 12.1\text{cm}$  and  $0.86\pm 0.06$  for %BF, WC, HC and WHR in the Pastoral group respectively. Difference between their means were statistically significant for % BF only, at  $p < .029$ , but not WC, HC and WHR within the Pastoral sample.

Mean % BF in the Pastoral males was  $10.2\pm 10\%$ . This was above the 3% essential fat for normal physiological function in men and therefore excellent (Florvall et al., 2006). Mean % BF in the Pastoral females was  $23.7\pm 9.3\%$ , above the 12% essential fat for normal physiological function in women and therefore good. The Pastoral males had lower mean percentage body fat values than those of the Pastoral females.

Mean WC in the Pastoral male was  $76\pm 11.8\text{cm}$  and below the 94cm the IDF cut-off for abdominal obesity in African and European males suggesting low risk for cardiovascular diseases as a result of low central adiposity. While mean WC in the Pastoral female was  $79.1\pm 12.1\text{cm}$  or borderline for abdominal obesity in African and European females. Mean WC in the Pastoral male and female sample's support the %BF findings in this same sample suggesting that this sample was relatively lean and not overweight.

Mean WHR in the Urban males was higher than that of the Urban females with the mean WHR in both the Urban males and females at  $< 1$  and borderline at  $.85$  in the males and females respectively. These results were within the threshold for android obesity and may thus have had a positive modification effect on their CVD risk profiles.

**Table 4.39 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Male Samples**

Variable	Urban Male	Pastoral Male	p-Value
N	38	26	-
% Body Fat	24.9± 8.1	10.2± 10	p<.001
Waist Circ.	94.6±10.1	76±11.8	p<.001
Hip Circ.	102.83±7.4	88.09±10.2	p<.001
WHR	0.92±0.07	0.86±0.06	p<.001

Means compared using a T-test

The means between the Urban and Pastoral male samples were 24.9± 8.1%, 94.6±10.1cm, 102.83±7.4cm, 0.92±0.07 and 10.2± 10%, 76±11.8cm, 88.09±10.2 and 0.86±0.06 for %BF, WC, HC and WHR respectively. The differences between their means were statistically significant for % BF, WC, HC and WHR at p<.001, p<.001, p<.001 and p<.001 respectively between the Urban and Pastoral male samples.

Mean % BF in the Urban male sample was 24.9± 8.1%, which was within the cut-off for overweight in males, this was in contrast to the 10.2± 10% mean % BF in the Pastoral male sample that was within the excellent classification for body composition.

Mean WC in the Urban male was 94.6±10.1cm, this was marginally above the 94cm the IDF's waist circumference cut-off for visceral obesity in African and European males, suggesting borderline overweight/obesity in this sample. Mean WC in the

Pastoral male sample was  $76\pm 11.8\text{cm}$  and below the IDF's 94cm waist circumference cut-off for overweight or obesity, suggesting normal body fat values in this sample. Mean HC in the Pastoral males was lower than that of the Urban males, this could perhaps have been a reflection of the difference in their %BF levels as this was significantly different

Mean WHR in the Urban males was significantly higher than that of the Pastoral males, however both male samples had their mean WHR  $<1$ , within the threshold for android obesity in males, this could have had a modifying effect on their overall CVD risk profiles.

**Table 4.40 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Female Samples**

Variable	Urban Female	Pastoral Female	p-Value
N	29	40	-
% BF	$35.3\pm 8.7$	$23.7\pm 9.3$	$p<.001$
Waist Circ.	$87.6\pm 11$	$79.1\pm 12.1$	$p<.004$
Hip Circ.	$107.13\pm 9.3$	$93.31\pm 12.1$	$p<.001$
WHR	$0.82\pm 0.07$	$0.85\pm 0.07$	NS

Means compared using a T-test

The means between the Urban and Pastoral female samples were  $35.3\pm 8.7\%$ ,  $87.6\pm 11\text{cm}$ ,  $107.13\pm 9.3\text{cm}$ ,  $0.82\pm 0.07$  and  $23.7\pm 9.3\%$ ,  $79.1\pm 12.1\text{cm}$ ,  $93.31\pm 12.1$ ,  $0.85\pm 0.07$  for %BF, WC, HC and WHR respectively. The differences between their

means were significant for %B.F, WC and HC but not for WHR at  $p<.001$ ,  $p<.004$ , and  $p<.001$  respectively.

Mean % BF in the Urban female sample was  $35.3\pm 8.7\%$ , which was above the 34.1% cut-off for obesity in females, indicating excess body fat/obesity in this female sample. This finding was in contrast to that of the Pastoral female sample whose mean % BF was  $23.7\pm 9.3\%$  which was within the cut-off for good body composition, indicating that the Pastoral female sample was neither too thin nor too fat.

Mean WC in the Urban female sample was  $87.6\pm 11\text{cm}$ , above the 80cm IDF cut-off for visceral obesity in African and European females, indicating high levels of visceral fat. While mean WC in the Pastoral female sample was  $79.1\pm 12.1\text{cm}$ , right on the borderline of the IDF cut-off for visceral obesity in African and European females.

These results suggested that the Urban female sample had a higher risk for CVD than the Pastoral female sample. Mean HC between these two female samples were significantly different, with the Urban female sample having a higher mean value than the Pastoral female sample.

Mean WHR in the two female samples were not significantly different despite the significant difference in their WC and HC, however the WHR in the Pastoral female sample was right on the cut-off for android obesity. Mean WHR in Pastoral females was due to their smaller HC indicating a relatively higher prediction of MI according

to Yusuf et al. (2005), in their case control study on Obesity and risk of myocardial infarction. However, given the low mean WC in the Pastoral female sample, excellent mean BP, good mean %BF, CVD biomarkers and superior median MET mins/wk, perhaps this may not be the case in this Pastoral female sample and calls for a longitudinal study to determine this.

**Table 4.41 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Samples**

Variable	Urban Sample	Pastoral Sample	p-Value
N	67	66	-
% Body Fat	29.4±9.8	18.4±11.6	p<.001
Waist Circ.	91.6±11	77.9±12	p<.001
Hip Circ.	104.69±8.5	91.26±11.6	p<.001
WHR	0.89±0.8	0.85±0.6	NS

Means compared using a T-test

The means between the Urban and Pastoral Samples were 29.4±9.8%, 91.6±11cm, 104.69±8.5cm, 0.89±0.8 and 18.4±11.6%, 77.9±12cm, 91.26±11.6, 0.85±0.6 respectively, for %BF, WC, HC and WHR. The differences between their means were statistically significant for % BF, WC and HC at p<.001, p<.001 and p<.001 respectively but not for WHR which was not significantly different.

Mean % BF in the Urban sample was 29.4±9.8%, which was higher than the mean %BF in the Pastoral sample whose mean was 18.4±11.6%. Thus the mean %BF in

the Urban sample suggested it was overweight and therefore had a relatively higher CVD risk. The Pastoral sample on the other hand, was neither too thin nor too fat, suggesting they had an excellent body composition and therefore a relatively lower CVD risk.

Mean WC in the Urban sample was  $91.6 \pm 11$  cm and was higher than the  $77.9 \pm 12$  cm mean WC in the Pastoral sample, suggesting more visceral fat in the Urban sample. Mean HC in the Urban sample was significantly higher than that of the Pastoral sample possibly due to greater deposition of gynoid fat and perhaps less physical activity.

Mean WHR in the Urban sample was  $> 0.85$  indicating higher levels of android fat deposition than that of the Pastoral sample, however, there was no significant difference between their means.

**Table 4.42 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Samples by Age-Category: 30-40**

Variable	Urban	Pastoral	p-Value
N	42	33	-
% BF	$26.3 \pm 7.9$	$18.1 \pm 13.4$	$p < .001$
Waist Circ.	$89 \pm 10.5$	$77.8 \pm 14.1$	$p < .001$
Hip Circ.	$102.82 \pm 6.7$	$92.57 \pm 14.3$	$p < .001$
WHR	$0.87 \pm 0.08$	$0.84 \pm 0.06$	NS

Means compared using a T-test

The means between the Urban and Pastoral Samples in the 30-40 age-category

were  $26.3\pm 7.9\%$ ,  $89\pm 10.5\text{cm}$ ,  $102.82\pm 6.7\text{cm}$ ,  $0.87\pm 0.08$  and  $18.1\pm 13.4\%$ ,  $77.8\pm 14.1\text{cm}$ ,  $92.57\pm 14.3$ ,  $0.84\pm 0.06$  respectively. The differences between their means were statistically significant for % BF, WC and HC at  $p<.001$ ,  $p<.001$ , and  $p<.001$  respectively, but not for WHR.

Mean % BF in the Urban sample in the 30-40 age-category was  $26.3\pm 7.9\%$ , which is classified as moderate –overweight depending on gender and age. This was higher than the mean % BF in the Pastoral sample which was  $18.1\pm 13.4\%$  and classified as excellent depending on age and gender. These findings are consistent with the BMI finding between both samples in this age-category, indicating a relatively higher risk of CVD in the Urban sample compared to the Pastoral sample.

Mean WC in the Urban sample in the age-category 30-40 was  $89\pm 10.5\text{cm}$ , and was higher than the  $77.8\pm 14.1\text{cm}$  mean WC in the Pastoral sample in the same age-category. This finding suggests earlier onset of visceral obesity in the Urban sample in contrast to the Pastoral sample and may be conferring an earlier and relatively higher risk of CVD in the Urban sample in this age-category. Mean HC was slightly higher in the Urban sample than in the Pastoral sample, however this was not significantly different between the two samples in this age category. The Urban group had relatively higher mean WHR values than the Pastoral group in this age-category, however this was not significantly different.

**Table 4.43 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Samples by Age-Category: 41-50**

Variable	Urban	Pastoral	p-Value
N	18	17	
% BF	34.6±12.4	18.5±10	p<.001
Waist Circ.	94.9 ±11.5	78.7±11.5	p<.001
Hip Circ.	109.5 ±11.3	91.3±9.1	p<.001
WHR	0.87 ±0.09	0.86±0.07	NS

Means compared using a T-test

The means between the Urban and Pastoral samples in the 41-50 age-category were 34.6±12.4%, 94.9±11.5cm, 109.5±11.3, 0.87±0.09 and 18.5±10%, 78.7±11.5cm, 91.3±9.1, 0.86±0.07 respectively. The differences between their means were statistically significant for %BF, WC, HC and WHR at p<.001, p<.001 and p<.001 respectively, but not WHR.

Mean %BF in the Urban sample in the 41-50 age-category was 34.6±12.4%, which is classified as obese irrespective of gender or age. This was higher than the mean %BF in the Pastoral sample which was 18.5±10% and classified as excellent irrespective of age or gender and only marginally higher than that of the 30-40 age-category in the same Urban sample. These findings are consistent with the BMI finding between both samples in this age-category, suggesting a higher risk of CVD in the Urban sample compared to the Pastoral sample.



Mean WC in the Urban sample in the age-category 41-50 was  $94.9 \pm 11.5$ cm, indicating visceral obesity in African females and just borderline for visceral obesity in African males using the IDF's waist circumference cut-offs. This was higher than the mean WC in the Pastoral sample which was  $78.7 \pm 11.5$ cm, which suggested mean measures that were normal or healthy in the 41-50 age-category in the Pastoral sample. Mean HC between these two samples were significantly different with the Urban sample having a higher mean value, perhaps reflecting greater deposition of gynoid fat than the Pastoral sample in this age-category. The Urban sample had relatively higher mean WHR values than the Pastoral sample in this age category, however this was not significantly different.

**Table 4.44 Differences in Body Composition and Anthropometric Measures Between the Urban and Pastoral Samples By Age-Category: 51-60**

Variable	Urban	Pastoral	P-Value
N	7	16	
% BF	$34.1 \pm 4.8$	$19 \pm 9.6$	$p < .001$
Waist Circ.	$96.2 \pm 11$	$77.2 \pm 7.5$	$p < .001$
Hips Circ.	$103.4 \pm 5.2$	$88.51 \pm 7.1$	$p < .001$
WHR	$0.93 \pm 0.08$	$0.87 \pm 0.06$	NS

Means compared using a T-test

The means between the Urban and Pastoral samples in the 51-60 age-category were  $34.1 \pm 4.8\%$ ,  $96.2 \pm 11$ cm,  $103.4 \pm 5.2$ ,  $0.93 \pm 0.08$  and  $19 \pm 9.6\%$ ,  $77.2 \pm 7.5$ cm,  $88.51 \pm 7.1$ ,  $0.87 \pm 0.06$  respectively. The differences between their means were

statistically significant for % BF and WC at  $p < .001$ ,  $p < .001$ ,  $p < .001$  respectively, but not for WHR.

Mean %BF in the Urban sample in the 51-60 age-category was  $34.1 \pm 4.8\%$ , which is classified as either over-weight or obese depending on gender or age. This was higher than the mean % BF in the Pastoral sample which was  $19 \pm 9.6\%$  and classified as excellent irrespective of age or gender and apparently higher than that of the 41-50 age-category in this sample.

Mean WC in the Urban sample in the age-category 51-60 was  $96.2 \pm 11\text{cm}$ , suggesting visceral obesity in African male and females males using the IDF's waist circumference cut-offs. This was higher than the mean WC in the Pastoral sample which was  $77.2 \pm 7.5\text{cm}$ , suggesting mean measures in the 51-60 age-category of the Pastoral sample were normal or healthy irrespective of gender.

Mean HC between these two samples were significantly different, with the Urban sample having a higher mean value, perhaps reflecting greater deposition of gynoid fat than the Pastoral sample in this age-category. The Urban sample also had relatively higher mean WHR values than the Pastoral sample in this age-category, however this was not significantly different.

#### **4.5.4.1. Relationship Between Body Composition and Blood Pressure in the Urban and Pastoral Samples**

The relationship between Obesity and Blood Pressure within the Urban and Pastoral Sample was analysed using the Pearson Correlation coefficient which found a low but significant and positive correlation between, BMI and SBP ( $r = .273$ ,  $p < 0.05$ ), BMI and DBP ( $r = .283$ ,  $p < 0.05$ ), WC and SBP ( $r = .322$ ,  $p < 0.01$ ) and WHR and SBP ( $r = .322$ ,  $p < 0.01$ ) in the Urban sample. These results indicate a direct relationship between over-nutrition ( $BMI > 24.9 \text{ kg/m}^2$ ) and increasing blood pressure in the Urban sample. While in the Pastoral sample low but significant and positive correlations were found between: WC and DBP ( $r = .313$ ,  $p < 0.05$ ), %BF and DBP ( $r = .244$ ,  $p < 0.05$ ) and WHR and DBP ( $r = .246$ ,  $p < 0.05$ ). These results indicate a direct relationship between measures of adiposity and increasing diastolic blood pressure in the Pastoral sample.

The relationship between obesity and blood pressure within the Urban and Pastoral samples was analysed by age-category using the Pearson Correlation coefficient that found low but significant and positive correlations in the 30-40 age-category between BMI and SBP ( $r = .333$ ,  $p < 0.05$ ), BMI and DBP ( $r = .312$ ,  $p < 0.05$ ), WC and SBP ( $r = .372$ ,  $p < 0.05$ ) and WHR and SBP ( $r = .330$ ,  $p < 0.05$ ) in the Urban sample. These results indicate a direct relationship between obesity with increasing systolic and diastolic blood pressure in the Urban sample. While in the Pastoral sample in this age-category, no significant correlation between obesity and blood pressure was found, perhaps due to the low mean values in their measures for obesity.

In the 41-50 age-category, moderate but significant and positive correlations between BMI and SBP ( $r=.500$ ,  $p<0.05$ ) and WC and SBP ( $r=.494$ ,  $p<0.05$ ) were found in the Pastoral sample, but not the Urban sample. These results indicate a direct association between obesity and rising blood pressure in the Pastoral sample in this age-category.

In the 51-60 age-category, a moderate but significant and positive correlation between WC and SBP ( $r=.574$ ,  $p<0.05$ ) was found in the Pastoral sample but not the Urban sample. This result indicates a direct association between obesity and rising blood pressure in the Pastoral sample and perhaps the importance of central obesity in rising SBP in this age-category.

#### **4.5.4.2 Relationship Between Body Composition and CVD Risk Biomarkers in the Urban and Pastoral Sample**

The relationship between body composition and CVD risk biomarkers in the Urban and Pastoral sample was analysed using the Pearson correlation coefficient. It found a low but significant and positive correlation between, BMI and apoB ( $r=.272$ ,  $p<0.05$ ) and a low but significant and negative correlation between WC and apoA-I ( $r=-.301$ ,  $p<0.05$ ) and WHR and apoA ( $r=-.399$ ,  $p<0.01$ ) in the Urban sample. These results indicated a direct association between an increase in body composition measures with an increase in the atherogenic apoB and a decrease in apoA-I that would otherwise activate cholesterol esterification and excretion. In the Pastoral sample significant correlations were found between, BMI and apoA-I ( $r=-.364$ ,  $p<0.01$ ), BMI and apoB ( $r=.255$ ,  $p<0.05$ ), BMI and apoB/A-I ratio ( $r=.385$ ,  $p<0.01$ ), WC and apoA-I ( $r=-.250$ ,  $p<0.01$ ), WC and apoB ( $r=.329$ ,  $p<0.01$ ), WC and apoB/A-I ratio ( $r=.449$ ,  $p<0.01$ ), HC and apoA-I ( $r=-.299$ ,  $p<0.05$ ), HC and apoB

( $r=.336$ ,  $p<0.01$ ) and HC and apoB/A-I ratio ( $r=.396$ ,  $p<0.01$ ) in the Pastoral sample. These results indicated the direct relationship between increasing measures of body composition with increasing atherogenic CVD biomarker levels or an inverse relationship showing increasing adiposity associated with a decrease in CVD risk lowering biomarkers.

The relationship between body composition and CVD risk biomarkers within the Urban and Pastoral samples were analysed by age-category using the Pearson correlation coefficient that found significant correlations in the 30-40 age-category between BMI and apoB/A-I ratio ( $r=-.325$ ,  $p<0.05$ ), WC and apoA ( $r=-.412$ ,  $p<0.051$ ), WC and apoB/A-I ratio ( $r=.370$ ,  $p<0.05$ ), WHR and apoA-I ( $r=-.506$ ,  $p<0.01$ ) and apoB/A-I ratio ( $r=.355$ ,  $p<0.05$ ) in the Urban sample in this age-category. These results indicated a direct association between increasing measures of adiposity and the corresponding increase in CVD risk biomarkers, and a decrease in CVD risk lowering biomarkers. In the Pastoral sample in the same age-category, significant correlations were found between: BMI and apoA-I ( $r=.377$ ,  $p<0.01$ ), BMI and apoB ( $r=.371$ ,  $p<0.01$ ), BMI and apoB/A-I ratio ( $r=.547$ ,  $p<0.01$ ), WC and apoA-I ( $r=-.363$ ,  $p<0.05$ ), WC and apoB ( $r=.445$ ,  $p<.01$ ), WC and apoB/A-I ratio ( $r=.597$ ,  $p<.01$ ), % BF and apoB ( $r=.473$ ,  $p<.01$ ), %BF and apoB/A-I ratio ( $r=.477$ ,  $p<.01$ ), HC and apoB ( $r=.460$ ,  $p<.01$ ), HC and apoB/A-I ratio ( $r=.545$ ,  $p<.01$ ), these results indicate a direct association between adiposity and increasing CVD risk biomarkers alongside a decrease in CVD risk lowering biomarkers and quite similar to that in the Urban sample.

In the age-category 41-50 in the Urban sample, the following significant correlations were found: BMI and apoB ( $r=.586$ ,  $p<0.05$ ), WC and Co-Q10 ( $r=.580$ ,  $p<0.05$ ), HC and apoB ( $r=.505$ ,  $p<0.05$ ) and WHR and Co-Q10 ( $r=.572$ ,  $p<0.05$ ). These results indicate the direct relationship between increasing adiposity in this age-category and an increase in CVD risk biomarkers with the exception of Co-Q10 which seemed to rise in association with an increase in WHR in this age-category. In the Pastoral sample, the significant correlations were, %BF and apoB ( $r=.567$ ,  $p<0.05$ ) and %BF and apoB ( $r=.567$ ,  $p<0.05$ ) indicating a positive relationship between adiposity and higher levels of atherogenic apoB in this age-category of the Pastoral sample, that is, increasing adiposity was associated with higher levels of the atherogenic apoB.

In the age-category 51-60 in the Urban sample, no significant correlation was found between body composition and CVD risk biomarkers, however moderate and significant correlations in the Pastoral sample were found among, BMI and apoB/A-I ratio ( $r=.552$ ,  $p<0.01$ ), %BF and apoB/A-I ratio ( $r=.591$ ,  $p<0.05$ ) and HC and apoB/A-I ratio ( $r=.524$ ,  $p<0.05$ ) indicating a positive relationship between adiposity and higher levels of atherogenic apoB in this age-category of the Pastoral sample.

#### **4.5.6 Objective Summary**

The objective of this section was to study if there was any significant difference in lifestyle factors: physical activity, dietary habits, nutritional status, body composition and anthropometric measurements between the Urban and Pastoral samples.

Analysis of the data on lifestyle factors: physical activity, dietary habits, nutritional status, body composition and anthropometric measurements between the two groups

showed the Urban sample reported achieving significantly lower Median MET minutes per week, a significantly lower intake of dietary protein, carbohydrate, dietary cholesterol, saturated fatty acids (SAFA), monounsaturated fatty acids (MUFA), docosahexaenoic acid (DHA) and folic acid than the Pastoral sample. The Urban sample was less malnourished and more obese than the Pastoral sample indicating a relatively higher risk for CVD and therefore reject the null hypothesis: There is no significant difference in lifestyle factors: physical activity, dietary intake, nutritional status, body composition and anthropometric measurements between the Urban and Pastoral sample in Kenya.

#### **4.6 Identification of Predictive CVD Lifestyle Factors**

Multiple regression analysis was used to identify lifestyle factors that can be used to predict CVD blood pressure and CVD risk biomarkers in the Urban and Pastoral sample were done using Stepwise multiple regression analysis.

##### **Blood Pressure**

Systolic blood pressure in the Urban sample could be predicted by the formula:

$(0.362 \times \text{MUAC}) + 59.487$  while diastolic blood pressure could be predicted by the formula:  $(1.161 \times \text{MUAC}) + 43.769$ . Systolic blood pressure in the Pastoral sample could be predicted by the formula  $(0.945 + \text{MUAC}) + 89.850$  while diastolic blood pressure could be predicted by the formula  $(1.161 \times \text{MUAC}) + 43.769$  and  $(0.830 \times \text{MUAC}) + 54.546$  in the Urban and Pastoral samples respectively.

**CVD Risk Biomarkers**

Apolipoprotein B/A-I ratio in the Urban sample could not be predicted by lifestyle factors however, apolipoprotein B/A-I ratio in the Pastoral sample could be predicted using the formula:  $(0.06 \times \%BF) + 0.335$  in this study.

Co-Q10 in the Urban sample could be predicted by the formula:  $(0.302 \times \text{lymphocyte count}) + 0.192$ , Co-Q10 could not be predicted by lifestyle factors in the Pastoral sample in this study.



## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Introduction

This chapter is a summary of the main results of this study, implementations of the findings, conclusions, recommendations for policy design, lifestyle interventions and further research

#### 5.2 Summary

The prevalence of high blood pressure in the Urban sample was 23.9 % (26.3% male, 20.7% female) and 9.1% (15.4% male, 5% female) in the Pastoral sample. Blood pressure was significantly higher in the Urban sample than in the Pastoral sample. CVD risk biomarkers: apoB, apoB/A ratio were significantly higher in the in the Urban sample than in the Pastoral sample indicating a higher CVD risk, while CVD biomarkers apoA-I and Co-Q10 were lower in the Urban sample indicating a relatively higher CVD risk than in the Pastoral sample.

The Pastoral sample reported a higher median MET minutes per week than the Urban sample, alongside reporting a higher consumption of animal protein, carbohydrate, dietary cholesterol, saturated fat, monounsaturated fat, DHA and folic acid than the Urban sample, but were significantly less overweight or obese than the Urban sample.

The study also found significant and positive relationships between lifestyle factors, blood pressure and atherogenic CVD biomarkers.

### **5.3 Implications of Findings**

The high prevalence of hypertension in the apparently healthy Urban sample coupled with the high prevalence of pre-hypertension in the Pastoral sample are a concern as hypertension is expensive to treat and a major cause of strokes in SSA.

CVD biomarkers are useful in determining CVD risk in both the Urban and Pastoral samples and may serve to predict cardiovascular diseases that are lifestyle related.

Lifestyle factors such as physical activity, dietary habits, adiposity, and girth measurements are useful and inexpensive means of determining or predicting, CVD risk in individuals or population groups. The use of a standard measuring tape to measure mid-upper arm circumference to predict systolic and diastolic blood pressure in Urban and Pastoral samples in Kenya can probably be used to determine or predict CVD risk in view of the simplicity and cost of the method.

### **5.4 Conclusions**

The findings of this study are concluded as follows:

- There is indeed a significant difference in the prevalence of hypertension between the Urban Nairobi and Pastoral Samburu sample in this study, mirroring studies in SSA.
- There are significant differences in blood pressure and biochemical cardiovascular disease risk markers, between the Urban Nairobi sample and the Pastoral Samburu sample in Kenya.

- Lifestyle factors such as physical inactivity, poor dietary intake, nutritional status, body composition and anthropometric measurements are associated with an increase in blood pressure and atherogenic CVD risk markers.
- Measures such as mid-upper arm circumference, derived percentage body fat and lymphocyte count can be used to predict blood pressure and CVD risk biomarkers.
- The apparently healthy Urban sample in Nairobi has a relatively higher risk of CVD than the Pastoral sample
- While the Pastoral sample in Samburu showed a much lower risk for cardiovascular disease than the Urban sample, analysis of their dietary intake, nutrition status and pre-hypertension prevalence are a concern as they indicate a negative change in their lifestyle predisposing them to CVD

### **5.5 Policy Recommendations**

Policy recommendations following the findings of this study are:

- Urgent measures to determine accurate national estimates of the prevalence of hypertension and CVD risk biomarkers in Kenya by conducting a national survey in view of the rapid lifestyle changes taking place as a result of urbanisation especially as we focus on attaining a middle –income status economy through vision 2030, as any economic gains are likely to be undermined by the costs of treating and managing CVD's.
- It is critical that any CVD risk survey is followed by development and swift deployment of strategies to intervene and or prevent the progression of the underlying factors behind the rapid epidemiological transition taking place stealthily.

- Preventive interventions and massive public health awareness campaigns of CVD need to be prioritised especially in Urban areas, but also taking into account the Pastoral groups who may be undergoing an epidemiological transition much faster than Urban groups and one that could easily decimate such groups owing to their fragile economies and relative inaccessibility of medical facilities owing to the vast distance they need to traverse.
- Emphasis on screening and awareness of CVD diseases need to be prioritised so as to prevent or detect them early even in the apparently healthy in view of the significant cost implications if left until too late.

### **5.6 Recommendations for Further Research**

From the findings of this study further research recommendations are:

- Establishment of a national prevalence of hypertension cross-sectionally but with a longitudinal component. This may need to focus on the inter-regional prevalence and causative factors so that practical and relevant intervention strategies can be designed and implemented.
- Investigation of the high prevalence of pre-hypertension in the Pastoral sample with the aim of identifying causative factors and intervention(s) to reverse this apparently new finding.
- Validation of BMI in SSA to avoid over exaggeration of malnutrition in adults to develop relevant norms.
- Determination of Co-Q10 levels in SSA and possible reasons for variation in different samples as indicated by this study.

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## **APPENDICES**

### **Appendix A: Informed Consent Form**

#### **Introduction**

Cardiovascular diseases are disorders of the heart, blood vessels and blood circulation. The vast majority of these are degenerative and man-made as they are heavily influenced by lifestyle.

If untreated these disorders result in serious complications such as coronary heart disease (CHD), congenital heart disease, arrhythmia, congestive heart failure, cardiomyopathies, arterial aneurysms, and heart valve diseases, hypertension, peripheral vessel disease and ischemic/hemorrhagic strokes. Differences in diet and level of physical activity (lifestyle) are thought to contribute to the increase in the risk factors for cardiovascular diseases. This study will help us understand how lifestyle contributes to the increase in bio-chemical risk markers for the development of cardiovascular diseases. With this knowledge, individuals, institutions and the government and stakeholders can then develop long-term strategies that will help reduce the occurrence of cardiovascular disease through appropriate lifestyle interventions.

#### **Procedures**

If you agree to participate in this study by signing the section at the end of this form, you will participate in the following activities today. At the first visit you will be questioned about your past medical, dietary, social, economic and physical activity history. You will be weighed and measurements for weight, height, arm, waist



circumference and blood pressure will be determined. A blood sample will be taken from your vein to determine any bio-chemical risk markers for Cardiovascular diseases.

### **Precautions**

You might feel a little discomfort when blood is being drawn, however there are no other expected complications associated with this exercise. In order to be diagnosed for bio-chemical risk factors for cardiovascular diseases, you will **not** need to fast overnight before blood testing. The team's well trained and experienced staff will guide you through this exercise and will take necessary precaution to ensure minimum discomfort.

### **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. The study team will provide you with examination results at a later date after analysis. The information obtained will be pooled with that of other individuals participating in the study.

### **Patient Information**

Participation in this study is entirely voluntary. If you no longer want to take part in the study, you may stop at any time. Refusal to participate will not result in loss of benefits you may be entitled to. 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 cardiovascular biochemical risk marker blood tests. Depending on your results, you will receive counselling and advice on ways to prevent and/or manage this disease. Those found to be at high risk for cardiovascular diseases will be referred to hospitals for further treatment. The study team will work closely with your local district health team to facilitate follow-up.

**Circumstances under which participation may be terminated**

In the event that you decide to revoke your decision to participate or become unwell and continued participation in the study is risked.

**Subjects Statement**

I the undersigned have understood the above information, which has been fully explained to me by the investigator, and I voluntarily consent to participate. I have had an opportunity to ask questions, all of which were answered to my satisfaction.

Name of Group \_\_\_\_\_

Name of participant \_\_\_\_\_

Signature of Participant \_\_\_\_\_

Date \_\_\_\_\_

Subject ID # \_\_\_\_\_

**Appendix B: Social-Economic Questionnaire**

**Recruitment Centre ..... Date.....Time .....**

**Subject Name. .... Subject ID. No. ....**

**Sex.....**

1. What is your date of birth?

\_\_\_\_\_

2. Place of birth?

\_\_\_\_\_

3. What is your mother tongue? \_\_\_\_\_

4. What is your marital status? \_\_\_\_\_

5. Is your partner working? \_\_\_\_\_

6. If **yes** to **no. 5**, what is your partner's occupation?

\_\_\_\_\_

7. What is the highest level of Education you have attained?

None

Primary

Secondary -‘O’ Level

Advanced Level -‘A’ Level

College / University

Other (Specify).....

8. What mode of transport do you use to work? Eg Car – Privately owned / lift/Company or Public

means – Matatu /Bus/ Taxi/ Bicycle/Walking

9. How would you describe your working status?

\_\_\_\_\_

10.If employed, what is your Occupation/ job category? eg Managerial/ Support staff/ Secretarial

Temporary/casual/ Other (specify).....

11. If self-employed, specify your occupation?

12. Do you have any other source of income? Y/N

13. If **yes, to no. 12** which one(s)? \_\_\_\_\_

14. Approximately how much money do you spend per month on the following items at home in Ksh?

Food	Clothes	General house hold	Health-care	Water, electricity/cooking	Transport to and	School Fees	Other
------	---------	--------------------	-------------	----------------------------	------------------	-------------	-------

		commodities		fuel	from work		

15. Who owns the house you live in? \_\_\_\_\_

16. If **self/spouse built in no. 15**, who owns that land?

\_\_\_\_\_

17. What is the acreage of the land you live in? \_\_\_\_\_

18. What is your source of water for domestic use?

\_\_\_\_\_

18. Approximately what is the distance from your house to the water source in meters? Eg Inside the

House/ under 50 meters/ 50-500m/500-1000m/ over 1km

20. Do you have any of the following in your house?

1 TV

2 Radio

3 Video/DVD/VCD

4 Refrigerator

5 Cooking Stove

6 Sofa Set

21. How many people live in your homestead? \_\_\_\_\_

22. How many dependants do you have? \_\_\_\_\_

23. Do you own any domesticated animals? Y/N

1. Yes

Which animals and how many of each?


For how long have you lived in your current area?

Do you have any relatives in Nairobi? Y/N

How many of them? \_\_\_\_\_

Approximately how old are the relative(s)?

25. What building material have been used for subject's: Roof \_\_\_\_\_ Walls \_\_\_\_\_  
Floor \_\_\_\_\_

**Appendix C: General Health and CVD Questionnaire**

1. Source recruited from Samburu or Nairobi

2. Sex M F

3. Medications Y N

4. Purpose of Medication \_\_\_\_\_

5. Have you experienced any of the following in the past year?

Marital Separation/divorce

Loss of job/retirement

Loss of crop/business failure

Violence

Major personal injury/illness

Major intra-family conflict

Death/major illness of a close

Death of a spouse

family member

Other major stress

If yes, please specify \_\_\_\_\_

7. Please answer the following question:

For the following question, stress is defined as feeling irritable or filled with anxiety, or as having sleeping difficulties as a result of conditions at work or at home.

Never Sometimes Severely

a) How often have you felt stress at work in the past year? \_ \_ \_

Mark here if not applicable: i.e no longer working \_

b) How often have you felt stress at home in the past year? \_ \_ \_

c) What level of financial stress do you feel?

Little/none

Moderate

High/severe

d) How much autonomy do you have in organising the events of your work day?

None    Little    Moderate    Substantial    Complete    N/A (i.e not working)

8. Past medical history:

Note- if not sure of parental history, for one or more of the following, please draw a circle around the word "No"

Disease	Subject		Mother		Father	
Hypertension	No	Yes	No	Yes	No	Yes
Diabetes	No	Yes	No	Yes	No	Yes
Angina	No	Yes	No	Yes	No	Yes
MI	No	Yes	No	Yes	No	Yes
Stroke	No	Yes	No	Yes	No	Yes
Other Vascular Disease	No	Yes	No	Yes	No	Yes
Cancer	No	Yes	No	Yes	No	Yes

9. Have you had an acute/ febrile illness within the past 4 weeks? Eg fever    No

Yes

10. Have you experienced any of the following during the past year? (Select all that

apply).    Painful teeth    Painful gums    Lost teeth    None

11. Do you smoke?    Y/N    11a) Have you ever been a smoker? Y/ N

12. a) Have any of the following people ever smoked regularly in your presence?

(Select



all that apply). Spouse/partner      Parents      Co-worker (in same room)

Children      Siblings      N/A      Other

b) Over the past 12 months, what has been your typical exposure to other peoples smoke? (Exposed" is defined as a minimum of 5 consecutive minutes, during which you inhale other people's smoke.)

Never      < Once/week      1-2 times/week      3-6 times/week  
Everyday

c) On average over the last 12 months, what has been the duration of this exposure?

hours per week

d) If your spouse smokes, number/day? \_      N/A

13. Which type of oil/fat do you most often use in cooking? (Select ONE only)

Olive Oil      Palm/coconut oil      Liquid Vegetable oil      Tallow  
Margarine      Ghee/butter      Lard

14. Do you drink alcohol?    Yes \_\_\_\_    No \_\_\_\_

If yes, how often? \_\_\_\_\_      Quantity \_\_\_\_\_ What    type?

15. To which extent do you agree or disagree with the following statements:

a) At work, I feel I have control over what happens in most situations. A/D

b) Over the next 5-10 years, I expect to have more positive than negative experiences. A/D

c) I often have the feeling I am being treated unfairly. A/D

d) In the past 10 years my life has been full of unpredictable changes? A/D

- e) I gave up trying to make big improvements in my life a long time ago A/D
- f) I think a lot about death (either your own, someone else's, or death in general) A/D
- g) I feel tired or low on energy? A/D
- h) I gain or lose weight easily? A/D
- i) I feel down on myself, no good or worthless? A/D

**Appendix D: Anthropometric and Physical Examination****Locality: Nairobi/ Samburu** \_\_\_\_\_**Subject ID. #** \_\_\_\_\_**Subjects Initials** \_\_\_\_\_

1. Date blood Drawn \_\_\_\_\_ Time \_\_\_\_\_

2. Blood Label# \_\_\_\_\_ 3. DOB year \_\_\_\_\_ month \_\_\_\_\_ day \_\_\_\_\_

Age (yrs) \_\_\_\_\_

3. Temperature \_\_\_\_\_ ° C

4. Physical Measurements

a). Blood Pressure 1<sup>st</sup> reading \_\_\_\_\_2<sup>nd</sup> reading \_\_\_\_\_

b) Heart Rate (bpm)

c). Wrist Circum.(cm)

d). Mid arm Circ (cm)

e). Waist Circum (cm)

f) Hip Circum (cm)

g). Weight (kg)

h) Height (cm)

5. BMI \_\_\_\_\_

### Appendix E: Food Frequency Questionnaire

1. How often do you serve the following meals?

MEAL	ALWAYS	SOMETIMES	NEVER
Breakfast			
Lunch			
Supper			
Others (Snacks)			

Put a tick in appropriate box

2. How often do you consume the following foods in a month?

Use the following response categories to indicate frequency of consumption of the foods indicated in the table below.

1= Never	3=2-3 times/month	5=2-4 times/week	7=Once per day	9=4-6 times/day
2= once/month or less	4=Once/week	6=5-6 times/week	8= 2-3 times/day	10= Over 6 times a day.

FOOD GROUPS	TYPE EATEN	FREQUENCY	FOOD COMPOSITION	NUTRIENTS INGESTED
Traditional Green Leafy Vegetables				
Exotic veges sukuma/ spinach cabbage				
Fruits				
Meat/Flesh				
Sea/lake food				
Offals (matumbo)				
Nuts & Seeds				
Tubers				
Sorghum/millet				

<b>Maize (boiled/roast)</b>				
<b>Maize Flour (sifted)</b>				
<b>Maize Flour (unsifted)</b>				
<b>Wheat</b>				
<b>Milk</b>				
<b>Eggs</b>				
<b>Beverages</b>				

**Put correct score in appropriate box**

**Appendix F: Dietary Recall**

<b>24-HOUR RECALL FORM</b>	<b>Protocol #:</b>
	<b>Investigator Name:</b>
	<b>Subject ID #:</b>
<b>Patient Name:</b>	<b>Interviewer:</b>
<b>Age:</b>	<b>District:</b>
<b>Time:</b>	
<b>Date dd/mm/yy:</b>	

Indicate in the spaces below the types of food described by the interviewee as having been consumed over the last 24 hours. 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.

<b>Meal</b>	<b>Time &amp; place eaten</b>	<b>DISH (Food or drink description)</b>	<b>Ingredients</b>	<b>Preparation method</b>	<b>Serving size/ amount (cups/250mls)</b>	<b>Food code</b>	<b>Amount code</b>
<b>Breakfast</b>							
<b>Snack</b>							
<b>Lunch</b>							
<b>Snack</b>							
<b>Supper</b>							
<b>Snack</b>							

## Appendix G: International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like

heavy lifting, digging, aerobics, carrying water, walking or fast bicycling?

\_\_\_\_\_ **days per week**

No vigorous physical activities

➔ ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those

days?

\_\_\_\_\_ **hours per day**



\_\_\_\_\_ **minutes per day**

Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

\_\_\_\_\_ **days per week**

No moderate physical activities → *Skip to question 5*

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

\_\_\_\_\_ **hours per day**

\_\_\_\_\_ **minutes per day**

Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

\_\_\_\_\_ **days per week**

No walking → *Skip to question 7*

6. How much time did you usually spend **walking** on one of those days?

\_\_\_\_\_ **hours per day**

\_\_\_\_\_ **minutes per day**

Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

\_\_\_\_\_ **hours per day**

\_\_\_\_\_ **minutes per day**

Don't know/Not sure

**Appendix H: Map of Area of Study**

