ASSESSMENT OF NUTRITION, INFECTION AND IMMUNE FACTORS IN HIV SERO-POSITIVE PATIENTS ENROLLED IN THE AMPATH CLINIC AT CHULAIMBO SUB-DISTRICT HOSPITAL, KISUMU WEST DISTRICT, KENYA

BY

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ABSTRACT

HIV worsens the nutritional status by increasing the body's requirement for food and also leads to opportunistic infections, which in turn, increase body nutrition requirements. This study was conducted to assess nutrition, infection and immune factors in HIV sero-positive patients at Chulaimbo Sub-district Hospital, Kenya. This is one of the centres for the Academic Model for the Prevention and treatment of HIV and AIDS (AMPATH) program of Moi University covering about 14,339 HIV and AIDS patients. Patients were followed for six months to collect information on selected variables including CD4 cell count, white blood cells and platelet count; to assess food consumption patterns, nutrient status and nutritional status of HIV sero-positive patients; to establish the infection pattern in HIV sero-positive patients; to establish the association of nutrition, infection and immune factors across the mild, moderate and severe categories of immune status; to determine the knowledge, attitude, beliefs and practices of the patients towards dietary management of HIV infection. A longitudinal study design was adopted where the HIV and AIDS patients enrolled at the hospital were followed for six months. Simple random sampling was adopted for the selection of the sample 497 patients for this study. Data was collected between the month of February and July, 2010 using focus group discussion guides, structured interview schedule, nutrient assessment measures, anthropometric measurements and immune status measures. Data analysis was qualitatively carried out using content analysis and quantitatively using descriptive statistics and inferential statistics. Food composition tables were used to compute the nutrient intake of the HIV sero-positive patients. Chi-square was used to establish if there was any relationship in marital status, education level, occupation, WHO staging and categories (mild, Moderate and severe) between sexes. Independent sample t-test was used to establish if there was any significant difference in the means between sexes and age, family size, immune status measures, nutrient intake, nutrient status, those who suffered infection and those who did not suffer infection, and those who had episodes of diarrhoea and those who did not have episodes of diarrhoea. Linear regression was used to determine mean differences of immune factors and nutrient intake, nutrient status indicators, BMI, immune status measures and infections. Findings in this study revealed that majority of the patients in this study were in the third WHO staging (42.3%) with CD4 cell count ranging between 200-499 cell/mm^3 (50.7%). There were more male patients (32.4%) compared to females (14.0%) with CD4 cell count below 200 cells/mm^3. There was inadequate nutrient intake reported in most of the patients although majority (55.3%) had three meals per day. Generally there was inadequate nutrient intake reported among the HIV patients in all the three categories of immune status, except for iron (10.49 ±3.49 mg) in the males and thiamine in both males (1.65 ±0.66 mg) and female (1.72 ±0.69 mg). Malnutrition was observed in 20.3% of 497 HIV sero-positive patients were who had a mean BMI < 18.5kg/m^2. Majority of the patients in the severe category (CD4 < 200 cell/mm^3) had a BMI of less than 18.5kg/m^2. There was a significant difference in the BMI between the male and female patients (February $p = 0.001$, April, $p = 0.010$, May $p = 0.011$ and July $p = 0.015$). Majority of the patients (66.4%) who had infections were in the severe category of immune status. Therefore, nutrition assessment of HIV and AIDS patients is important at all stages of the disease in order to identify those with signs of malnutrition. Results of this study will help to educate health workers on the relative value of using various measurements to assess nutritional status of HIV-infected populations for appropriate interventions. The inferences drawn from this study will assist the Government of Kenya and health professionals in designing nutritional support for HIV-infected persons.

CHAPTER ONE: INTRODUCTION

This chapter provides information on the background of the study which is drawn from the statement of the problem and the conceptual framework. It also presents the objectives and research questions that are guiding this study. The justification of the study is also outlined.

1.1 Background of the Study

There exists a complex interaction between Human Immunodeficiency Virus (HIV), infection and immune function, with a dominant effect of HIV infection on nutritional status (Macallan, 1999). The influence of nutrition on immune function generally shows that suboptimal nutrition results in immunological deficiencies (Macallan, 1999). Nutrient deficiencies cause immunosuppression and increase susceptibility to infections. This results in loss of immune cell function which allows intrusion by several different infectious agents. Thus there is a reduction of the ability of the body to fight disease and subsequent acquisition of opportunistic infections (Hoffmann *et al.,* 2007).

Nutrients play a big role in immune function and this includes: protein, total energy, lipids, vitamins and minerals (Baum & Shor-Posner, 1998). Normal antibody production, phagocytic cell and T-lymphocyte functions depend on the adequate intake of energy, protein, fat, minerals and vitamins (Semba & Tang, 1999). Optimal nutrition alters immunological function and therefore disease states. In HIV infection this interaction affects the body's immune status predisposing individuals to infections. Proteins play roles as structural components of tissues and also antibodies, cytokines, acute-phase proteins, components of the complement pathways, transcription factors and enzymes (Friis, 2006). Deficiency of protein could lead to

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immunologically important changes in enzyme-dependent activation, antioxidant protection, complement activation, antibody-mediated virus neutralization and intercellular communication via cytokines (Gershwin *et al.,* 2000). During HIV infection, there is faster metabolism and increased energy expenditure which results in weight loss that tends to be in the form of lean tissue, such as muscle (Baum & Shor-Posner, 1998). Weight loss strongly predicts illness or death among people with HIV (Friis, 2006).

When macronutrient intake is insufficient to meet metabolic needs, protein-calorie malnutrition (PCM) and deficiencies of micronutrients develop (Baum & Shor-Posner, 1998). These deficiencies impair both the synthesis of molecules necessary for the immune response and the function of immune-related enzyme systems (Friis, 2006). When this impairment occurs the individual is predisposed to opportunistic infections. In HIV disease, the presence of malnutrition strongly predicts patient survival independent of CD4 (Cluster of Differentiation) T-lymphocyte counts (Friis, 2006). Clinical deficiencies of some nutrients occur rapidly in response to dietary deficiencies, malabsorption, or altered metabolism, while those having a storage form in the body may take longer. Malnutrition alters the immune function with a subsequent increase in susceptibility to infections, faster disease progression, reduced functional status, quality of life, and increased morbidity and mortality (Schwarz, 1996). The presenting symptoms of malnutrition typically include weight loss, a change in body habitus (loss of lean body mass) or a change in functional status (inability to perform daily activities) (Baum & Shor-Posner, 1998).

Infections affect the nutritional status of an individual suffering from HIV and AIDS in various ways. The pathogenesis of nutritional impairment in HIV-positive patients is multifaceted and

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includes decreased food intake, decreased nutrient absorption and decreased efficiency of utilization, in addition to increased nutritional demand (Semba & Tang, 1999). HIV infection accelerates the release of pro-oxidants, cytokines and other reactive oxygen species, leading to increased utilization of antioxidants such as vitamin E, C, beta-carotene and micronutrients e.g. iron, zinc, selenium, manganese and copper (Friis & Michaelsen, 1998). An imbalance between these pro-oxidants and antioxidants causes oxidative stress which further damages the immune cells, proteins and enzymes, thus accelerating HIV replication (Schwarz, 1996).

HIV and nutrition are intimately linked in that HIV infection can lead to malnutrition, while poor diet can in turn speed disease progress. AIDS is characterized by progressive depletion of a specific group of immune cells called (CD4+) helper T lymphocytes whose loss leads to opportunistic infections and cancer (Baum & Shor-Posner, 1998). Micronutrients play an important role in building cellular structures, generating biological energy and acting as biocatalysts of multiple enzymatic processes in the body. Macro-and micronutrient deficiencies could impair host immune functions and promote viral replication and pathogenicity, thus potentially affecting the clinical course of HIV infection (Friis, 2006). Micronutrient deficiency and infections are mutually aggravating, as infections can turn marginal micronutrient deficiencies into severe conditions, and vice versa (Friis & Michaelsen, 1998). Vitamins A, C, B-group, D and E support the production of white blood cells, as well as various cytokines and cellular modulators of immunity, including antibody production (Friis & Michaelsen, 1998). Among other important biological factors impacting on immunity at cellular and organ levels are availability of minerals, such as iron, copper, magnesium, selenium and zinc, (Friis, 2006).

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Nutrition is a fundamental intervention in the early and ongoing treatment of HIV disease. Nutrition therapy, in coordination with other medical interventions, can extend and improve the quality and quantity of life in individuals infected with HIV and living with AIDS (Elbein, 1995). Usable energy and the structural components required to build an immune system are derived through food intake. Without adequate nutrition, the immune system is clearly deprived of components needed to generate an effective immune response (Gershwin *et al.*, 2000). During HIV infections, proper nutrition and aggressive nutritional support play an essential role. Nutritional status is affected by nutrient and immune status and therefore, the likelihood of getting infections is higher in a compromised immune system (Friis, 2006). Therefore, nutrition may play a role in the progression of HIV infection to AIDS, as well as mortality from AIDS.

1.2 AMPATH Programme

Academic Model for the prevention of HIV and AIDS (AMPATH) is a partnership between Moi University College of Health Sciences and Moi Teaching and Referral Hospital in Eldoret, Kenya and Indiana University School of Medicine in the United States of America. AMPATH has 18 comprehensive HIV care clinics in urban and rural centers in western Kenya and Chulaimbo Sub-district hospital is one of the 18 sites. Currently AMPATH has over 60,000 registered patients, of whom 15,000 are from Chulaimbo Sub-district hospital. Over 70% of registered patients in AMPATH programmes are economically unstable and hence the innovative interventions to tackle not only the HIV/AIDS virus in the body but in the reconstruction of livelihoods. The overriding goal of AMPATH is to establish and assess a working model of both urban and rural comprehensive HIV preventive and treatment services. Representing the unique attributes of academic institutions, AMPATH has structured its patient care programmes to

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simultaneously serve as a virtual laboratory for HIV-related teaching and research. The Pilot Phase of AMPATH began in November 2001.

AMPATH provides a wholistic HIV care as a Comprehensive care Clinic providing services that includes: psychosocial counselling, social services and support, income generating activities through the business development officer, Prevention of mother to child transmission (PMTCT) and provision of formula milk to the needy depending on criteria, follow-ups for defaulters, community mobilization and prevention strategies, PITC (Provider Initiated Testing and Counselling) and nutrition services. The objectives of the AMPATH Nutrition Department are to improve nutritional status of all patients through nutrition education and counselling as well as providing quality food and nutrition to food insecure patients and their dependants; and to educate and counsel all patients on nutrition management of HIV and other related illnesses. Nutrition lessons focusing on providing skills to health care providers and PLWHA are held on Tuesdays in all sites. Participants are offered an opportunity to contribute actively in the lesson. Food prescriptions are written by a qualified nutritionist working in AMPATH clinics based on specified eligibility criteria. Nutritional assessment for weight monitoring is done monthly during revisits.

1.3 Statement of the Problem

Despite the diverse programs geared towards reducing the rates of infections and severity of HIV and AIDS such as ART, the prevalence of HIV in Kenya still remains high at 7.4%. Many people in Kenya and in other parts of sub-Saharan Africa continue to become infected with HIV and AIDS and very few patients have access to ARV drugs (NACC, 2007). HIV attacks the

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immune system, resulting in susceptibility to infection and eventually into an impaired ability to mount an adequate immune response. Malnutrition and its complications can further render an HIV-infected person susceptible to opportunistic infection and reduced response and tolerance to medications and other therapies. Most studies in Kenya suggest that nutrition either used alone or in combination with ARVs could hold a key to the realization of better quality of life for HIV and AIDS patients in the developing countries (Mbakaya & Wakori, 1997).

Nutritional health depends on the triad of appropriate nutrient intake, adequate nutrient absorption, and normal metabolism (Gershwin *et al.,* 2000). Alterations or disruptions of these processes are common in HIV disease and often occur simultaneously. HIV infection may precipitate an inadequate dietary intake causing anorexia, nausea and vomiting or mastication and swallowing problems. These inadequacies increase nutrient loss and reduce availability of the nutrients (Friis, 2006). Nutrient inadequacies may cause malabsorption with or without diarrhoea and alterations in metabolism such as increased metabolic rate or HIV-associated wasting. Patients with these problems may purposefully limit their intake to avoid adverse gastrointestinal symptoms or pain. Nutritional problems must be treated or the effects can be very adverse (Baum & Shor-Posner, 1998).

Nutrients are important for immune function and when they are affected, the immune system becomes compromised. Adequate nutrients provide the support necessary (increase the number of white cells in the immune system) for the immune system to mount responses. Every component of the immune system appears susceptible to nutritional deficiencies including non-specific responses such as cell mediated and humoral immune functions (Friis, 2006; Stephensen

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& Marquis, 2007). Understanding nutrition and its association with infection and immunity may slow disease progression which could delay early death in an HIV infected patient (Schwarz, 1996). Therefore this study sought to find out the association of nutrition, infection and immune factors in HIV sero-positive patients.

1.4 General Objective

The general objective of the study was to assess the association of nutrition, infection and immune factors in HIV sero-positive patients enrolled at Chulaimbo Sub-district hospital, Kenya.

1.5 Specific Objectives

1. To assess the demographic and socio-economic characteristics of HIV sero-positive patients in Chulaimbo Sub-district Hospital, Kenya.

2. To determine the immune status of HIV sero-positive patients.

3. To assess food consumption patterns of HIV sero-positive patients.

4. To assess of the nutrient status of HIV sero-positive patients.

5. To assess nutritional status of HIV sero-positive patients.

6. To establish the infection pattern in HIV sero-positive patients.

7. To establish the association of nutrition, infections and immune factors in patient with mild, moderate and severe HIV infection.

8. To determine the knowledge, attitude, beliefs and practices of the HIV patients on dietary management during HIV infection.

1.6 Research Questions

1. What are the demographic and socio-economic characteristics of HIV sero-positive patients?

2. (a) What is the CD4+ cell count of HIV sero-positive patients?

   (b) What is the WBC count of HIV sero-positive patients?

   (c) What is the platelets count of HIV sero-positive patients?

3. (a) What are the types of foods consumed by the HIV sero-positive patients?

   (b) What is the nutrient intake of HIV sero-positive patients?

4. What is the nutrient status of HIV sero-positive patients?

5. What is BMI of HIV sero-positive patients?

6. (a) What are the common types of infections existing in HIV sero-positive patients?

   (b) What is the rate of these infections in HIV sero-positive patients by sex and category?

7. What is the association of nutrient intake, nutrient status, nutritional status, infections and immune factors in HIV sero-positive patients?

8. What are the knowledge, attitude, belief and practices of HIV sero-positive patients on dietary management of HIV infection?

1.7 Justification of the Study

Kenya has about 1.4 million adults infected with HIV with a prevalence rate of 7.4% (KNBS & ICF Marco, 2010). Kenya AIDS Indicator Survey (KAIS), 2007 shows that there are provincial disparities in HIV prevalence with Nyanza having 15.3%, Nairobi 9.0%, Coast 7.9% and Rift Valley 7.0%. While the national prevalence rate has considerately come down in the recent past, disparities continue to be seen in different regions/provinces of Kenya. While North Eastern

Province has the lowest prevalence rate in the country, Nyanza Province on the other hand continues to lead with a prevalence of 15.3% Kisumu District in Nyanza Province has a prevalence of 11.2% (KNBS & ICF Marco, 2010). HIV and AIDS affects the length and quality of human lives thus exposing them to risks and challenges. Good nutrition is critical for people living with HIV and AIDS (PLWHA). It strengthens the immune system so as to fight opportunistic infections and further delays progression of the disease (Friis, 2006). Studies have shown that there is a relationship between HIV and AIDS progression and adequate nutrition (FANTA, 2004). Chulaimbo Sub-district hospital is located in a region of high HIV infection and poor nutrition among the population (Ministry of Planning and National Development, 2003; Ministry of State for Planning, 2010). There are several intervention programmes that have been initiated including ARVs, food programmes and mobile clinics. One of the organizations involved in these interventions is AMPATH (Academic Models for the Prevention and Treatment of HIV and AIDS) clinic at Chulaimbo Sub-district Hospital, Kisumu West District, Kenya. This study assessed the association between nutrients with infections as well as with immune function in HIV sero-positive patients in Chulaimbo Sub-district hospital, Kenya.

1.8 Delimitations/Scope of the Study

- There are other methods used to assess immune status but this study used CD4 cell count, WBC count and platelet count.

- Although there are many nutrients that may affect the immune status, this study focused on iron, protein, energy, calcium, vitamin A, vitamin C, riboflavin, thiamine and niacin.

- There are many indicators used to assess iron status, but this study assessed haemoglobin and Mean Corpuscular Volume (MCV), were used as indicators, however there are other

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indicators that can be used for iron status assessment that have not been included in this study.

- The study focused only on HIV and AIDS out-patients attending the AMPATH clinic at Chulaimbo Sub-district Hospital.

1.9 Conceptual Framework

Nutrition, infections and immunity in HIV-positive individuals can interact in three ways (Gershwin *et al.,* 2000). The interplay occurs within the demographic, social and economic environment. First, HIV-induced immune impairment and the heightened risk of subsequent infection can worsen nutritional status. HIV infection can also lead to nutritional deficiencies through decreased food intake and malabsorption and increased utilization and excretion of nutrients, which in turn hasten the onset of AIDS (Semba & Tang, 1999). Nutrient status modulates the immunological response to HIV infection, affecting the overall clinical outcome as shown in Figure 1.1. Immune suppression caused by protein-energy malnutrition is similar in many ways to the effects of HIV infection (Beisel, 2000). When the immune system is weakened by HIV and AIDS, other infections start to occur and every new infection raises the need for nutrients and energy. HIV and AIDS lowers food intake, resulting in poor appetite, mouth and throat infections, which cause difficulties with eating and swallowing. HIV and AIDS causes physical problems, which affect the lining of the gut leading to deterioration due to HIV and other infections, in the process affecting the ability of the gut to digest and absorb food. The result of malabsorption is diarrhoea. During diarrhoea, water and nutrients are lost from the body. A combination of these factors, cause poor nutrition and weight loss in people with HIV and AIDS. Poor nutrition primarily leads to poor absorption and a weakening of the immune

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system, which gives the virus a chance to multiply, and so the cycle continues. Poor nutrition also leads to a decreased ability of the body to cope with the medicines a person with HIV and AIDS has to take. This results in one being malnourished due to poor absorption and subsequently, a weakened immune system.

Economic environment

NUTRITION
Nutrient levels
BMI

Loss of immune cells

INFECTIONS
Pneumonia
Tuberculosis
Throat infection
Malaria

Decreased
CD4 cell count

Progression

Loss of nutrients
(diarrhoea)
Poor absorption
(Ulceration)

IMMUNITY
CD4
WBC
Platelets

Social environment

Demographic environment

FASTER DISEASE PROGRESSION

MORBIDITY

DEATH
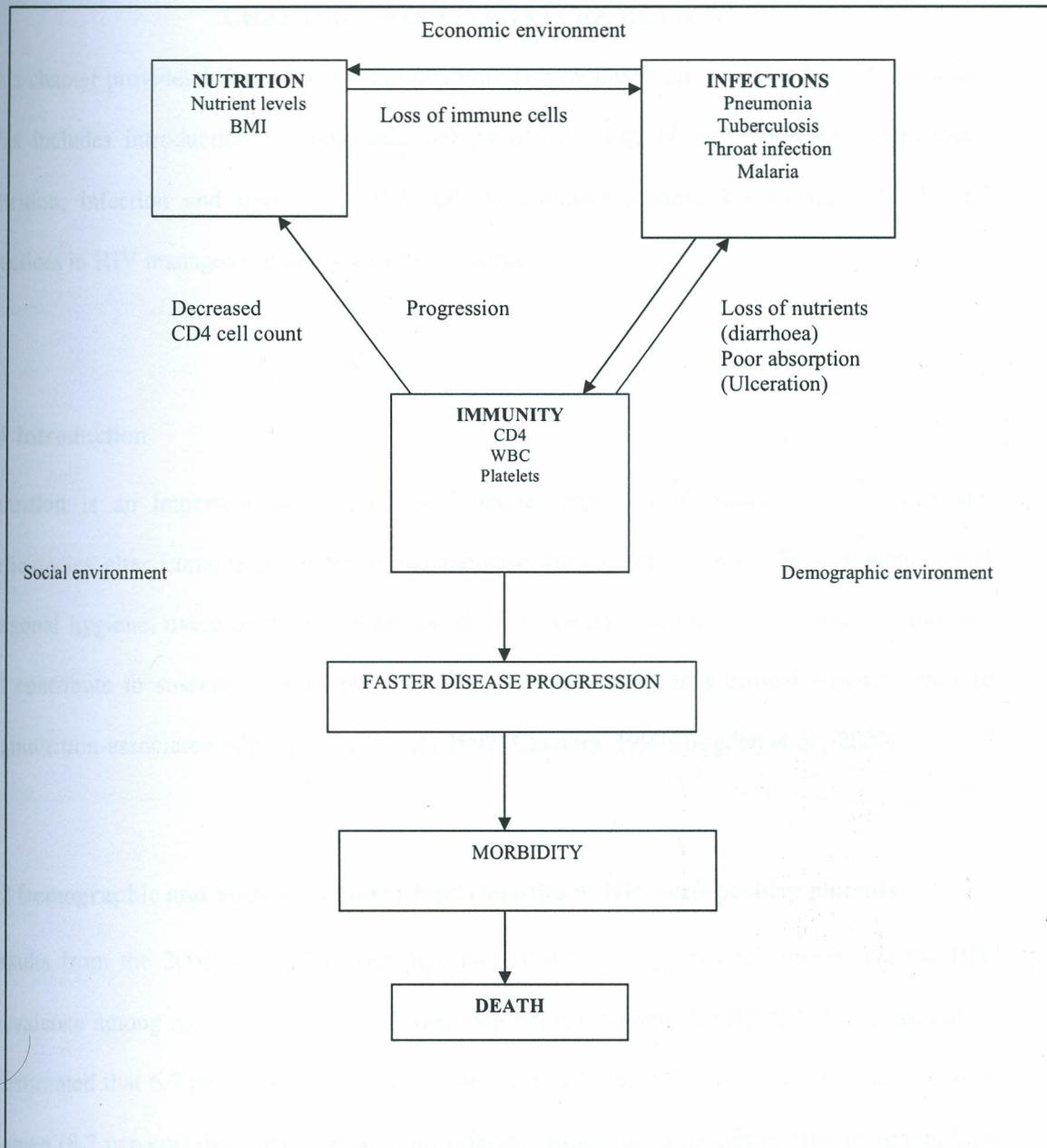
Figure 1.1: Conceptual Framework

Source: (Adapted from FANTA, 2004)

CHAPTER TWO: LITERATURE REVIEW

This chapter provides information on the literature review based on the objectives of the study. This includes introduction, pathogenesis and pathophysiology of HIV infection, assessment, nutrition, infection and immunity, HIV and the immune system, knowledge, attitude and practices in HIV management and gaps in knowledge.

2.1 Introduction

Nutrition is an important determinant of immune responses (Chandra, 1997). Nutritional deficiencies alter immune-competence and increase the risk of infection. Poor sanitation and personal hygiene, overcrowding, contaminated food, water, inadequate knowledge of nutrition all contribute to susceptibility to infection. Impaired immunity is a critical adjunct factor in malnutrition-associated infection (Bell *et al.,* 1997; Chandra, 1997; Bogden *et al.,* 2000).

2.2 Demographic and Socio-economic Characteristics of HIV sero-positive patients

Results from the 2008 Kenya Demographic and Health Survey (KDHS) shows that the HIV prevalence among men is substantially lower than among women (KNBS & ICF Marco, 2010). It estimated that 6.7 percent of adults age 15-49 were HIV-infected, with a higher proportion of women (8.7 percent) than men (4.6 percent) infected. Regional variations in HIV infection, high prevalence among girls age 15-19 years (3.0 percent), low levels of voluntary HIV testing, and discordance among cohabiting couples (7.5 percent) pose major challenges in the control of HIV infection (KNBS & ICF Marco, 2010).

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The 2007 Kenya AIDS Indicator Survey (KAIS) showed a reversal of the declining trend, with an estimated HIV prevalence of 7.4 percent among adults age 15-49 years (NASCOP *et al.,* 2008). These results indicate proportionately more women (8.8 percent) than men (5.5 percent) age 15-49 are infected. An estimated 1.4 million adults age 15-64 are infected with HIV/AIDS, with about 1 million rural and 400,000 urban residents infected (NASCOP *et al.,* 2008). Moreover, the 2007 KAIS results show that 35 percent of Kenyans aged 15-64 years are infected with herpes simplex virus-2 (HSV-2). Among those with HSV-2, 16 percent are also HIV-positive, while among those who do not have HSV-2, HIV prevalence is only 2 percent.

The level of education attained by women and men age 15-49 strongly relates to their knowledge of ways to avoid contracting HIV and AIDS. Women and men who have no education show much lower levels of knowledge of HIV and AIDS prevention methods than those with some education. The data further show that the poorest women and men are the most disadvantaged in terms of knowledge of methods to reduce the risk of getting HIV and AIDS. A study conducted by Schechter *et al.,* (1994) indicates that higher socioeconomic status is associated with slower progression of HIV infection independent of access to health care (Schechter *et al.,,* 1994). Urban employed residents (7%) are slightly more likely to have HIV than are rural residents (6%) (KNBS & ICF Marco, 2010). The effects of HIV infection on the nutritional status are likely to be more pronounced among low income populations with a low dietary intake (Baum & Shor-Posner, 1998). A study conducted in Eastern Uganda aimed at establishing the nutritional knowledge, attitude and practices among PLWHA revealed that majority (50.4%) of the participants were neither employed nor engaged in any form of business and the highest educational level attained by most study participants was primary (54.9%) (Bukusuba *et al.,*

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2010). Demographic and socio-economic factors are important thus the study assessed these factors in HIV sero-positive patients.

2.3 Pathogenesis and Pathophysiology of HIV Infection

Two HIV types (type 1 in America and most of the world and type 2 in some parts of Africa) produce similar human illnesses. Both HIV retroviruses are spherical and exhibit two identical RNA strands within a coma-shaped core surrounded by viral proteins. After cellular infection, viral RNA is converted by the action of reverse transcriptase enzymes to pro-virus DNA, which then moves to the nucleus, where it becomes integrated into host cell genomes (Figure 2.1). The bilayered outer envelope of HIV is composed of host-derived phospholipids which support protruding virally-encoded glycoproteins, gp 41 and gp120. HIV penetration into CD4+ helper lymphocytes, macrophages and follicular dendritic cells (in lymph nodes) requires initial binding of gp120 to cell-wall receptors (Mehandru, 2007). In T helper cells, the HIV receptor is the CD4+ molecule itself. Because viral envelope proteins contain highly variable amino acid sequences, HIV has an innate ability to resist the immune system as well as experimental vaccines (Mehandru, 2007).

Reverse
transcriptase

Mature
HIV

Immature
HIV

CD4+ lymphocyte
Cell's DNA
Nucleus
New virus forming
at cell membrane

Key

〜 Viral RNA   〜 Viral DNA   ◦◦ Cell DNA
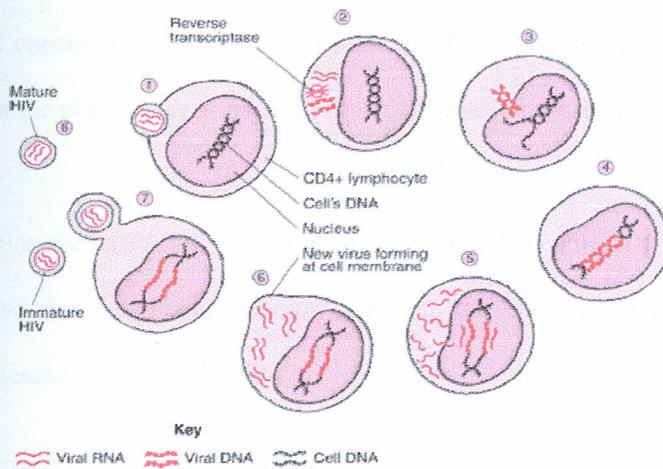
Figure 2.1: Life Cycle of the Human Immunodeficiency Virus

Source: (CDC, 1993)

Infection is followed by rapid, continuous viral replication and dissemination. The resulting viral

burden (or load) can be quantitated by commercially available assays (which employ competitive

reverse transcription) expressed as HIV-1 copies/mL of plasma or serum. Within 3 months, anti-

HIV antibodies are formed that partially curtail plasma viremia and induce the sequestration of

HIV in lymphoid tissues.

The human immunodeficiency virus is transmitted to other people via blood, semen or other

body fluids when the virus contacts open lesions or traumatized mucosa in the recipient's body

(Beisel, 1996). Pre-infection risk factors include sexual orientation, an HIV- infected partner,

intravenous drug use, contact (including transfusions) with whole blood or products derived from

human blood, breastfeeding and open lesions of the mouth or genitalia, the latter often resulting

from other sexually transmitted diseases. The predominant pathophysiological effects of HIV

infection on T cells occurs within the lymph nodes, with resultant lymphadenopathy. Although

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lymphadenopathy is considered a component of the AIDS-related complex, its development

provides evidence for the progressive worsening of the patients' condition (Mehandru, 2007).

The CDC Classification System (CDC, 1993) for patients with HIV infection was introduced as

a consistent guideline for recognizing specific stages in the ensuing clinical progression of

infection and are indicated in Table 2.1 below:

Table 2.1: WHO Clinical Staging of HIV Infection

Stage	Symptomatic or Asymptomatic	Characteristics
Primary HIV infection	Asymptomatic	Acute retroviral syndrome
Clinical stage 1	Asymptomatic	Persistent generalized lymphadenopathy (PGL)
Clinical stage 2	Symptomatic	Moderate unexplained weight loss (<10% of presumed or measured body weight) Recurrent respiratory tract infections (RTIs, sinusitis, bronchitis, otitis media, pharyngitis) Herpes zoster Angular cheilitis Recurrent oral ulcerations Papular pruritic eruptions Seborrhoeic dermatitis Fungal nail infections of fingers
Clinical stage 3	Symptomatic	Conditions where a presumptive diagnosis can be made on the basis of clinical signs or simple investigations Severe weight loss (>10% of presumed or measured body weight) Unexplained chronic diarrhoea for longer than one month Unexplained persistent fever (intermittent or constant for longer than one month) Oral candidiasis Oral hairy leukoplakia Pulmonary tuberculosis diagnosed in last two years Severe presumed bacterial infections (e.g. pneumonia, empyema, pyomyositis, bone or joint infection, meningitis, bacteraemia) Acute necrotizing ulcerative stomatitis, gingivitis or periodontitis Conditions where confirmatory diagnostic testing is necessary Unexplained anaemia (< 8 g/dl), and or neutropenia (<500/mm3) and or thrombocytopenia (<50 000/ mm3) for more than one month

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Clinical stage 4	Symptomatic	Conditions where a presumptive diagnosis can be made on the basis of clinical signs or simple investigations
		HIV wasting syndrome
		Pneumocystis pneumonia
		Recurrent severe or radiological bacterial pneumonia
		Chronic herpes simplex infection (orolabial, genital or anorectal of more than one month's duration)
		Oesophageal candidiasis
		Extrapulmonary TB
		Kaposi's sarcoma
		Central nervous system (CNS) toxoplasmosis
		HIV encephalopathy
		Conditions where confirmatory diagnostic testing is necessary:
		Extrapulmonary cryptococcosis including meningitis
		Disseminated non-tuberculous mycobacteria infection
		Progressive multifocal leukoencephalopathy (PML)
		Candida of trachea, bronchi or lungs
		Cryptosporidiosis
		Isosporiasis
		Visceral herpes simplex infection
		Cytomegalovirus (CMV) infection (retinitis or of an organ other than liver, spleen or lymph nodes)
		Any disseminated mycosis (e.g. histoplasmosis, coccidiomycosis, penicilliosis)
		Recurrent non-typhoidal salmonella septicaemia
		Lymphoma (cerebral or B cell non-Hodgkin)
		Invasive cervical carcinoma
		Visceral leishmaniasis

Source: WHO 2005

Although people may not experience any symptoms during stage 2 (Table 2.1), HIV is slowly damaging the immune system. When enough damage to the immune system has occurred, people will start to experience symptoms of HIV disease and may progress to HIV stage 3 or 4 (AIDS) (McCutchan, 2008).

2.4 HIV and the Immune System

The T-cells contribute to the immune defenses in two major ways: Regulatory T-cells are vital to orchestrating the elaborate system (B cells, for instance, cannot make antibodies against most substances without T-cell help), (Beisel, 1996) and cytotoxic T-cells, on the other hand, directly attack body cells that are infected or malignant (Beisel, 2000). The cells that are part of this defense system are white blood cells, or leukocytes. The leukocytes come in two basic types; phagocytes (cells that chew up invading organisms) and lymphocytes (cells that allow the body to remember and recognize previous invaders and help the body destroy them), which combine to seek out and destroy the organisms or substances that cause disease (Hoffmann *et al.*, 2007).

Production of pro-inflammatory cytokines (interleukin (IL)-1, IL-6, IL-8, tumor necrosis factor (TNF) and gamma interferon is a cardinal feature of most infectious illnesses (Beisel, 1995). These cytokines initiate fever by inducing the release of prostaglandins within the hypothalamic temperature regulating centre (Beisel, 1995). Pro-inflammatory cytokines also enhance the proliferation of HIV (Dondrop *et al.*, 1994). These mechanisms thus contribute to the loss of body weight in AIDS patients, as do metabolic effects by which pro-inflammatory cytokines lead to direct losses of body nutrient stores (Beisel, 1996).

Cytokines can function in different body locations as apocrines, paracrines or endocrines. Thus, they do not need to reach the plasma in order to induce cellular responses. For this reason, measured concentrations of individual cytokines in plasma do not necessarily reflect their true activity during HIV infections (Gershwin *et al.*, 2000). Pro-inflammatory cytokines are also subject to numerous checks and balances, including the release of cell-wall receptors, which can activate them; the synthesis of receptor antagonists (blockers), which prevent them from

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initiating target-cell responses; and the synthesis of other cytokines (such as IL-10) or cortisol, which can inhibit their synthesis (Beisel, 1996). Losses of body weight appear to correlate with serum concentrations of the IL-1 receptor antagonist (Esser *et al.,* 1996). Pro-inflammatory cytokines trigger a broad array of acute phase reactions including fever, anorexia, and headache (Dondrop *et al.,* 1994). Although these diverse, generalized, cytokine-induced responses are believed to represent beneficial host defensive mechanisms, they also incur large nutritional costs. Such losses of body nutrients can lead to damaging immunosuppressive consequences (Esser *et al.,* 1996). Thus this study thus sought to assess the immune status of HIV sero-positive patients.

2.5 HIV and Nutrient Intake

Nutrition and immunity in HIV-positive individuals can interact in two ways: First, HIV-induced immune impairment and the heightened risk of subsequent infection can worsen nutritional status. HIV infection can also lead to nutritional deficiencies through decreased food intake and malabsorption and increased utilization and excretion of nutrients, which in turn hasten the onset of AIDS (Semba & Tang, 1999). Nutritional status modulates the immunological response to HIV infection, affecting the overall clinical outcome. The strong linkages between malnutrition and infection were decades ago, referred to as nutritionally acquired immunodeficiency syndrome (NAIDS) (Schneider *et al.,* 1995). AIDS itself during the 1980s was called "Slim," reflecting the characteristic wasting syndrome.

There are studies that have reported an association between low micronutrient level and faster HIV-disease progression. While low serum or plasma vitamin A level has been described as a

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risk factor for mortality during HIV-infection, high intakes of micronutrients has been associated with reduced progression to AIDS and improved survival (Semba & Tang, 1999).

Recent studies indicate that multiple nutritional abnormalities occur relatively early in the course of HIV-1 infection (Baum & Shor-Posner, 1998). Decreased plasma levels of vitamins B_6, B_{12}, A, and E and zinc have been correlated with dietary intake and associated with significant alterations in immune response and cognitive function. In a study done on HIV positive men, results revealed that in order to achieve normal plasma nutrient values, the HIV+ men appeared to require intake in multiples of the Recommended Daily Allowance (RDA) for vitamins A, E, B_6, and B_{12} and zinc. For the HIV+ men, a relatively high proportion of biochemical deficiency was associated with consumption of vitamin B6 and zinc at the RDA level (Baum, 1998).

Nutrition evaluation and medical nutrition therapy (MNT) is an integral part of the ongoing health care programs of people with HIV and AIDS to address multiple factors that can contribute to health decline (Kotler, 2000). Medical nutrition therapy involves both assessment and appropriate treatments to maintain and optimize nutritional status. Nutrient-based treatment may include diet therapy, counseling, or the use of supplemental nutrition (oral, enteral, and/or parenteral delivery of nutrients). Symptoms that threaten nutritional status may require both dietary and medication interventions. Metabolic alterations that result in malnutrition may require additional therapies to achieve optimal nutritional status, such as hormonal and inflammatory modulation (Kotler, 2000).

Nutrient deficiencies develop in all stages of HIV disease, and are not just seen in patients with AIDS. Because early signs and symptoms of nutrient deficiencies are often non-specific in nature (e.g., fatigue, irritability, dry skin), many marginal or "sub clinical" deficiencies are not diagnosed until they have progressed to levels of significant body depletion (Baum, 1998). At this point, classic symptoms of deficiency such as visual changes (vitamin A), peripheral neuropathy (vitamin B_6), gingivitis (vitamin C), neurologic or neuropsychiatric symptoms (vitamin B_{12}), etc, may be apparent. Although these classic symptoms are not typically present with marginal deficiencies, enzyme systems and normal metabolic pathways may be significantly altered (Stephensen & Marquis, 2007).

Intestinal malabsorption leading to nutrient energy loss is common in patients with HIV and AIDS (Macallan *et al.,* 1993). Chronic weight loss in HIV and AIDS often is related to gastrointestinal disease and malabsorption (Macallan *et al.,* 1993). In addition to the damage to the intestinal villi caused by HIV, Cryptosporidium, one of the commoner and more serious opportunistic gut infections, for example, causes malabsorption and the degree of intestinal injury is related to the number of organisms infecting the intestine (Sharpstone *et al.,* 1999). Several studies have shown that those with more severe malabsorption have lower BMI (Arpadi, 2000). Children with HIV and AIDS can have devastating severity of diarrhoea, making it almost impossible to keep pace with rehydration therapy (Watson, 1994).

The impact of HIV on villi, specific enzyme deficiencies in intestinal mucosa, the effect of opportunistic infections and altered intestinal transit have all been considered as possible mechanisms but these are mainly conjectural and effective treatments remain to be developed.

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The impact of nutritional interventions which are known to improve diarrhoea and nutrient absorption in non-HIV populations such as zinc (Crenn *et al.*, 2004; Fawzi *et al.*, 2005), have not been evaluated in children with HIV and AIDS (Hatløy *et al.*, 1998). High levels of faecal fat occur; for example one study showed that over 90% of HIV-positive adult patients had high faecal fat levels that were not related to dietary fat intake (Fawzi *et al.*, 2005). Over 80% of HIV-positive patients in one study had faecal fat levels in the range of 20–30% of dietary fat intake (Kotler, 2000). With these high levels of fat malabsorption, a negative energy balance develops unless there is considerable increase in dietary energy. Fat malabsorption may be improved by use of pancreatic enzyme supplements (Kotler, 1997). Despite the well-documented evidence of fat malabsorption in HIV and AIDS, it is possible to achieve nutritional rehabilitation using high fat diets (Watson, 1994).

Carbohydrate malabsorption occurs in children with HIV and AIDS, even in those without bacterial or protozoal pathogens (Sharpstone *et al.*, 1999). Carbohydrate malabsorption is especially severe among children with immune depression (Fawzi *et al.*, 2005). Malabsorption of iron also occurs (Crenn *et al.*, 2004). Understanding nutrition in HIV infection can delay death thus this study assessed the food patterns, adequacy of nutrients, nutritional status and nutrients status of HIV sero-positive patients.

2.5.1 Acute Phase Proteins

Plasma levels of most acute phase proteins are altered in HIV, even in asymptomatic cases (Semba *et al.*, 1995). The role of these proteins in contributing to host immunity and carrying micronutrients in blood to tissues is increasingly recognized (Kotler, 2000). Levels of acute phase proteins in the blood are controlled by changes in production and breakdown in the liver

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and other tissues, together with alterations in the various pools of these proteins in the body (Beisel, 1996). Measurement of some of these processes provides an understanding of how their levels in blood and tissues are controlled (Gorbach *et al.,* 1993). The changes in acute phase proteins appear to be more related to severity of the infection and metabolic stress than to nutritional status or dietary intake (Semba *et al.,* 1995).

The acute phase response also influences interpretation of indicators of iron status. As a result of cytokine actions during generalized infectious illness, iron is quickly removed from the plasma and sequestered in storage depots (Kotler, 2000). The sequestered iron is not used for incorporation into the haemoglobin of new red blood cells. Thus in chronic infections, an anaemia may develop that is both hypochromic and microcytic, although it is unlike the usual form of iron-deficiency anaemia, because body iron stores remain high and plasma ferritin values are elevated (Gorbach *et al.,* 1993). This same pattern of sequestrated iron appears to hold true for patients with advancing HIV infections, for iron accumulates in their bone marrow and liver, in macrophages and in cells of the brain and muscles (Tang *et al.,,* 1993). In such situations, iron status may be determined by assessing iron status indicators.

Most of the body protein is present in the skeletal muscle (about 43%). The metabolism of protein and amino acids in skeletal muscle is profoundly affected by inadequate intakes of dietary nitrogen, energy and some specific essential amino acids (Gardner *et al.,* 2003). This can lead to a reduction in the size and metabolism status of muscle protein. These changes can be monitored by the measurement of creatinine and 3-methylhistidine in urine (Gardner *et al.,* 2003). There is a highly significant linear relationship between muscle mass and creatinine

excretion. Skeletal muscle (SM) mass decreases with disease in HIV infection (Yarasheski *et al.,* 2011). Results from a study conducted by Yarasheski *et al.,* 2011 among HIV infected adults showed that muscle mass is lower and decline faster in HIV-infected adults. Thus when there is adequate nutrient intake, the immune system is able to mount responses thus reducing susceptibility to infections. In this study haemoglobin, Mean Corpuscular Volume and creatinine indicators were used to assess nutrient status.

2.6 Impact of HIV on Body Composition

In the absence of adequate energy intake, body fat and protein are used as fuel sources, thus energy and protein metabolism cannot be separated within the context of clinical HIV and AIDS. During weight loss in HIV and AIDS the proportion of body stores that are lost, be they protein, fat or carbohydrate depends on the underlying nutritional state and the dietary intake. Thus the initial level of body protein and fat, together with the dietary intake and the severity of the inflammatory response will affect the rate of weight loss (Wilcox *et al.,* 1996). The proportion of loss of each compartment varies between individuals, possibly as a result of genetic differences. Fat is usually lost first and as body fat stores become progressively depleted, more lean body mass is lost per kilogram of total weight loss. The overall result is that protein depletion becomes more striking once fat reserves are lost. These changes are widely described in many wasting illnesses, but HIV seems to induce a special metabolic effect in the host involving a preferential loss of protein over fat (Macallan, 1999).

Evidence for preferential protein depletion in HIV comes largely from cross-sectional body composition studies in which patients with AIDS wasting have been found to have

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proportionately greater loss of lean mass than fat (Kotler, 1997). Not all studies support this hypothesis: in a longitudinal study of weight and body composition in HIV patients, the ratio of change in lean body mass to total body weight was similar to that found in dietary deprivation alone (Paton *et al.*, 2006).

Patients with HIV and AIDS, frequently experience episodes of clinical infection from repeated opportunistic pathogen infections, in between which they can rebuild nutrient stores. Repeated episodes of weight loss due to loss of fat and lean tissue followed by recovery appear to allow fat to be preferentially repleted. Indeed preferential fat repletion occurs elsewhere in post-starvation re-feeding (Crenn *et al.*, 2004), in TB (Guadalupe *et al.*, 2003) and in some severely malnourished children where they deposited more fat than protein if they were zinc deficient (Macallan, 1999). Loss of protein mass is markedly accelerated during opportunistic infections (Macallan, 1999). It is not, however, clear why some patients experience a starvation like metabolic response, whereas others, especially those with *Pneumocystis carinii* infection, for example, may experience a hypermetabolism (Joshi *et al.*, 2002).

Endocrine changes have been noted in chronic dietary deficiency and certain infections but their contribution to metabolism and changes in body composition seem particularly striking in HIV and AIDS. Gonadal function is altered in HIV infection and hypotestosteronaemia may result in substantial loss of muscle mass (Batterham, 2005). Screening for hypogonadism as part of the clinical assessment of HIV-infected patients provides the potential for endocrine treatment as a means of enhancing lean body mass. Loss of body protein during HIV and AIDS is therefore caused by poor diet, malabsorption, endogenous intestinal losses and altered metabolism. Thus

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adequate nutrition provides the support necessary and may assist in reducing these processes in HIV infection.

Depletion of protein stores adversely affects many aspects of morbidity and mortality from infectious disease (Crenn *et al.*, 2004). Early studies of HIV suggested that mortality correlated with loss of lean tissue rather than overall weight loss (Kotler, 1997). Studies support these findings (Guenter *et al.*,, 1993). However, the close association between the immune suppression from HIV, changes in blood levels of nutrients as a result of inflammation (Paton *et al.*, 2006), opportunistic infection and loss of lean body mass makes it difficult to determine how much the morbidity and mortality from an immunologically crippling disease are further contributed to by loss of body protein. The absence of carefully performed trials of nutritional supplementation makes it difficult to be absolutely certain as to how much nutrition interventions will improve the outcome of HIV and AIDS. However, it is possible to extrapolate from the many studies of the effect of nutritional interventions in other diseases; there are many examples of benefits in terms of progression, severity and survival among children with malnutrition and other diseases (Tang *et al.*, 1993; Hogg *et al.*, 1995). There are many interventions possible to overturn the detrimental effect of severe malnutrition in other diseases in children and adults (Kotler *et al.*, 1990). Nutrition intervention programmes can therefore be incorporated in the Comprehensive Care Clinics to help address malnutrition issues in HIV infection.

HIV-associated protein depletion is likely to have a major effect on work output and thus on the ability of an individual to generate income or produce food in economies without a well-developed welfare system. This will adversely affect the future nutritional state in a self-

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perpetuating spiral. Levels of lean body mass or body mass index at which function - whether physical activity, immune tolerance, recovery from illness or other measures declines has not yet been determined for patients with HIV and AIDS. There is enough evidence that overcoming even moderate malnutrition will have considerable benefits for health, development and survival (Gorbach *et al.*, 1993). Loss of body protein plays a key role in reducing immunity, delaying tissue repair and slowing recovery after opportunistic infection. Recovering body proteins requires a combination of improved infection control, increased food availability, including items which are palatable for those with anorexia and compassionate care and support.

2.7 Opportunistic Infections and Disease Progression

The number of $CD4^+$ lymphocytes in blood (the CD4 cell count) helps determine how well the immune system can protect the body from infections and severity of the HIV damage. Healthy people have a CD4 cell count of about 800 to 1,300 cells per microliter of blood. Typically, 40 to 60% of $CD4^+$ lymphocytes are destroyed in the first few months of infection. After about 3 to 6 months, the CD4 cell count stops falling so quickly, but without treatment, it usually continues to decline at rates that vary from slow to rapid. If the CD4 cell count falls below about 200 cells per microliter of blood, the immune system becomes less able to fight certain infections (such as the fungal infection that causes *Pneumocystis carinii pneumonia*), (WHO, 2005). These infections do not usually appear in people with a healthy immune system. Such infections are called opportunistic because they take advantage of a weakened immune system. A count below about 50 cells per microliter of blood is particularly dangerous because additional opportunistic infections that can rapidly cause severe weight loss, blindness, or death commonly occur (McCutchan, 2008).

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Figure 2.2 shows the viral load and CD4+ counts as a function of time in the progression of the HIV disease. The viral load is highest during the acute stage of infection. Transmission during early primary HIV infection can occur as early as seven days before the onset of acute retroviral syndrome (CDC, 1993). The notch in the CD4+ dashed curve at the maximum of the viral load is where the body mounts an HIV-specific immune response, thus driving down the viral load. This is followed by a period of clinical latency. As the immune system is destroyed, the virus rebounds and constitutional symptoms and opportunistic infections follow.
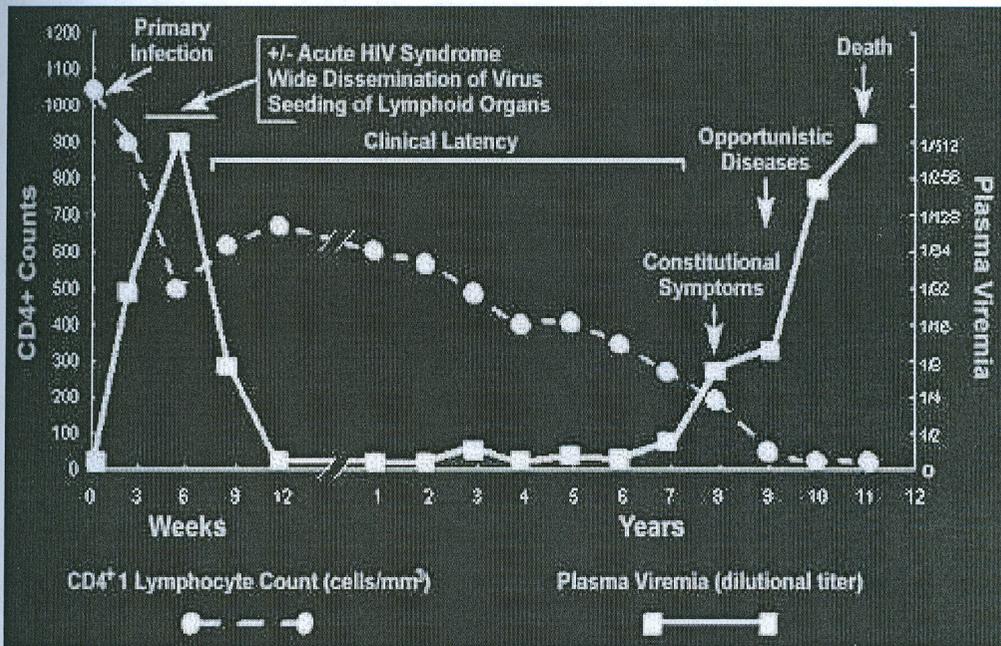

Figure 2.2: The Progression of HIV Disease

Source: CDC, 1993

2.8 Nutrition, Infection and Immunity

The causative Human Immunodeficiency Virus (HIV) was first identified in 1983, a time when published reports were beginning to describe AIDS-related cachexia and the fundamental role of

malnutrition in the pathogenesis of AIDS (CDC, 1993). Unexplained weight loss remains an important criterion in the diagnosis of AIDS (CDC, 1993). Nutritional status plays a cardinal role in the gradual progression of HIV infections to full-blown AIDS. Although combinations of antiretroviral drugs greatly reduce the HIV burden and delay the decline in T-helper (CD4+) lymphocytes, optimal nutrition plays a prophylactic role by supporting helper-cell proliferation and by ensuring the maintenance of other immune system activities as well as innate, non-specific aspects of host defense. The asymptomatic period of HIV infections is not nutritionally benign, for it is accompanied by production of pro-inflammatory cytokines, body hypermetabolism (Lambi *et al.,* 1996) and an accelerated metabolic degradation of many essential micronutrients (Baum & Shor-Posner, 1998). Body energy expenditure increases as the viral burden increases. These facts must be taken into account when providing prophylactic nutritional support.

Secondary infections and/or malignancies develop in HIV-positive individuals. These illnesses are accompanied by a release of additional pro-inflammatory cytokines, cytokine-induced cachexia, as well as reductions in both food intake and intestinal absorption of nutrients (Friis, 2006). Various forms of malnutrition lead to dysfunctions of the immune system and impair other host defensive mechanisms as well. These nutritionally Acquired Immunodeficiency Syndromes that result are intensely synergistic with AIDS (Beisel, 1996). This synergism permits the development of severe, protracted immune suppression and the secondary infections which lead to additional losses of body weight and nutrient stores, and early death. Intensive use of aggressive nutritional therapy during symptomatic AIDS can slow and sometimes reverse this downward spiral and can greatly improve the quality and duration of life (Beisel, 1996).

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Adequate nutrition/nutrition intervention in HIV may delay faster progression thus this study assessed the association between nutrition and immune factors.

2.8.1 The Gastrointestinal Tract and Immunity

The gastrointestinal tract (GI) is targeted during all stages of HIV disease, and this is especially so during acute and early HIV infection. CD4 cells are preferentially lost from the GI tract within weeks of HIV infection. Despite long-term antiretroviral therapy, $CD4^+$ T-cell reconstitution remains deficient in the GI tract in spite of the reconstitution seen in the peripheral blood. Studies conducted during the 1990s indicated that intestinal $CD4^+$ T-cell depletion may be an early feature of HIV-1 infection as well (Lambi et al., 1996) and that intestinal $CD4^+$ T-cell depletion is more substantial than depletion of $CD4^+$ T-cells in the peripheral blood (Schneider et al., 1995). During acute HIV-1 infection, a preferential and profound depletion of $CD4^+$ T-cells occurs within the GI tract (Mehandru et al., 2004). In the first of these studies, Guadalupe and co-workers described 2 individuals with acute HIV-1 infection in which significant $CD4^+$ T-cell depletion occurred within approximately 4 to 6 weeks of infection (Mehandru et al., 2004). Additional studies on one individual with acute HIV-1 infection (infected for <1 month) and 4 individuals with early HIV-1 infection (duration of infection was 4-9 months) were conducted. In all 5 subjects, a preferential $CD4^+$ T-cell depletion was noted in the intestines. A significant GI $CD4^+$ T-cell depletion was characteristic of all stages of HIV-1 infection (Brenchley et al., 2004; Mehandru et al., 2004).

Immune cells in the GI tract are organized into distinct anatomic and functional sub-compartments as shown in Figure 2.3 (Mehandru et al., 2004). These are classified as immune

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inductive sites, considered as sites of T cell education, and immune effector sites, where T cells neutralize foreign antigens—both microbial and non-microbial. Immune inductive sites are comprised of Peyer's patches (PPs) and mesenteric lymph nodes (MLNs) (Mehandru et al., 2004). Peyer's patches have the anatomic appearance of secondary lymphoid organs, with clearly defined T- and B-cell–dependent areas. A single layer of epithelial cells separates the PPs from the intestinal lumen. This epithelial cell layer contains specialized cells called M cells in addition to conventional enterocytes (Mehandru, 2007). The function of M cells is transport of antigen into immune inductive sites resulting in initiation of T-cell education and maturation. Further maturation of T cells continues within MLNs that drain GI mucosal tissue. MLNs are the crossroads of systemic and mucosal immunity. Within the MLNs, lymphoid cells from mucosal and systemic immunity interact, T-cell maturation continues, and it is likely that critical issues of gut homeostasis are determined (Mehandru, 2007).

Immune effector sites may be thought of as the battlegrounds where terminally differentiated T cells perform effector function, neutralizing antigen and protecting the host against invading pathogens. Effector site lymphocytes can be sub-classified into lamina propria lymphocytes (LPLs) and intra-epithelial lymphocytes (IELs). LPLs have a unique phenotype these cells are terminally differentiated effector T cells that have pathways of stimulation that are different from peripheral blood T cells. For example, it appears that LPLs proliferate at relatively low levels in response to antigen or other T-cell antigen receptor (TcR)–dependent stimuli (Mehandru et al., 2004). LPLs secrete large amounts of effector cytokines, such as IFN-γ, IL-4, and IL-5 (Taguchi et al., 1990) and have a unique requirement for CD2-dependent pathways of activation (Targan et al., 1995). The IELs also constitute a unique population of lymphocytes in the body. More

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than 80% of IELs are CD8^{+} and a substantial proportion express the CD8 $\alpha\alpha$ homodimer in contrast to the CD8 $\alpha\beta$ heterodimer expressed on a majority of peripheral blood CD8^{+} lymphocytes (Guy-Grand *et al.*, 1991).
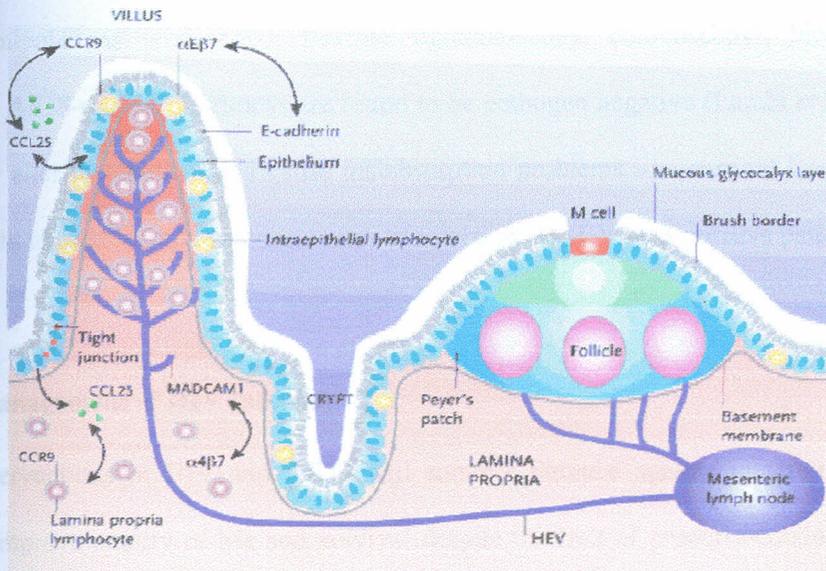
Figure 2.3: Organization of the Intestinal Immune System

Source: (Mehandru, 2007)

Diarrhoea is a very common symptom in persons with HIV infection and Chronic diarrhoea is frequently observed in association with AIDS (Suresh *et al.*, 2006). Diarrhoea causes direct losses of sodium, potassium and bicarbonate and possibly proteins and unabsorbed fats. Diarrhoea can also be associated with chronic mucosal inflammation (with detectable HIV in both mucosal lymphatic tissues and stools). Increased concentrations of plasma tumor necrosis factor (TNF) (Lambi *et al.*, 1996) may be detected during AIDS-related diarrhoeas, as may varying degrees of villus shortening and the malabsorption of nutrients including vitamin A and B$_{12}$ (Wilcox *et al.*, 1996). Most diarrhoea in AIDS patients is caused by secondary infectious

agents such as Cryptoporidia, Microsporidia, Clostridia, Salmonella, Campylobacter, Giardia, Amoeba, Cytomegalovirus and *Mycobacterium Avium* (Wilcox *et al.,* 1996). These agents are localized in different areas of the gastrointestinal tract. Organism isolation requires a variety of diagnostic manipulations (endoscopy, flexible sigmoidoscopy, colonoscopy), biopsies and cultures. Some AIDS-related diarrhoeas are found to be pathogen negative (Lambi *et al.,* 1996). Infections may alter metabolism and cause malabsorption problems like nutrient loss therefore this study sought to establish the types and rates of infections in HIV sero-positive patients.

2.9 Dietary Management of HIV Infection

Nutritional interventions in HIV and AIDS will enhance defence against infection, promote recovery and improve quality of life and survival despite the lack of properly-conducted trials. In a cohort of relatively healthy HIV-positive adults, benefits of intervention in terms of well-being and physical functioning score were rather small, however, there are many anecdotal reports of considerable weight gain as patients become effectively treated with ARVs (Watson, 1994). The absence of food seriously impairs the ability to respond to ARVs effectively. Those with severe HIV and AIDS associated wasting have profound fatigue and are unlikely to be able to maintain high levels of physical activity. However, physical activity needs to be considered more positively as a means of rebuilding muscle protein stores. Based on the role of nutrition intervention in HIV infection, this the study sought to establish the association of nutrition, infection and immune factors in HIV sero-positive patients.

Good nutrition for all individuals, but especially PLWHAs, requires the consumption of an adequate amount in the appropriate proportions of macronutrients (i.e. proteins, carbohydrates,

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and fats) and micronutrients (i.e. vitamins, minerals (FANTA, 2004). The HIV-infected person has additional energy needs because of energy used for HIV infection and opportunistic infections, nutrient malabsorption and altered metabolism. The various phases of the infection are marked by an increase in metabolism, increased energy needs, and nutrient depletion (Friis, 2006). These effects of infection often occur synergistically and result in weight loss and wasting. In the absence of AIDS symptoms (WHO stage 1), HIV-infected persons should increase energy intake by 10 percent over the level of energy intake recommended for healthy non- HIV-infected persons of the same age, sex, and physical activity level. In the presence of symptoms (WHO stage 2 and above), HIV-infected persons should increase energy intake by 20 to 30 percent over the level of energy intake recommended for healthy non-HIV-infected persons of the same age, sex, and physical activity level. These recommendations are for HIV-infected persons, including those taking HIV-related medications such as ARVs (FANTA, 2004).

HIV-infected persons do not require more protein than the level recommended for healthy non-HIV-infected persons of the same age, sex, and physical activity level. At the onset of opportunistic infections, the body loses nitrogen, which suggests a need or increased protein intake if opportunistic infections remain untreated (Macallan, 1999). Further research is needed on the optimal protein requirements of HIV-infected persons during the course of HIV disease. HIV-infected people often have pre-existing protein-energy malnutrition. Deficiencies of vitamins and minerals such as vitamins A, B-complex, C, E, selenium, and zinc, which are needed by the immune system to fight infection, are common in people living with HIV (Macallan, 1999). Deficiencies of anti-oxidant vitamins and minerals contribute to oxidative stress, a condition that may accelerate cell death and increase the rate of HIV replication. Good

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nutrition is best achieved by consuming a diverse diet with foods rich in micronutrients, especially vitamins A, B_6, B_{12}, and selenium, iron and zinc (Friis, 2006).

2.10 Knowledge, Attitude and Practices in HIV Management

Food and nutrition security are fundamentally important for the prevention, care, treatment, and mitigation of HIV and AIDS. Gillespie and Kadiyala showed that a programme of care without a nutritional component is likely to crumble, and the efficacy of ART may be compromised by malnutrition (Gillespie &, Kadiyala, 2005). Similarly, since access to and availability of food are affected by the impact of HIV, any strategy to improve nutrition of those affected must prioritize enhancing appropriate nutritional knowledge, attitudes, and use of the little available food (Bukusuba *et al.*, 2007).

Poor nutritional knowledge, attitudes, and dietary practices, therefore, play a role in the rapid progression of HIV. However, very little data exist concerning these aspects of nutrition among HIV sero-positive patients, such as Kenya. These aspects are also among the key factors that determine the quality of life among PLWHA, although they have been largely overlooked (Kim *et al.*, 2001).

A study conducted among adult HIV patients study in Uganda revealed that poor dietary practices among the study population are an example of the negative coping strategies that HIV-affected households use as the HIV and AIDS pandemic steadily erodes positive coping mechanisms of the households over the long run (Bukusuba *et al.*, 2007). The same study provided the evidence of negative impacts that HIV had on access to food in the affected

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households. The increasing failure of households to ensure the availability of adequate food and access, thus, hinders the practice of recommended nutrition habits for the PLWHA in these households. Changes in dietary quantity and quality are among the common coping mechanisms adopted among HIV patients (Bukusuba *et al.,* 2007). Other studies have shown low socio-economic status, level of education, personal beliefs, availability of food, and low nutrition knowledge as contributory factors to poor dietary practices (Torheim *et al.,* 2004; Hu *et al.,* 1997; HatlØy *et al.,* 2000; Ogle *et al.,* 2001; Dallongeville *et al.,* 2001).

The poor dietary practices among the PLWHA may also result from loss of appetite and anorexia, thus reducing the frequency of meal and variety at the very time when their requirements are higher, i.e. up to 50% and 15% increase in protein and energy respectively (Haddad & Gillespie, 2001). Given the fact that the poor nutritional practices are linked to deterioration in immunity and subsequent nutritional status of the PLWHA, interventions geared at improving the practices are essential in the prevention of rapid progression of HIV.

2.11 Gaps in Knowledge

There is evidence that nutritional status and immune status are tightly linked and that immune integrity can be rapidly altered by changes in nutritional status (Friis, 2006). Whereas many studies have been reported on nutrition and HIV infection, or HIV and the immune system (Friis, 2006) knowledge on the association of nutrition, infection and immune function, remains scanty. Early studies demonstrated that weight loss and wasting were associated with increased risk of opportunistic infections and shorter survival time in HIV-positive adults, independent of their immune status (Baum & Shor-Posner, 1998). In the same studies, it was demonstrated that

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clinical outcome was poorer and risk of death was higher in HIV-positive adults with compromised micronutrient intake or status, (Baum & Shor-Posner, 1998). Many organizations have produced excellent state-of-the art papers and guidelines on different technical aspects of nutrition responses to HIV and AIDS, but the materials have not necessarily found their way into the work and resource allocations of national HIV and AIDS commissions or secretariats or other national partners, in the public sector (WHO, 2005).

Addressing gaps in nutrition among people living with HIV and AIDS (PLWHA) is essential because nutrition plays a vital role in the care and management of HIV and AIDS as it is intrinsically linked to immune function (Tang *et al.*, 1993; Steinhart, 2001; Tang, 2003). This study was therefore, undertaken to assess the gaps in association of nutrition, infections and immune status among HIV sero-positive patients.

CHAPTER THREE: RESEARCH METHODS

3.1 Introduction

This chapter presents the research methods adopted for this study. The chapter includes: study setting; the design; study population; sample size and sampling procedure; data collection instruments; reliability and validity; pre-testing; data collection procedures; data analysis and ethical consideration.

3.2 Study Setting

This study was carried out at Chulaimbo Sub-district hospital which is situated in Kisumu West District in Nyanza Province, Kenya. Kisumu West District borders Kisumu East to the East, Vihiga to the North East, Emuhaya to the North, Siaya to the North West, Rarieda to the West and Lake Victoria to the South. It lies within longitude 33 20'E and 35 20'E and latitude 0.20'S and 0.50'S. The District's fertility rate is 5.8 births per woman (Ministry of State for Planning, 2010). The District has two administrative divisions namely Maseno and Kombewa and further sub-divided into 8 locations and 37 sub-locations. The mean annual rainfall is 1,630 mm as recorded at Maseno. The mean annual temperature ranges from 20°C to 30°C. The district has a wide range of soil types but is mainly dominated by vertisols on the uplands are curbsides and lavishly of volcanic origin which have low fertility. The area receives an annual rainfall of 1500-1800 mm (Ministry of State for Planning, 2010). There are various socio-economic activities undertaken by households in the area in order to generate income. These include casual labour, fishing, small scale business e.g. sale of vegetables and small scale farming of food crops such as maize, rice, sorghum vegetables and beans.

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AMPATH has 18 care sites that offer comprehensive care in western Kenya with a catchment population of 2 million. The HIV prevalence ranges between 2 – 30% and >70,000 patients are enrolled in different sites with 55,000 in care and 25,000 on Antiretroviral Therapy (ART). AMPATH Nutrition services offered at the sites include: Nutrition assessment, education and counseling; Food prescription; Food distribution; AMPATH HAART 'n' Harvest Initiative (HHI) farms; Community-based therapeutic feeding (CTF) program; Infant and young child feeding; Nutrition Information System. The setting chosen for the study was Chulaimbo Sub-district Hospital, one of the 18 sites in western Kenya, as shown in Appendix 1. The hospital is one of the Academic Models for the Prevention and Treatment of HIV and AIDS (AMPATH). It is located in Maseno Division, Kisumu West District. Chulaimbo Sub-district Hospital is located along Kisumu-Busia Road about 17 km from Kisumu town as shown in Appendix 2. The study was carried out within the AMPATH clinic in Chulaimbo Sub-district Hospital.

Chulaimbo Sub-district hospital was chosen because it is located in an area where HIV and AIDS prevention and control remains a serious social challenge, with a prevalence rate of 11.2% far above the national prevalence rate of 7.4% (KNBS & ICF Marco, 2010) but slightly below the Nyanza prevalence rate of 15.3% (Ministry of State for Planning, National Development and Vision 2030, 2010). The United Nations Development Programme (UNDP, 2002) has cited Nyanza Province as having the greatest number of poor people in Kenya. The relationship between poverty and the HIV and AIDS infection cannot be overemphasized.

3.3 Study Design

The study adopted a longitudinal research design. This design was chosen for this study because there is accuracy of data collection with regard to exposures, confounders, and endpoints (Rothman *et al.,* 2008). HIV sero-positive patients were followed every month for a period of six (6) months to assess nutrition, immune factors and infections as illustrated in Figure 3.1.

Patient identification	Start study	End of study
(January 2010)	(February 2010)	(July 2010)

| **Hospital records**

- Identification of the patients
- Identification of Medical information of patients | **Composition of cohort and baseline assessment**

- Demographic and socio-economic characteristics
- Nutrient intake
- Dietary diversity
- BMI
- Infection patterns
- Knowledge, attitude, beliefs and practices
- Immune status | **Assessment of outcome**

- Socio-economic characteristics
- Nutrient intake
- BMI
- Infection patterns
- Immune status |

Figure 3.1: The Timelines in the Study

3.4 Study Population

The population of this study comprised of female and male patients enrolled in the AMPATH clinic at Chulaimbo Sub-district Hospital. There were 14,399 HIV sero-positive patients enrolled at the AMPATH clinic at the start of the study. This ensured that the results of the study were purely patients enrolled in the AMPATH clinic. There were 3,230 paediatrics patients, 869 were

PMTCT mothers and 1,500 were patients above 60 years. The final sample size for study was based was 9,100 patients. The sampling unit was an adult patient either female or male aged 18 to 60 years attending clinic and were identified from the hospital records who had information on CD4 cell count.

3.4.1 Inclusion Criteria

HIV sero-positive patients within the age range of 18 – 60 years old who had information on CD4 cell count in January 2010 and consented to participate were recruited in the study. The burden of infections is statistically higher among females than males until age 35 after which the ratio of female to male infections starts to approach 1.9 to 1 (NASCOP *et al.*, 2008). The out-patients who had been enrolled in the AMPATH clinic within the six (6) months preceding the study were included in this study. The six months period was chosen because the patients at this stage will have undergone most of the procedures required for the programme.

3.4.2 Exclusion Criteria

Those aged less than 18 years and above 60 years, inpatient, Prevention of Mother to Child Transmission (PMTCT) mothers, eligible patients who declined to provide written consent to participate in the study and those who had not been enrolled in the AMPATH clinic for the last six (6) months that preceded the study were not included in the study.

3.5 Sample Size and Sampling Procedures

Given that the specific populations based on the detailed age categories are likely to be more than 10,000 (Kenya National Bureau of Statistics Projections, 1999) the independent sample units was determined using Fisher's formulae (Fisher *et al.*, 1991) as shown below:

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$$n = \frac{Z^2 \, pq \, D}{d^2}$$

Where: n = minimum sample size (for population >10,000) required.

Z = the standard normal deviate at the required confidence level, (set at 1.96 corresponding to 95%, Confidence level adopted for this study).

p = population proportion estimated to have a particular characteristic. (Where there is no reasonable estimate a default of 50% or 0.5 was acceptable).

q = 1-p

d = the degree of accuracy required (usually set at 0.05).

D = the design effect.

Therefore, on substitution: $n = \dfrac{1.96^2 \times 0.5 \times (1-0.5) \times 1}{0.05^2}$

$$n = 384.16 \approx 385$$

Based on the pilot study, an additional 29% was added to cover for the anticipated non-responses and fouled (spoilt) questionnaires. A non-response rate of 20% should be used because it yields more accurate measurements than higher non-response rates (60% or 70%) (Visser *et al.*, 1996; Keeter *et al.*, 2006).

Therefore;

$$\frac{29}{100} \times 385 = 112$$

Therefore;   385+ 112 = 497

Simple random sampling technique was used to select the patients. All the HIV sero-positive patients who were expected to attend the clinic that month were assigned random numbers ranging from 1 to 9100 and a random number table used to select 497 patients as follows:

1) The first step was to assign all the patients expected in a month numbers ranging from 1-9100 having determined the population size of 9100 and sample size of 497.

2) The next step was to determine starting point in table by randomly picking a page and dropping a finger on the page with eyes closed.

3) The third step was to choose a direction in which to read (up to down, left to right, or right to left).

4) The fourth step was to select the first 497 numbers read from the table whose last 4 digits were between 0 and 9100. (This was done because 9100 was a four digit number).

5) Once a number was chosen that number was not used again.

6) In case the end of the table was reached before obtaining the intended 497 unique numbers, another starting point was picked and reading made in a different direction and using the first 4 digits until done.

This process was blinded for the research assistants by concealing the patient's clinic numbers. This was done to increase confidentiality on the patient/keep patients anonymous.

3.5.1 Patient Selection

The investigation was performed by the researcher with the help of ten research assistants. The patient's entry point to the AMPATH clinic was through Voluntary Counselling and Testing (VCT), Prevention of Mother to Child Transmission (PMTCT), laboratory and pediatrics clinic.

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After the diagnosis through these entry points, the patients are registered and attended to by the nurses and then observed by the clinicians. They are then referred to pharmacy for collection of drugs, laboratory for different laboratory tests as prescribed by the clinician, X-ray in case of any chest related problem, nutrition for nutritional support especially those who met the criteria for the programme or Income Generating Activity for advice on activities to be carried out to generate income before being released to go home as shown in Figure 3.2.

The study population was selected among HIV sero-positive patients attending the outpatient clinic from February 2010 to July 2010. Only those who provided written informed consent were included in the study. Data was collected two days a week between Tuesdays to Fridays. Each patient was recruited once only, on his or her first visit during the study period. The patients were first sensitized on the objectives and importance of the study during the health talks in the morning before the clinic sessions started. The researcher with the help of the psychosocial worker gave a nutrition/health introductory talk. The patients included in the study had their files and clinic cards tagged with green stickers labeled MU (Maseno University). This was done to be able to identify the patients on every visit to the clinic for the period of the study. Clinicians on duty in the outpatient department on the selected days (Tuesday and Wednesday) attended to the patients after the interviews and gave them a return date of one month. The patient flow is approximately 200 to 250 per day and the researcher interviewed 100 to 150 per day with the help of the research assistants.

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VCT   PMTCT WARD LAB PAED

AMPATH CLINIC (registration)

NURSES

CO   CO   CO   CO   CO   CO

PHARMACY   LAB   X-RAY   NUTRITION   IGA

HOME
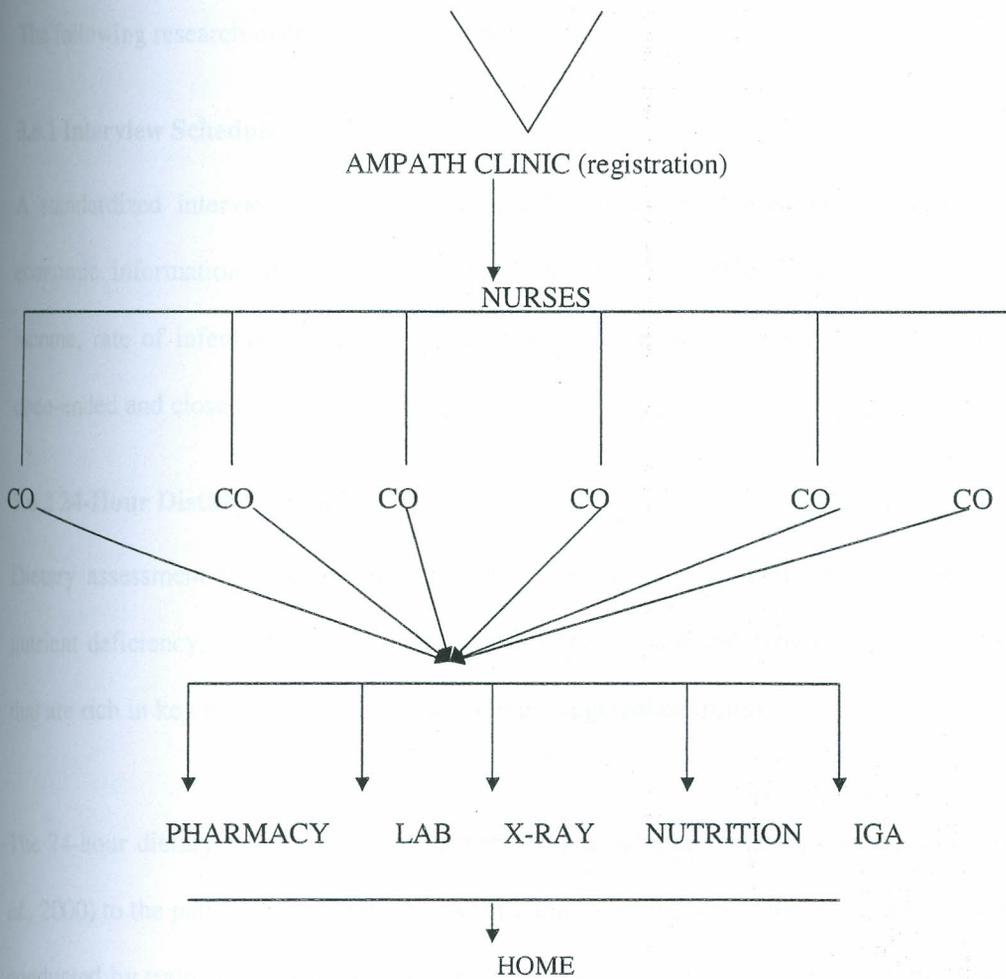
Key:
VCT: Voluntary Counselling and Testing
PMTCT: Prevention of Mother to Child Transmission
LAB: Laboratory
PAED: Paediatrics
CO: Clinical Officer
IGA: Income Generating Activity

Figure 3.2: Patient Flow at AMPATH Clinic

3.6 Data Collection Instruments

The following research instruments were employed in the study:

3.6.1 Interview Schedule

A standardized interview schedule was used to collect morbidity, demographic and socio-economic information of the patients (Appendix 4). This yielded data on the age, gender, income, rate of infections and livelihood activities. The interview schedule consisted of both open-ended and closed-ended questions.

3.6.2 24-Hour Dietary Recall Survey

Dietary assessment is a proxy indicator of a client's nutrient intake and risk of energy and nutrient deficiency. The tool was used to assess the amount and frequency of foods consumed that are rich in key nutrients (e.g. animal sources, vegetables, fruits).

The 24-hour dietary recall was administered using a validated interview schedule (Resnicow *et al.*, 2000) to the patients attending AMPATH clinic (Appendix 5). Dietary intake assessment was conducted by trained research assistants once a month for six months. Data using 24-hour recall was collected from all 497 patients. The recall method is useful for estimating intakes in culturally diverse populations, such as Chulaimbo Sub-district hospital in Kisumu West District, representing a wide range of foods and eating habits. The 24-hour recall method is susceptible to recall bias, both for identification of foods eaten and for quantification of portion sizes. Collecting dietary data by trained research assistants in this study reduced this type of error. The 24-hour dietary recall describes reported intakes from midnight to midnight and meal after meal.

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Individuals were asked whether the day of recalls was a usual day or not. Each respondent was asked to demonstrate the quantity of a given food that he/she consumed in the last 24 hours via an interview. The 24-hour recall forms were completed by the research assistants every month for six months starting February 2010 to July 2010; the 24-hour recall hence showed the usual intake of patients. Standard reference tables (United States Department of Agriculture National Nutrient Database) were used to convert household portions to grams for computerization (Kotler *et al.*, 1990). After coding, the dietary recall form was linked to a nutrient database and nutrient intakes calculated using the Nutri-Survey Software for conversion of quantity to serving of food consumed. For mixed dishes, food groups were calculated according to their ingredients. The data was modified according to the Kenya Food Composition Table as previously described by (Sehmi, 1993).

3.6.3 Food Frequency Checklist

The food frequency checklist was used to collect information on food items or food groups consumed by the HIV patients (Appendix 6). This was assessed by the use of a food frequency checklist questionnaire. At baseline, a validated food frequency checklist questionnaire was used to determine the variety of food groups (Resnicow *et al.*, 2000). Both traditional and western foods were included in the food frequency checklist questionnaire. A food frequency checklist questionnaire was chosen to determine the dietary variety because it is believed to be a suitable method for use in describing the intake of groups rather than for individuals, and is commonly used in epidemiological studies to determine the relationships between diet and disease (Dwyer, 1998). It also provides an overall picture of food intake, which was found to be relatively cheaper and more representative of the usual food intake than a few days of diet records (Hammond, 2004). Each patient was asked to state the number of times each food was consumed

on a daily, weekly or monthly basis via an interview. The food frequency checklist questionnaire was completed by the research assistants.

3.6.4 Anthropometric Assessment

Anthropometry is an indicator used to assess the general nutritional status of an individual. Anthropometry was used to assess and predict performance, health and survival of the patient. This comprised taking the weight (kg) and height (m^2) of the patient which yielded data on their Body Mass Index (BMI). A BMI of < 18.5 kg/m^2 was considered as underweight, $18.5 - 24$-9 kg/m^2 normal, overweight $25 - 29$ kg/m^2 and < 30 kg/m^2 obese based on the WHO guidelines (WHO, 2005) (Appendix 7). In the anthropometric measures, the researcher used a square-faced weighing scale (Seca 881 U) which was calibrated and a height board that was placed on a levelled floor. These measurements were taken every month for six months to provide data on the weights and heights of the patients.

3.6.5 Biochemical and Blood Cell Assessment

Biochemical evaluations are used to assess nutritional status, monitoring for opportunistic infections, and disease progression (Appendix 8). The tests are advantageous because they provide information on a patient's risk of nutrient deficit long before anthropometric changes can be detected. Often, they complement other tests such as clinical presentations. They are also important in monitoring the effects of treatment. This involved taking blood and urine samples from sites of the patient's body. The samples were obtained twice per patient, at the beginning (February 2012) and at the end of the study (July 2012). Blood was collected using a vacutainer system. The urine sample was used to measure urinary creatinine while CD4 cell count, WBC (white blood cells), MCV (Mean corpuscular volume), platelets and haemoglobin level were

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measured in the blood sample. These parameters are used to detect immune status and levels of nutrients in body tissues or fluids or decreased activity of an enzyme that is nutrient-dependent. The procedures used were developed from Integrated HIV and AIDS Prevention, Treatment and Care Manual: Unit 2 Clinical Laboratory in Diagnosis and Treatment of HIV and AIDS (AMREF, 2007).

3.6.6 Measures of Immune Status

The patient's WHO staging was first assessed based on the clinical symptoms using the WHO (2005) guidelines as shown in Table 2.1. The immunological assessment methods included CD4 cell count which yielded the actual CD4 cell count and CD4 cell percentage (%) of the patients. They are cells marked with specific molecules on their surface (called cluster of differentiation, or CD) that identify their immune function. The patients were categorized into three main groups according to their CD4 cell count; mild patients (category -1) were those who had a CD4 cell count above 500 cells/mm^3 (cells per cubic millimeter of blood), moderate patients had a CD4 cell count between 200 to 499 cells/mm^3 (category - 2) and severe patients had a CD4 cell count below 200 cells/mm^3 (category - 3).

3.6.7 Focus Group Discussions (FGDs)

Focus group discussions are a form of group interview conducted to fill gaps, which were not addressed through quantitative analysis. The FGDs were guided by a specific outline that was structured to be flexible enough to allow themes relevant to the participants to emerge (Appendix 9). Participatory techniques (e.g. listing and ranking) were used during FGDs to ensure that all participants were involved in the discussion. In the context of this study, FGD guide was used to elicit information on themes related to HIV and nutrition management. The construction of the

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two guides were drawn from the concepts of Kenya National Guidelines on Nutrition and HIV and AIDS (Ministry of Health, 2007). The main concepts drawn from the guidelines included relation between nutrition and HIV and AIDS, nutritional care and support of People Living with HIV and AIDs and communication about nutrition and HIV and AIDS.

The FGDs involved six to twelve participants selected randomly from the study target. The exercise was conducted with a heterogeneous representation within the participating patients to obtain diverse responses. The number of focus group sessions conducted is mediated by factors such as the purpose and scale of the research, as well as the heterogeneity of the participants (Morgan, 1993). The FGDs allowed the team to record a large amount of relevant information within a limited period and were conducted according to a pre-arranged topical outline. Eight FGDs involving both male and female participants were carried out. There was an observer whose main task was to observe the session and to take notes and a moderator who was the discussion leader, and whose role was to control the session and give the direction of the focus group.

3.7 Pre –testing Instruments

The main aim of the pre-test was to validate the research instruments and ascertain their reliability. The pre-test helped check the appropriateness of the language used in the tools and to contextualize them for predictability. That way, the pre-test enabled the researcher to identify items that were ambiguous and reconstructed them. The researcher pre-tested the instruments on the patients enrolled in the AMPATH clinic. The patients of the pre-test were 50 (10%) who were randomly selected. These patients did not however take part in the main study. The pre-test

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patients were encouraged by the researcher to make comments and give suggestions concerning the items. Data collected at the pre-test was analysed and the results used for appropriate amendments of the research instruments.

3.7.1 Reliability and Validity of Data

3.7.1.1 Questionnaire: Reliability and Validity

The results from the pre-test were used to ascertain reliability. This was done by comparing answers to questions in different questionnaires so as to check for ambiguity. Test-Retest Reliability was used to assess the consistency of a measure from one time to another. The time between one test and the other was one week. The shorter the time gap, the higher the correlation; the longer the time gap, the lower the correlation. This is because the two observations are related over time, the closer in time, the more similar the factors that contribute to error (Fraenkel & Wallen, 2000). Face validity demonstrated that the questions measured what they intended to measure. Content validity is estimated by comparing the sample of items with the content and behaviours, which they should represent. If the sample of items cover all aspects of the content of behaviours, a high degree of content validity is attained (Nwadiuto, 1997). Content validity also has to do with the format of the instrument, which includes clarity of printing, size of type, adequacy of workspace, appropriateness of language and clarity of directions (Fraenkel & Wallen, 2000). Content validity was achieved by giving the instruments to the nutrition professionals to go through. Both face validity and content validity were ascertained. In effect, the reliability of the instrument was judged by estimating how well the items that reflect the same construct yield similar results.

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3.7.1.2 Quality Control

In order to ensure that there was quality in the handling the specimen, two government trained laboratory technicians with a certificate from the Kenya Medical Laboratory, Technicians and Technologists Board (KMLTTB) were engaged. The weight and height measurements were taken by two trained nurses using standardized and calibrated weighing scales and height boards. The personnel assisting were diploma holders from recognized institutions. The calibration was carried out following the procedures below: The weighing scale and height board was put on a flat and firm surface. An uneven surface such as a rug or mat can alter your readings and give inaccurate results. The scale was set it to read zero kilograms. This is also known as "zeroing" your scale. A known weight was placed on the scale like the 20 litres jerrican of water twice and the average of the results calculated to come up with a desired weight.

3.8 Data Collection Procedures

3.8.1 Qualitative Data Collection

A total of 8 focus group discussions were carried out with the participants (male and female) 18 - 60 years old until saturation, to elicit information on attitude, practices, perceptions and knowledge on nutrition management of HIV. Focus group discussions were conducted with optimal number of participants eight (8) per session. Sessions were conducted by a trained nutrition facilitator to ensure consistency in responses among the participants of the eight sessions while allowing flexibility for the patients to share their experiences. The purpose and objectives of the study were explained to the participants at the onset of the FGDs and confidentiality of their identities was ensured. Each participant signed a consent form and was

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required to fill in basic socio-demographic data. Each focus group was audio and audio-visual taped with participants' permission, and each session lasted about 45-90 minutes.

During the FGDs, the observer took notes of the discussions so that important points were not left out. Participants were encouraged to speak freely and to describe their experiences in managing HIV infection. Prompts were also used if the participants did not mention certain related topics spontaneously. The study was terminated with saturation of ideas after eight FGDs. The tape-recorded interviews were transcribed in their entirety into text files. The transcripts were read and checked independently by the researcher to ensure consistency.

3.8.2 Quantitative Data Collection

The researcher recruited eighteen personnel to assist in data collection, which included ten research assistants (undergraduate level of education), a nutritionist, two nurses, two laboratory technicians, records personnel, outreach personnel, and a psychosocial worker. The personnel underwent training for two days. The training involved both lecture-based and interactive practical applications. The research assistants were given interview schedules in English in addition to other instruments. The tools were translated to Kiswahili and the local language to accommodate respondents not conversant with English. The ten research assistants were again trained for one day after the baseline investigations on how to use the follow-up tool. The clinicians were briefed on the study objectives and their involvement in the study.

3.8.2.1 Demographic and Socio-economic Characteristics

Data was collected using an interview schedule which was administered to the patient by the researcher and research assistants. The interview schedule was filled during the interviewing process. Data on socio-economic characteristics was collected every month for six months from February 2010 to July 2010.

3.8.2.2 Blood Collection Procedures

A full haemogram was conducted to generate data on haemoglobin, MCV, WBC, Platelets. The equipment used included evacuated collection tubes that are designed to fill a predetermined volume of blood by vacuum; Needles with the gauge number indicated and the larger the gauge number, the smaller the needle bore; A holder was used with the evacuated system; Tourniquets were used for ease of vein identification; Cotton swabs was used to wipe off with alcohol and replace frequently; The Alcohol wipes used were 70% isopropyl alcohol; Adhesive bandages/tape was for protecting the venipuncture site after collection; there was a needle disposal unit, where any broken, bent, or recapped and the used ones were disposed unit immediately after their use; the gloves were made of latex, rubber, or vinyl, and were worn to protect the patient and the phlebotomist and syringes was used in place of the evacuated collection tube for special circumstances.

The blood sample was obtained following some procedures which included, first checking the request form is checked for the test to be carried out. The requirements were then availed e.g. swabs, plastic hub, a hypodermic needle, vacuum tubes with rubber stoppers of various colors and a single BD vacutainer device (Becton, Dickinson and Company). The vein was located and blood (serum) was obtained from the median cubital vein following standard procedures. 2.5 ml

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of blood was withdrawn from each patient for a full haemogram. The tourniquet was applied 3-4 inches above the selected puncture site. It was not placed too tightly or left on more than 2 minutes. The needle shield was removed and venipuncture performed with patient's arm in a downward position and tube stopper uppermost. This reduces the risk of backflow of any anticoagulant into the patient's circulation. A dry swab was put at the place punctured and then the blood samples were labeled and place in a rack.

The specimens for CD4 cell count, WBC and platelets were stored in vacutainer tubes at room temperature for 12 hours before transportation for analysis. The specimens for creatinine was stored in micro cryvial tubes in the refrigerator. Specimens for haemoglobin test were used immediately as this test was done at Chulaimbo Sub-district Hospital. The other specimens collected at Chulaimbo Sub-district hospital laboratory, were stored appropriately and transported to Busia for analysis.

3.8.2.3 Urine Collection Procedures

Urine analysis was used to yield information on creatinine levels. The first morning specimen was used for urinalysis, since the urine is generally more concentrated (due to the length of time the urine is allowed to remain in the bladder) and, therefore, contains relatively higher levels of cellular elements and analytes such as protein, if present. The urine collection container (3 litres for 24-hour collection) made of break-resistant plastic with a wide-mouth (the wide base prevents spillage and a 4 cm opening is an adequate target for urine collection), secure lid (to prevent specimen loss and to protect the specimen from contaminants), clean, and properly labeled was used. The laboratory supplied proper preservative (boric acid) with the container and it was given to the patient prior to the collection. After the patient brought back the specimen

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they were well labeled to include the patient name and identification, time and date and the time the specimen was received in the laboratory was documented for verification of proper handling after collection. The specimen was then processed within 2 hours of collection.

3.8.2.4 Immune Status

Data on immune status of the patients was collected from the hospital records at the start (February 2010) and at the end of the study (July 2010) from assessing blood samples for CD4 cell count, white blood cells and platelets. In persons with untreated HIV infection, the CD4 count declines by approximately 50-80 cells/µL per year, on average. The pattern of decline may be slow and steady, or the CD4 count may level off for an extended period of time (as in long-term non-progressors) and then decrease (CDC, 2009). CD4 cell count was used to help evaluate the progression of HIV infection shown in Table 3.1. CD4+ percentage (%) is used to determine the number of CD4 cells in a sample of blood. The CD4 % is a more reliable measurement than the CD4 cell count because it tends to vary less between measurements.

Table 3.1: CD4 Levels in Relation to the Severity of Immunosuppression

Immunosuppression	CD4 level
Not significant immunosuppression	> 500/mm3
Mild immunosuppression	350 – 499/mm3
Advanced immunosuppression	200 – 349/mm3
Severe immunosuppression	< 200/mm3

White blood cell (WBC) count is a count of the actual number of white blood cells per volume of blood. White blood cells (leukocytes) carry out the body's immune responses. The platelet count

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is the number of platelets in a given volume of blood. Mean platelet volume (MPV) is a machine-calculated measurement of the average size of platelets. New platelets are larger, and an increased MPV occurs when increased numbers of platelets are being produced. MPV gives information about platelet production in the bone marrow. Platelets (thrombocytes) are necessary for blood clotting.

3.8.2.5 Nutrient Intake, Nutritional Status and Nutrient Status

Data on nutrient intake and nutrient status included 24-hour dietary recall data, food frequency checklist data, BMI, creatinine, haemoglobin, and MCV. Nutrient intake data was collected every month for six months and nutrient status was assessed at the start (February 2012) and at the end of the study (July 2012). The 24-hour dietary recall was used to assess the nutrient intake. The food frequency checklist was used to assess the variety in food groups. A varied and adequate food intake may provide all the nutrients the body requires. Food frequency checklist was administered by the research assistants with the assistance of the nutritionist. BMI was derived from the weight (kg) divided by height (m^2).

A full haemogram was conducted to generate data on haemoglobin and Mean Corpuscular Volume (MCV). Hemoglobin (Hb) measures the amount of oxygen-carrying protein in the blood. Hb is a protein molecule in Red Blood Cells (RBC) that helps them transport oxygen from the lungs to tissues and organs. This protein also helps the RBC carry off excess carbon dioxide. MCV is a measurement of the average size of the RBCs. The MCV is elevated when the RBCs are larger than normal (macrocytic), for example in anemia caused by vitamin B_{12} deficiency. Urine sample was used to generate data on creatinine levels. Creatinine is the waste product of protein metabolism excreted by the kidneys.

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3.8.2.6 Pattern of Infections

A morbidity survey tool was used to collect information on the types and the rate of infections of the patients every month for six months. This tool was administered by the research assistants with the help of the clinicians and researcher. With an increase in the rate of infections, the patient may progress faster from HIV to AIDS.

3.9 Measurement of Variables

3.9.1 Independent variables

Immune factors were a categorical variable.

3.9.1.1 Immune Factors

This comprised of data on mild, moderate and severe categories of CD4 cell count levels. The patients were categorized into the three groups according to their CD4 cell count. Mild were patients with a CD4 cell count above 500cells/mm^3, moderate were patients with CD4 cell count between 200 – 499cells/mm^3 and severe were patients with CD4 cell count below 200cell/mm^3. CD4 cell count was used to help evaluate the progression of HIV infection. The normal adult values for CD4 cell counts ranged from 500 - 1,200 cells/mm^3 and a CD4 cell count below 200 cells/mm^3 may increase susceptibility to infections that are normally controlled by the immune system. CD4+ percentage (%) is used to determine the number of CD4 cells in a sample of blood. The CD4 % is a more reliable measurement than the CD4 cell count because it tends to vary less between measurements. Normal adult values are between 30 - 60%. A CD4 percentage at or below 13% regardless of what the actual CD4 cell count usually means that the immune system is damaged.

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3.9.2 Dependent variables

These were both categorical and continuous variables. They comprised of nutrient intake, nutrient status, infections, BMI, immune status measures, demographic, socio-economic, knowledge, attitude, beliefs and practices characteristics of the sampled patients'.

3.9.2.1 Patient demographic characteristics

This comprised data and information on background characteristics as age, sex, educational level, occupation, religion, marital status, residence and size of the household. Age was defined as years since birth; household size as the sum of all household members; sex as male or female; occupation as type of income generating activity; educational level as highest level of education attained; The solicited data facilitated assessment and interpretation of patients' population by age and sex; household size and educational attainment.

Patient by Age and Sex: Age and sex are the primary basis of demographic classification. The information was used to show the percent distribution of patient's exact age in years according to sex, marital status, religion and residence.

Patient Household Composition: The solicited data and information was used to show percent distribution of the patients' by number of persons in a household.

Education Level of Patient: The generated data on educational attainment of the patients' was used to show percent distribution of patients by highest level of schooling attended according to background characteristics.

3.9.2.2 Socio-economic status

This comprised data and information on patient's economic activity and income.

Patient income: This part provided data and information on patient's source of income ranging from formal employment, fishing, business, agriculture; the average total monthly income of the patients'. This was used to show the percentage distribution of patient's by type of income source and average monthly income.

3.9.2.3 Immune Status Measures

This comprised of White Blood Cell Count (WBC) and platelet count. Change in immune status indicators over six months was assessed by computing the difference between the values at the end of the study (6th month) and at baseline. Normal adult values for WBC count ranged from 4,000 - 11,000 cells/mm^3. A WBC increase often indicates that a person is actively fighting an infection or has recently received a vaccine. Decreased WBC (leukopenia) can leave a person vulnerable to various pathogens and cancers. Normal adult values for platelet count ranged from 130,000 to 440,000 cells/mm^3. Low platelet counts (thrombocytopenia) can lead to easy bruising and excessive bleeding.

3.9.2.4 Nutrient Intake, Food Variety and Frequency of Meals

This comprised data on nutrient intake of the patients. A 24 hour recall was used to compute the patient's average usual intake and frequency of meals over the study period. A food frequency checklist was used to collect data on food variety among the patients. Usual intake was assessed by comparing it to Recommended Daily allowances (RDA), frequency of meals was assessed by computing the number of meals consumed in a day and food variety was determined by the

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number of times one consumed different food items from a food group. A diet was considered varied if a patient consumed two or more food items from one food sources.

3.9.2.5 Nutrient Status Indicators

This comprised of haemoglobin, Mean Corpuscular Volume (MCV) and creatinine. Change in nutrient status indicators over six months was assessed by computing the difference between the values at the end of the study (6th month) and at baseline. Normal haemoglobin levels in adults were considered as between 14 - 18 g/dL for men and 12 - 16 g/dL for women. With low Hb, there may be poor healing and less efficient organ function resulting in anaemia. Normal MCV levels in adults were considered as ranging from 79 - 100 femtoliters (fl). When the MCV is decreased, the RBCs are smaller than normal (microcytic) as is seen in iron deficiency anaemia or thalassemias (anaemia associated with inflammation). A normal blood creatinine level ranged from 0.6 - 1.5 mg/dL.

3.9.2.6 Body Mass Index

BMI was derived from the weight (kg) divided by height (m^2). Change in Body Mass Index over six months was assessed by computing the difference between the values at the end of the study (6th month) and at baseline. A BMI of 18.8 - 24.9 kg/m^2 was considered as normal range. BMI < 18.5kg/m^2 was considered as underweight and may be at the risk of clinical complications and a BMI > 30 was considered as obese and may indicate the risk of co-morbidities associated with weight.

3.9.2.7 Infections

A morbidity survey tool was used to generate data on types and rate of infections over six months. Infections were considered as the total monthly reported number of times one was

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infected. Episodes of diarrhoea were determined by the number of times one had had an episode. This was computed from reports collected monthly.

3.9.2.8 Potential Confounders

Antiretroviral (ARVs) and food programme were measure in this study as possible confounders. This was done to see if there was any influence the between nutrient intake, nutrient status, BMI, Infections and immune status measures and the confounders. Data from the two variables was generated while establishing the associations of nutrition, infections and immune factors.

3.9.2.9 Knowledge, Attitude, Beliefs and Practices

Data and information on knowledge, attitude, beliefs and practices was generated from the guiding questions in the FGD guide. Information on knowledge was solicited from five questions, attitude four questions, beliefs and practices two questions.

3.10 Data Analysis

3.10.1 Qualitative Data Analysis

The qualitative data were analyzed using standard content analysis technique. Broad themes were first identified followed by a more grounded approach. The prevalent themes that were identified formed broad categories, which were then subjected to more detailed data investigation of subcategories nested within the broad categories. All transcripts were read several times and simultaneously coded to explore potential conceptual and content-related themes. The quotes included in the results were typical views expressed by the participants and were used to exemplify emergent themes.

3.10.2. Quantitative Data Analysis

Data were entered in Microsoft excel 2007 then imported to SPSS version 15.0. Data was analysed quantitatively using descriptive and inferential statistics. Alpha level (α) for all relationships was set at 0.05. Food composition tables were used to compute the nutrient intake of the patients. Chi-square was used to establish if there was any relationship in marital status, education level, occupation, WHO staging and categories (mild, Moderate and severe) between sexes. Independent sample t-test was used to establish if there was any significant difference in the means between sexes and age, family size, immune status measures, nutrient intake, nutrient status, those who suffered infection and those who did not suffer infection, and those who had episodes of diarrhoea and those who did not have episodes of diarrhoea. Linear regression was used to determine mean differences of immune factors and nutrient intake, nutrient status indicators, BMI, immune status measures and infections.

3.11 Ethical Consideration

Permission to carry out the study was obtained from School of Graduate Studies Maseno University (Appendix 10) and the National Council for Science and Technology (NCST) (Appendix 11). Ethical clearance was obtained from the Institutional Research Ethics Committee (IREC) of Moi University (Appendix 12). The researcher also obtained permission from the Kisumu West District Commissioner and Medical Officer of Health to access the study site (Appendix 13 and Appendix 14). The District Education Officer, Divisional officers and chiefs were informed and briefed on the objectives, procedures and the requirements of the research. The researcher also sought informed consent (Appendix 15 and 15.1) from the patients and who were briefed on the research procedures and assured of confidentiality. The patients were

informed about the laboratory procedures considering that there were to be infliction of pain to obtain the samples. Patients were not coerced into giving information but were requested to participate voluntarily.

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CHAPTER FOUR: RESULTS

In this chapter findings of the study are presented under the following sub-headings: Demographic and socio-economic characteristics of HIV sero-positive patients; immune status of HIV sero-positive patients; food and nutrient intake and nutritional status of HIV sero-positive patients; infections patterns in HIV sero-positive patients; linkage between nutrition, infection and immune factors and knowledge, attitude and practices of HIV sero-positive patients.

4.1 Demographic and Socio-economic Characteristics of HIV Sero-positive Patients

4.1.1 Demographic Characteristics

A total of 497 patients from Chulaimbo Sub-district Hospital in Kisumu West District were recruited into the study. Of the 497 HIV sero-positive patients, 493 completed the study. Two of the patients were transferred to other clinics, one declined to continue and one died. Demographic characteristics of the patients including residence, age, marital status, education, religion and size of household are shown in Table 4.1.

Of the 497 patients 105 (21.1%) were male and 392 (78.9%) female with a male to female ration of 1:4. Majority of the patients were between the ages 31 – 40 years (17.7% male and 82.3% female) with a mean age of 39 years. Almost half 221 (44.5%) of the participants were either married or widowed 213 (42.9%) and a half had attained primary school level 322 (64.8%). Most of the participants were from Winam and Maseno divisions with a family size of between 6-10 members in a household, as illustrated in Table 4.1.

Table 4.1: Distribution of HIV Sero-positive Patients by Demographic Characteristics

(n= 497)

Characteristics	Male	Female	Total
	No (%)	No (%)	No (%)
Residence			
Winam	31 (29.5%)	126 (32.1%)	157 (31.6%)
Maseno	40 (38.1%)	145 (37.1%)	185 (37.2%)
Kombewa	14 (13.3%)	48 (12.2%)	62 (12.5%)
Kadibo	1 (1.0%)	4 (1.0%)	5 (1.0%)
Other areas	19 (18.1%)	69 (17.6%)	88 (17.7%)
Total within residence	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Age			
18 – 20	1 (1.0%)	10 (2.6%)	11 (2.2%)
21 – 30	18 (17.1 %)	85 (21.7%)	103 (20.7%)
31 – 40	33 (31.4%)	153 (39.0%)	186 (37.5%)
41 – 50	27 (25.7%)	95 (24.2%)	122 (24.5%)
51 – 60	26 (24.8%)	49 (12.5%)	75 (15.1%)
Total within age	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Marital status			
Single	11 (10.5%)	31 (7.9%)	42 (8.5%)
Married	51 (48.6%)	170 (43.4%)	221 (44.5%)
Widowed	39 (37.1%)	174 (44.3%)	213 (42.8%)
Separated	3 (2.8%)	12 (3.1%)	15 (3.0%)
Divorced	1 (1.0%)	5 (1.3%)	6 (1.2%)
Total within marital status	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Education			
Informal education	7 (6.7%)	25 (6.3%)	32 (6.4%)
Primary	64 (60.9%)	258 (65.8%)	322 (64.8%)
Secondary	31 (29.5%)	103 (26.3%)	134 (27.0%)
University	2 (1.9%)	6 (1.6%)	8 (1.6%)
Other (Tertiary)	1 (1.0%)	0 (0%)	1 (0.2%)
Total within Education	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Religion			
Pagan	0 (0%)	1 (0.2%)	1 (0.2%)
Christian	103 (98.1%)	388 (99.0%)	491 (98.8%)
Muslim	2 (1.9%)	3 (0.8%)	5 (1.0%)
Total within residence	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Family Size			
1 – 5 members	47 (44.8%)	178 (45.4%)	225 (45.3%)
6 – 10	56 (21.7%)	202 (51.5%)	258 (51.9%)
Above 10	2 (14.3%)	12 (3.1%)	14 (2.8%)
Total within household	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**

4.1.2 Socio-economic Characteristics

4.1.2.1 Income Status

The socio-economic characteristics of the study group included occupation, income levels, agricultural and non-agricultural activities such as small businesses including the sale of fish, mats, clothes and vegetables. A majority 238 (47.9%) were farmers and businessmen/women 141 (28.4%) as illustrated in Table 4.2.

Table 4.2: Distribution of HIV Patients by Sources of Income and Income per Month (n = 497)

Characteristics	Male No (%)	Female No (%)	Total No (%)
Source of income			
Fishing	15 (14.3%)	0 (0%)	15 (3.0%)
Farming	33 (31.4%)	205 (52.3%)	238 (47.9%)
Employed	15 (14.3%)	10 (2.6%)	25 (5.0%)
Business	20 (19.0%)	115 (29.3%)	141 (28.4%)
No source of income	22 (21.0%)	62 (15.8%)	78 (15.7%)
Total	**105 (100%)**	**392 (100%)**	**497 (100%)**
Income per month (kshs)			
1500 – 2000	49 (46.5%)	233 (59.4%)	282 (56.7%)
2001 – 2500	14 (13.3%)	42 (10.7%)	56 (11.3%)
2501 – 3000	1 (1.0%)	17 (4.3%)	18 (3.6%)
3001 – 4000	5 (4.8%)	5 (1.3%)	10 (2.1%)
4001 – 6000	3 (2.9%)	20 (5.1%)	23 (4.6%)
6001 – 8000	4 (3.8%)	9 (2.3%)	13 (2.6%)
8001 – 10000	2 (1.9%)	6 (1.5%)	8 (1.6%)
Above 10000	1 (1.0%)	8 (2.1%)	9 (1.8%)
No income	26 (24.8%)	52 (13.3%)	78 (15.7%)
Total	**105 (100%)**	**392 (100%)**	**497 (100%)**

Majority had a source of income mainly from farming and business, with very few employed and only 16% had no source of income. However, it was mainly ≤ Kshs 2000 monthly with only 4.2% above kshs 7000 which is the minimum monthly wage, as illustrated in Table 4.3. By eyeballing, income will not influence associations as there seemed to be no changed over the study period.

Table 4.3: Distribution of HIV Sero-positive Patients by Income Change

	Month					
Income	**Baseline**	**March**	**April**	**May**	**June**	**July**
Kshs	**n = 497**	**n = 495**	**n = 493**	**n = 493**	**n = 493**	**n = 493**
	No (%)	**No (%)**	**No (%)**	**No (%)**	**No (%)**	**No (%)**
1500 – 2000	282 (56.7%)	301 (61.2%)	413 (83.9%)	373 (75.8 %)	394 (79.9%)	390 (79.1%)
2001 – 2500	56 (11.3%)	62 (12.3%)	10 (2.0%)	25 (5.1%)	20 (4.2%)	16 (3.2%)
2501 – 3000	18 (3.6%)	16 (3.2%)	15 (3.0%)	15 (3.0%)	14 (2.8%)	14 (2.8%)
3001 – 4000	10 (2.1%)	8 (1.6%)	9 (1.8%)	11 (2.2%)	8 (1.6%)	9 (1.8%)
4001 – 6000	23 (4.6%)	19 (3.8%)	3 (0.6%)	3 (0.6%)	1 (0.2%)	5 (1.0%)
6001 – 8000	13 (2.6%)	13 (2.6%)	1 (0.2%)	2 (0.4%)	2 (0.4%)	2 (0.4%)
8001 – 10000	8 (1.6%)	8 (1.6%)	1 (0.2%)	4 (0.8%)	3 (0.6%)	4 (0.8%)
Above 10000	9 (1.8%)	9 (1.8%)	2 (0.4%)	1 (0.2%)	2 (0.4%)	2 (0.4%)
No income	78 (15.7%)	59 (11.9%)	39 (7.9%)	59 (11.9%)	49 (9.9%)	51 (10.5%)
Total	**497 (100%)**	**495 (100%)**	**493 (100%)**	**493 100%)**	**493 (100%)**	**493 (100%)**

4.1.2.2 Land ownership and Food Availability

Results in Table 4.4 show that 383 (77.1%) owned land while 114 (22.9%) had no land. Majority of the patients grew cereals 338 (68.0%). The patients relied on purchasing 351 (70.6%) for their sources of food. Four hundred and forty one (88.8%) had no food for the last one week and the main reason was lack of money 380 (76.4%). Food acquisition was done by the mothers in the home 448 (90.1%). There were 465 patients (93.6%) who experienced difficulty in accessing food with the main reason being was lack of money 386 (77.7%) as shown in Table 4.4.

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Table 4.4: Distribution of the HIV Sero-positive Patients by Food Availability and Agricultural

Activities

(n = 497)

Characteristics	Frequency (%)
Household land ownership	
Own land	383 (77.1%)
Do not own land	114 (22.9%)
Total	**497 (100%)**
Crop grown	
Cereals	338 (68.0%)
Roots/tuber	12 (2.4%)
Pulses/legumes	3 (0.6%)
Fruits	2 (0.4%)
Vegetables	26 (5.3%)
Other crops	2 (0.4%)
No crops grown	114 (22.9%)
Total	**497 (100%)**
Sources of food	
Food aid	76 (15.3%)
Purchase	351 (70.6%)
Other sources	70 (14.1%)
Total	**497 (100%)**
Food security	
Had food	441 (88.7%)
Did not have food	56 (11.3%)
Total	**497 (100%)**
Reason for having no food	
Lack of money	380 (76.4%)
Sickness	53 (10.7%)
Death	8 (1.6%)
Had no food	56 (11.3%)
Total	**497 (100%)**
Food acquisition	
Father	161 (32.4%)
Mother	314 (63.2%)
Child/children	8 (1.6%)
Relatives/friends	14 (2.8%)
Total	**497 (100%)**
Food accessibility	
Ease	32 (6.4%)
Difficulty	465 (93.6%)
Total	**497 (100%)**
Factors affecting food accessibility	
Lack of money	386 (77.7%)

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Loss of employment	15 (3.0%)
Death	2 (0.4%)
Illness	56 (11.3%)
Not in the market	3 (0.6%)
Other	3 (0.6%)
Had no difficulty	32 (6.4%)
Total	497 (100%)

Availability of Markets

Markets near residence	470 (94.6%)
Markets not near residence	27 (5.4%)
Total	497 (100%)

No markets

Food aid	18 (3.6%)
Relatives	26 (5.2%)
Others	426 (85.8%)
Residence no near market	27 (5.4%)
Total	497 (100%)

Food preparation

Father	14 (2.8%)
Mother	448 (90.2%)
Child/children	30 (6.0%)
Relatives	2 (0.4%)
Others (friends)	3 (0.6%)
Total	497 (100%)

4.1.3 Difference in Demographic Characteristics between Sexes

T-test was used to assess whether there were any significant differences between males and females in the mean age and family size. There was a significant difference between male and female for age (t-test = 3.245, df = 159.146, p = 0.001; t-test = 2.875, df = 336.696, p = 0.004). However, no significant difference was observed on family size ($p > 0.05$). Chi-square was used to assess whether there was any significant relationship between males and females in their marital status, occupation and education level. However, no significant difference was observed on marital status (χ^2_{obt} = 2.140, n = 497, df = 1, p = 0.144), occupation (χ^2_{obt} = 4.029, n = 497, df = 1, p = 0.45) and education level (χ^2_{obt} = 2.051, n = 497, df = 1, p = 0.152).

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4.2 Immune Status of HIV Sero-positive Patients

4.2.1 Immune Status Measures

The immune status of the patients in terms of CD4 cell count was classified into three independent categories at baseline as shown in Table 3.1. There was 89 (17.9%) in the severe category, 252 (50.7%) in the moderate, and 156 (31.3%) in mild. There was a higher percentage of males in the severe category where majority of the patients had their CD4 cell count below < 200 cells/mm^3, as illustrated in Figure 4.1.
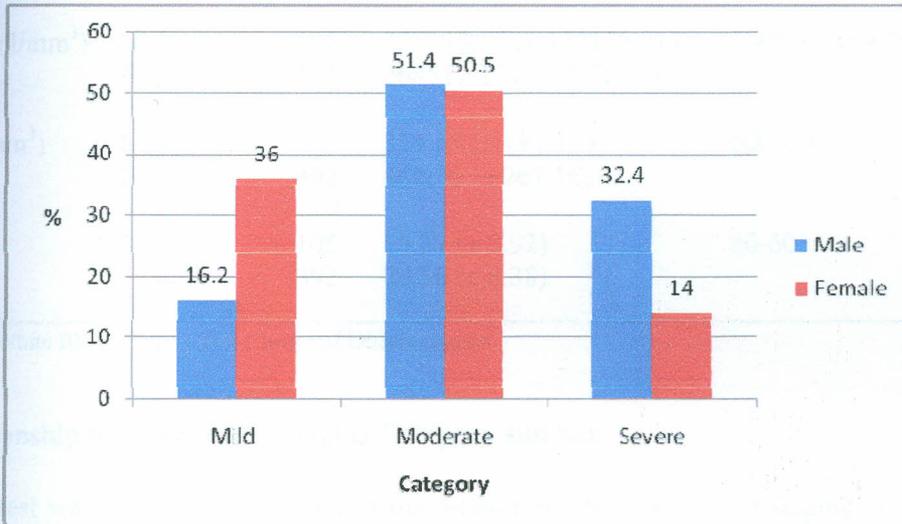
Figure 4.1: CD4 Cell Count at Baseline by Immune Status Category

White blood cells (WBC), platelets, CD4 cell count and CD4 percentage (%) were measured to assess the immune integrity at baseline as shown in Table 4.5. The mean WBC was 5503.32 cell/mm^3; mean platelets count 265957.46 cell/mm^3, mean CD4 cell count 431 cell/mm^3 and mean CD4 percentage 19.3%. Majority of the patients were within the normal range for WBC

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(4000-11000 cell/mm^3) and platelet count (130000-440000 cell/mm^3) but there was a drop below the normal range for CD4 cell count (600-1200 cell/mm^3) and CD4 cell percentage (30-60%) were below the normal range, (Appendix 8).

Table 4.5: Distribution of HIV Sero-positive Patients by Immune Status Measures and Sex (n= 497)

Immune status measures	Sex	N	Mean (± SD)	Normal range
WBC (cell/mm^3)	Male	105	5749.05 (± 2440.648)	4000-11000
	Female	392	5564.05 (± 3415.409)	
Platelets (cell/mm^3)	Male	105	256398.65 (± 153178.31)	130000-440000
	Female	392	268517.86 (± 135761.76)	
CD4 (cell/mm^3)	Male	105	314.35 (± 193.179)	600-1200
	Female	392	462.36 (± 267.16)	
CD4% (%)	Male	105	15.39 (± 9.92)	30-60
	Female	392	20.36 (± 8.38)	

Key: WBC = White Blood Cells, CD = Cluster of Differentiation

4.2.2 Relationship between WHO Staging Category and Sex

Chi-square test was carried out to establish the relationship between WHO staging and sex as illustrated in Figure 4.2. Results revealed a significant relationship between WHO staging and sex, (χ^2_{obt} = 18.070, n = 497, df = 1, $p < 0.0001$). There were more male patients (61.9%) in the third and fourth WHO staging compared to the female patients (44.1%). There was a significant relationship between age and HIV and AIDS status, (χ^2_{obt} = 24.636, n = 497, df = 1, $p < 0.0001$).

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4.2.3 Immune Status Measures by Sex

There was a significant difference between male and female in the mean CD4 (t-test = -6.384, df = 222.35. $p < 0.0001$). The male patients (32.4%) had significantly lower CD4 cell count compared to the female patients (14.0%) as shown in Table 4.6.

Table 4.6: Differences in Immune Status Measures by Sex

(n = 497)

Characteristics	t for equivalence of means	df	p-value
WBC (cell/mm^3)	0.632	225.24	>0.05
Platelets (cell/mm^3)	-.737	150.60	>0.05

Key: WBC = White Blood Cells

4.2.4 Immune Status Measures across CD4 Cell Count Categories

Linear regression was used to establish if there was any difference between immune status measures and CD4 cell count categories (mild, moderate and severe) of groups of individuals at the start of the study and at the end of the study. There was no significant difference between the groups even though there was a decreased of 595cells/mm^3 between mild and moderate and mild and severe and 30cells/mm^3 between mild and severe as illustrated in Table 4.7.

Table 4.7: Mean Values of Immune Status Measures across CD4 Cell Count Categories

(n=497)

Nutrient	Category	Mean difference	Confidence Interval (CI)	Sig
WBC (cells/mm^3)	Mild/moderate	-565.07	-1215.69, 85.56	0.089
	Mild/severe	-595.24	-1443.61, 253.14	0.169
	Moderate/severe	-30.04	-817.533, 757.45	0.940
Platelets (cells/mm^3)	Mild/moderate	1964.52	-137.83, 4066.84	0.067
	Mild/severe	2187.86	-553.46, 4929.19	0.117
	Moderate/severe	222.82	-2321.75, 2767.39	0.863

Key: * α= 0.05, WBC – White Blood Cell, Mild = CD4 cell count> 500 cells/mm^3, Moderate = CD4 cell count between 200 and 499 cells/mm^3, Severe < 200 cells/mm^3

4.3 Food Consumption Patterns, Nutrient Status and Nutritional Status of HIV Sero-positive Patients

Food consumption patterns were assessed by use of 24-hour dietary recall and food frequency checklist. This yielded the number of meals of per day, nutrient intake per day and food variety of the HIV sero-positive patients.

4.3.1 Frequency of Meals and Nutrient Intake

On average there were three meals served per day. This included breakfast, lunch and supper. Foods commonly served for breakfast included porridge, strong tea and "*nyoyo*" (a mixture of cooked maize and beans), and sweet potatoes. For lunch the patients consumed "*ugali*' (a

cooked mixture of maize meal flour and water) and traditional (indigenous) vegetables, porridge, "*nyoyo*", "*ugali*" and "*omena*", "*ugali*" and beef stew, strong tea and sweet potatoes. The foods served for supper were similar to those served for lunch. Majority of the patients had an average of three meals per day in the month of February 63 (22.0%) males and 212 (77.1%) females as illustrated in Table 4.8.

Table 4.8: Frequency of Meal Intake among HIV Sero-positive Patients

Month	Sex	None n (%)	One n (%)	Two n (%)	Three n (%)	Total n (%)
			Number of meals per day			
n = 497						
February	Male	0 (0%)	9 (19.6%)	33 (19.0%)	63 (22.9%)	105 (21.1%)
	Female	2 (100%)	37 (80.4%)	141 (81.0%)	212 (77.1%)	392 (78.9%)
Total		3 (100%)	46 (100%)	174 (100%)	275 (100%)	497 (100%)
n = 495						
March	Male	1 (50%)	3 (11.5%)	43 (19.8%)	58 (23.2%)	105 (21.1%)
	Female	1 (50%)	23 (88.5%)	174 (80.2%)	192 (76.8%)	390 (78.9%)
Total		2 (100%)	26 (100%)	217 (100%)	250 (100%)	495 (100%)
n = 493						
April	Male	0 (0%)	9 (23.1%)	47 (21.9%)	49 (20.5%)	105 (21.3%)
	Female	0 (0%)	30 (76.9%)	168 (78.1%)	190 (79.5%)	388 (78.7%)
Total		0 (0%)	39 (100%)	215 (100%)	239 (100%)	493 (100%)
n = 493						
May	Male	0 (0%)	9 (23.1%)	39 (17.9%)	57 (25.1%)	105 (21.3%)
	Female	0 (0%)	30 (76.9%)	188 (82.1%)	170 (74.9%)	388 (78.7%)
Total		0 (100%)	39 (100%)	227 (100%)	227 (100%)	493 (100%)
n = 493						
June	Male	0 (0%)	4 (11.4%)	52 (21.2%)	49 (23.0%)	105 (21.3%)
	Female	0 (0%)	31 (88.6%)	193 (78.8%)	164 (77.0%)	388 (78.7%)
Total		0 (100%)	35 (100%)	245 (100%)	213 (100%)	493 (100%)
n = 493						
July	Male	0 (0%)	5 (16.7%)	48 (20.1%)	52 (23.2%)	105 (21.3%)
	Female	0 (0%)	25 (83.3%)	191 (79.9%)	172 (76.8%)	388 (78.7%)
Total		0 (100%)	30 (100%)	239 (100%)	224 (100%)	493 (100%)

Nutrient intake was generated from the repeated 24 hour dietary recalls as shown in Table 4.9, revealed that the mean intake were below the RDA, except for iron in the males (10.35 ±3.49) and thiamine in both male and female (1.63 ±0.66 male, and 1.76 ±0.69 female).

Table 4.9: Nutrient Intake of HIV Sero-positive Patients by Sex

Nutrients	Sex	Mean SD (±)	February n = 497	March n = 495	April n = 493	May n = 493	June n = 493	July n = 493	Average
Energy (Kcal)	Male	Mean	1555.93	1575.92	1578.05	1575.72	1581.44	1577.62	1574.11
		SD	± 549.02	± 629.74	± 580.70	± 579.09	± 575.47	± 579.18	± 578.29
	Female	Mean	1596.19	1686.22	1636.14	1630.47	1632.11	1633.65	1635.79
		SD	± 536.74	± 536.74	± 621.52	± 617.744	± 606.16	± 620.14	± 620.97
Protein (gm)	Male	Mean	40.43	41.51	42.53	42.54	40.16	42.73	41.65
		SD	± 11.41	± 15.19	± 15.42	± 14.93	± 12.48	± 14.76	± 15.67
	Female	Mean	40.83	39.02	39.93	38.89	37.88	38.81	39.23
		SD	± 11.23	± 11.90	± 11.86	± 10.97	± 9.96	± 10.93	± 11.89
Iron (mg)	Male	Mean	10.35	10.48	10.48	10.52	10.57	10.56	10.49[a]
		SD	± 3.40	± 3.17	± 3.45	± 3.06	± 2.97	± 3.01	± 3.49
	Female	Mean	10.54	10.46	10.43	10.41	10.50	10.44	10.47
		SD	± 3.29	± 3.39	± 3.28	± 3.24	± 3.10	± 3.21	± 3.40
Calcium (mg)	Male	Mean	415.10	500.20	499.98	499.86	507.59	502.71	487.57
		SD	± 280.77	± 312.50	± 323.64	± 324.6	± 312.00	± 321.33	± 306.15
	Female	Mean	561.41	541.40	538.58	534.66	542.89	534.33	542.21
		SD	± 320.30	± 319.47	± 324.31	± 321.96	± 310.48	± 317.74	± 320.59
Vit A (IU)	Male	Mean	3874.14	4039.83	3999.07	4245.36	4281.56	4265.56	4117.59
		SD	± 4468.34	± 4390.48	± 4422.36	± 4370.88	± 4340.79	± 4353.56	± 4347.50
	Female	Mean	4535.39	5150.39	4935.38	5119.59	5157.73	5138.88	5006.23
		SD	± 6510.64	± 6766.37	± 6741.48	± 6662.64	± 6636.02	± 6649.87	± 6660.74
Vit C (mg)	Male	Mean	49.54	52.05	51.78	50.38	49.97	51.01	52.01
		SD	± 28.38	± 27.22	± 26.84	± 27.69	± 24.48	± 27.25	± 28.28
	Female	Mean	47.06	54.66	52.79	53.08	52.70	52.92	52.20
		SD	± 26.84	± 23.64	± 25.05	± 25.21	± 24.06	± 24.82	± 24.93
Thiamine (mg)	Male	Mean	1.63	1.68	1.68	1.66	1.58	1.68	1.65[a]
		SD	± 0.52	± 0.73	± 0.72	± 0.68	± 0.62	± 0.67	± 0.66
	Female	Mean	1.76	1.73	1.78	1.72	1.60	1.73	1.72[a]
		SD	± 0.66	± 0.71	± 0.81	± 0.68	± 0.61	± 0.67	± 0.69
Riboflavin (mg)	Male	Mean	0.44	0.44	0.42	0.46	0.46	0.47	0.45
		SD	± 0.35	± 0.41	± 0.74	± 0.42	± 0.42	± 0.42	± 0.43
	Female	Mean	0.42	0.42	0.43	0.47	0.46	0.48	0.45
		SD	± 0.38	± 0.39	± 0.42	± 0.43	± 0.43	± 0.43	± 0.43
Niacin (mg)	Male	Mean	10.21	10.49	10.63	10.08	10.08	10.05	10.38
		SD	± 3.40	± 4.62	± 4.46	± 3.55	± 3.56	± 3.62	± 3.96
	Female	Mean	10.86	10.63	10.75	10.15	10.16	10.12	10.45
		SD	± 4.47	± 4.69	± 4.56	± 3.99	± 3.97	± 4.03	± 4.52

[a] Above Recommended Daily Allowance (RDA)

The analysis of the nutrient value of the foods consumed within 24 hours was done by the use of the food composition tables by Sehmi (1993). A value of over 100% was considered as above RDA nutrient consumption, whereas those consuming 90% - 100% optimum nutrient consumption and those consuming <90% below RDA nutrient consumption (Appendix 5.1). The foods consumed among the HIV sero-positive patients contained the following nutrients energy, proteins, calcium, iron, vitamin A, vitamin C, thiamine, riboflavin and niacin as shown in Table 4.10.

Table 4.10: Percentage RDA Nutrient Intake among HIV Sero-positive Patients
(n = 497)

Nutrients	Sex	No. (%)
Energy (kcal)	Male	51.9%
	Female	76.0%
Total		**127.9%**
Proteins (gm)	Male	72.1%
	Female	88.7%
Total		**160.80%**
Calcium (mg)	Male	34.6%
	Female	38.5%
Total		**72.1%**
Iron (mg)	Male	128.8%[a]
	Female	58.3%
Total		**187.1%**
Vitamin A (IU)	Male	22.8%
	Female	26.7%
Total		**49.5%**
Vitamin C (mg)	Male	55.0%
	Female	62.7%
Total		**117.7%**
Thiamine (mg)	Male	135.8%[a]
	Female	160.0%[a]
Total		**295.8%**
Riboflavin (mg)	Male	33.8%
	Female	38.4%
Total		**72.2%**
Niacin (mg)	Male	63.8%
	Female	77.6%
Total		**141.4%**

[a] Above RDA

This proportion is obtained by dividing the total nutrient intake by the RDA multiplied by 100 percent.

$$\frac{\text{Nutrient intake}}{\text{RDA}} \times 100\%$$

4.3.2 Food Variety

The foods were classified into the following sources: cereals, animal and animal products, legumes, vegetable, fruit, fats/oils and beverages, as shown in Appendix 6.1. Majority had variety of vegetables 1442 (23.8%) and cereals 769 (15.5%) on a daily basis. There was variety of foods consumed as shown in Table 4.11.

Table 4.11: Food Variety of HIV Sero-positive Patients

(n = 497)

Food groups	Frequency of Consumption			
	Daily n (%)	Weekly n (%)	Occasionally n (%)	Never n (%)
Cereal	769 (15.5%)	681 (13.7%)	2707 (54.4%)	813 (16.4%)
Animal and animal products	286 (7.3%)	458 (11.5%)	2201 (55.4%)	1026 (25.8%)
Legume	250 (10.1%)	346 (13.9%)	1421 (57.2%)	468 (18.8%)
Vegetables	1442 (23.8%)	966 (15.9%)	2690 (44.5%)	963 (15.8%)
Fruits	358 (10.3%)	411 (11.8%)	2239 (64.4%)	471 (13.5%)
Fats/oil	493 (49.6%)	50 (5.0%)	200 (20.1%)	251 (25.3%)
Beverage	587 (23.6%)	159 (6.4%)	1231 (49.5%)	508 (20.5%)

n denotes the number of times a food item is consumed in the sample population

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4.3.3 Nutrient Status Assessment

Haemoglobin, creatinine and MCV indicators were used to assess nutrient status of iron and protein. Mean haemoglobin was 11.2 g/dL (11.4 male and 11.2 female), creatinine 0.63 mg/dL (0.728 males and 0.604 females) and MCV 85.0 femtoliters (86.6 males and 84.6 females) as shown in Table 4.12.

Table 4.12: Mean Values of Nutrient Status Indicators by Sex

Nutrient Status Indicators	Sex	N	Mean ± (SD)	Normal range
Haemoglobin (g/dL)	Male	105	11.41 (± 2.60)	14-18
	Female	392	11.19 (± 4.25)	12-16
	Total	**497**		
Creatinine (mg/dL)	Male	105	0.73 (± 0.22)	0.7-1.2
	Female	392	0.60 (± 19.14)	0.5-1.0
	Total	**497**		
MCV (fL)	Male	105	86.63 (± 15.93)	79-100
	Female	392	84.61 (± 14.51)	79-100
	Total	**497**		

Key: MCV = Mean Corpuscular Volume

4.3.4 Anthropometrics Assessment

Body Mass Index (BMI) was used to define the patient's nutritional status (see Appendix 7). BMI was assessed over a period of six months (Table 4.13) and the mean BMI over the months ranged between 20kg/m² and 22kg/m². The mean BMI in February was 20.39kg/m² in males and

22.01kg/m^2 in females and in the month of July the mean BMI for the males seemed to have increased to 20.60kg/m^2 and females decreased to 21.58kg/m^2 as illustrated in Table 4.13.

Table 4.13: Mean BMI Values by Sex over the Study Period

BMI - Month	Sex	N	BMI values (kg/m^2) Mean (±SD)	Normal range
BMI - February	Male	105	20.39 (±3.65)	18.5-24.9kg/m^2
	Female	392	22.01 (±3.27)	
BMI - March	Male	105	21.02 (±3.54)	
	Female	390	21.58 (±3.65)	
BMI - April	Male	105	20.32 (±3.86)	
	Female	388	21.42 (±3.81)	
BMI - May	Male	105	20.34 (±3.78)	
	Female	388	21.41 (±3.77)	
BMI - June	Male	105	20.36 (±3.74)	
	Female	388	21.35 (±3.77)	
BMI - July	Male	105	20.60 (± 3.54)	
	Female	388	21.58 (±3.77)	

Most of the patients were within the normal BMI range but there were fluctuations between February and July in group mean values. In March 336 (76.9%) were within the normal BMI range where there seemed to be a decline in the presiding months April 311 (63.1%), May 307 (62.3%), June 309 (62.7%), and July 312 (63.3%) as shown in Table 4.14.

Table 4.14: HIV Sero-positive Patients by BMI Category over the Study Period

Month	BMI (kg/m^2)			
	< 18.5 No (%)	18.5 – 24.9 No (%)	25.0 – 29.0 No (%)	> 30 No (%)
n = 497 February	101 (20.3%)	318 (64.0%)	65 (13.1%)	13 (2.6%)
n = 495 March	86 (17.4%)	336 (76.9%)	63 (12.7%)	10 (2.0%)
n = 493 April	110 (22.3%)	311 (63.1%)	60 (12.2%)	12 (2.4%)
May	115 (23.3%)	307 (62.3%)	58 (11.8%)	13 (2.6%)
June	108 (21.9%)	309 (62.7%)	65 (13.2%)	11 (2.2%)
July	100 (20.3%)	312 (63.3%)	67 (13.6%)	14 (2.8%)

4.3.5 Comparing Nutrient Intake and Nutrient Status by Food Programme

Food programme and ARVs were assessed in this study as a possible confounders. The HIV sero-positive patients were enrolled on a monthly basis after meeting the criteria as shown in Appendix 16.1- 16.3. The patients who met the criteria for the food programme were enrolled in it until they attained the required nutritional status of BMI>18.5kg/m^2. There were 80 (16.1%) HIV sero-positive patients enrolled in the food programme and 417 (83.9%) were not.

T-test was used to assess whether there were any significant differences between those in the food programme and those not at baseline. Differences in nutrient intake and nutrient status were observed in energy, protein, iron, vitamin A, calcium, vitamin C, vitamin B$_1$, vitamin B$_2$, vitamin B$_{12}$, haemoglobin, creatinine and MCV, as shown in Table 4.15. There were significant

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differences in the mean values of iron (p=0.005), vitamin A (p=0.004), thiamine (p=0.001), riboflavin (p=0.001), and niacin (p <0.0001).

Table 4.15: Mean Values of Nutrient Intake and Nutrient Status Indicators by Food Programme Status

(n = 497)

Characteristics	Food programme Status	Mean (± SD)	Sig
Haemoglobin (g/dL)	On food programme Not on food programme	11.23 (± 2.3149) 11.27 (± 3.7720)	0.855
Creatinine (mg/dL)	On food programme Not on food programme	0.612 (± 17.6337) 0.639 (± 21.2138)	0.102
MCV (fL)	On food programme Not on food programme	83.62 (± 13.6487) 84.86 (± 14.4535)	0.301
Energy (kcal)	On food programme Not on food programme	1536.45 (± 639.84) 1661.53 (± 917.08)	0.001*
Protein (g)	On food programme Not on food programme	38.04 (± 11.97) 40.24 (± 11.25)	0.000*
Iron (mg)	On food programme Not on food programme	10.13 (± 3.128) 10.59 (± 3.16)	0.004
Calcium (mg)	On food programme Not on food programme	504.38 (± 322.22) 501.91 (± 301.07)	0.879
Vit A (IU)	On food programme Not on food programme	5642.59 (± 10079.99) 4373.53 (± 5172.74)	0.005*
Vit C (mg)	On food programme Not on food programme	49.66 (± 25.10) 51.64 (± 26.02)	0.128
Thiamine (mg)	On food programme Not on food programme	1.63 (± 0.66) 1.74 (± 0.67)	0.001*
Riboflavin (mg)	On food programme Not on food programme	0.39 (± 0.35) 0.46 (± 0.15)	0.001*
Niacin (mg)	On food programme Not on food programme	9.90 (± 4.41) 10.73 (± 4.09)	0.000*

Key: * α= 0.05, MCV = Mean Corpuscular Volume

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4.3.6 Nutritional Status, Nutrient Intake and ARVs in HIV Sero-positive Patients

Body Mass Index was used to assess the patient's nutritional status over the study period. There was a significant difference between the males and females in mean BMI in the months of February (p=0.001), April (p=0.010), May (p=0.011) and July (p=0.015) as illustrated in Table 4.16.

Table 4.16: Difference in Mean BMI between Sexes over the Study Period

Month	t for equivalence of means	df	Sig
February	-3.409	286.018	0.001*
March	-1.422	286.018	0.157
April	-2.608	162.980	0.010*
May	-2.583	164.551	0.011*
June	-1.910	165.542	0.058
July	-2.466	173.210	0.015*

* $\alpha = 0.05$

Three hundred and sixty eight (74.0%) patients were on ARVs and 129 (24.0%) were not on ARVs. T-test was used to establish if there was evident difference in those on ARVs and those not at baseline. There was a statistical significant difference in nutrient intake between patients on ARVs and those not on ARVs in the levels of calcium ($p < 0.001$), vitamin A ($p = 0.036$), and riboflavin ($p = 0.017$) intake. There was no significant difference in the levels of energy ($p = 0.985$), protein ($p = 0.914$), iron ($p = 0.575$), vitamin C ($p = 0.914$), thiamine ($p = 0.385$) and

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niacin (p = 0.746) intake between those on ARVs and those not on ARVs. There was no difference in mean WBC (p = 0.880) or mean levels of platelets (p = 0.885) in patients on ARVs compared to those not on ARVs.

4.3.7 Nutrient Intake and Nutritional Status between Sexes

There was a significant difference in creatinine levels between the male and female patients (t-test = 5.3444, df = 150.865, p < 0.0001). The male had higher creatinine levels than the females (72.792 male and 60.430 female). Although the female had a higher intake of the most nutrients, there was no statistically significant difference in nutrient intake except in thiamine (t = -2.267, df = 205.178, p = 0.024), as shown in Table 4.17.

Table 4.17: Comparison of Mean Values of Nutrient Intake and Nutrient Status between Males and Females

(n = 497)

Nutrient status and Nutrient intake Indicators	t for equivalence of means	df	Sig
Haemoglobin (g/dL)	0.661	269.232	0.509
Creatinine (mg/dL)	5.3444	150.865	0.000*
MCV (fL)	1.179	153.349	0.240
Energy (Kcal)	-0.670	161.254	0.504
Protein (g)	-0.323	160.926	0.747
Iron (mg)	-0.526	159.699	0.599
Calcium (mg)	-1.455	183.227	0.147
Vitamin A (IU)	-1.211	235.640	0.227
Vitamin C (mg)	0.806	157.390	0.421
Thiamine (mg)	-2.267	205.178	0.024*
Riboflavin (mg)	0.451	175.100	0.652
Niacin (mg)	-1.615	210.635	0.108

Key: * α= 0.05, MCV = Mean Corpuscular Volume

4.4 Infection Patterns in HIV Sero-positive Patients

4.4.1 Staging and Categorization

Assessment of the immune status of HIV patients in samples collected at baseline was based on WHO staging. Ninety five (19.1%) were in stage-1 (asymptomatic), 164 (33.0%) in stage-2 (Mild symptoms), 210 (42.3%) in stage-3 (Advanced symptoms) and 28 (5.6%) in stage-4 (Severe symptoms). Results in Figure 4.2 show that 86 (21.9%) females and 9 (8.6 %) males were in stage one, 133 (33.9%) females and 31 (29.5%) males were in stage two, 158 (40.4%) and 52 (49.5%) males were in stage three and 15 (3.8%) females and 13 (12.4%) males were in stage four. There seemed to be a higher proportion of the females in stages 1 and 2 but there is a shift in stages 3 and 4 having more males as illustrated in Figure 4.2.
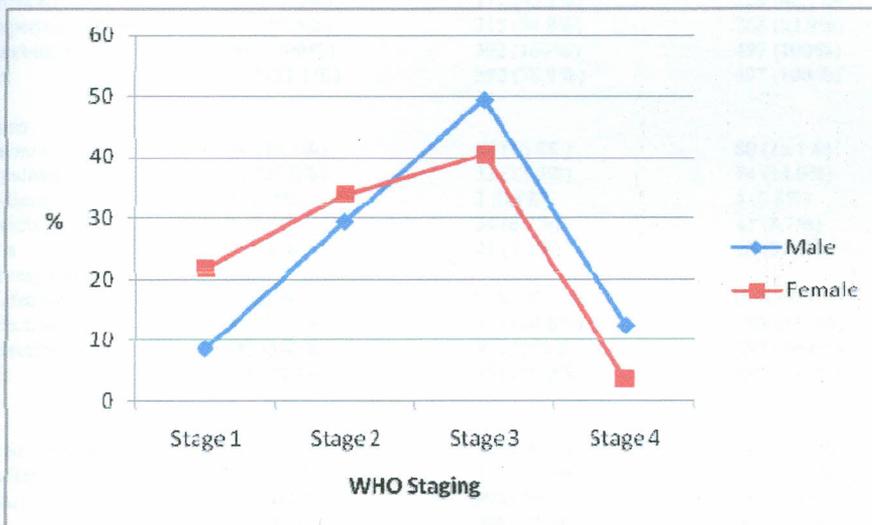

Figure 4.2: WHO Staging at Baseline by Sex

4.4.2 Morbidity of Selected Infections

Morbidity and infections by sex were assessed to establish whether there were any differences in the prevalence of morbidity. Two hundred and twenty nine (46.1%) patients experienced illnesses. The most prevalent infections were diarrhoea (37.8%), pneumonia (16.1%) and tuberculosis (14.9%) as illustrated in Table 4.18. The males seemed to have had a higher prevalence of diarrhoea 43.8% than to the females (36.2%).

Table 4.18: Prevalence of Morbidity, Diarrhoea and Type of Infections among HIV Sero-positive Patients by Sex at Baseline

Characteristics	Male No. (%)	Female No. (%)	Total No. (%)
Morbidity			
Experienced illness	52 (49.5%)	177 (45.2%)	229 (46.1%)
Not experience illness	53 (50.5%)	215 (54.8%)	268 (53.9%)
Total within morbidity	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Type of infections			
Pneumonia	14 (13.3%)	66 (16.8%)	80 (16.1%)
Tuberculosis	21 (20.0%)	53 (13.5%)	74 (14.9%)
Candidiasis	1 (1.0%)	3 (0.8%)	4 (0.8%)
Dermatitis	9 (8.6%)	34 (8.7%)	43 (8.7%)
Malaria	7 (6.6%)	21 (5.4%)	28 (5.6%)
Upper respiratory tract infections	0 (0.0%)	0 (0.0%)	0 (0.0%)
No infection	53 (50.5%)	215 (54.8%)	268 (53.9%)
Total within infections	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Diarrhoea			
Suffered diarrhoea	46 (43.8%)	142 (36.2%)	188 (37.8%)
Not suffered	59 (56.2%)	250 (63.8%)	309 (62.2%)
Total within diarrhoea	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**
Frequency of diarrhoea			
Daily	1 (1.0%)	7 (1.8%)	8 (1.6%)
Weekly	4 (3.8%)	14 (3.6%)	18 (3.6%)
Monthly	5 (4.8%)	12 (3.1%)	17 (3.4%)
Occasionally	36 (34.2%)	109 (27.8%)	145 (29.2%)
Not suffered diarrhoea	59 (56.2%)	250 (63.7%)	309 (62.2%)
Total within frequency of diarrhoea	**105 (100%)**	**392 (100%)**	**497 (100%)**
Total within sex	**105 (21.1%)**	**392 (78.9%)**	**497 (100%)**

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The patients in this study were mainly in WHO stage three, which is characterized by pneumonia and tuberculosis. The results (Table 4.19) show that in February a lower proportion of the patients 229 (46.1%) suffered from infections compared to July 270 (53.7%). Majority of the patients had malaria 83 (16.8%), tuberculosis 82 (16.5%) and pneumonia 52 (10.5%). In the month of June, malaria was seen as higher 104 (21.1%) than the other infections. There were no patients with upper respiratory tract infections in the months of February and March compared to April 6 (1.2%), May 7 (1.4%), June 9 (1.8%) and July 7 (1.4%), Table 4.19.

Table 4.19: Infections among HIV Sero-positive Patients over the Study Period

Type of Infection	Month					
	February	March	April	May	June	July
Pneumonia	80 (16.1%)	80 (16.1%)	57 (11.6%)	63 (12.8%)	62 (12.6%)	52 (10.5%)
Tuberculosis	74 (14.9%)	73 (14.8%)	85 (17.2%)	86 (17.5%)	73 (14.8%)	82 (16.5%)
Candidiasis	4 (0.8%)	4 (0.8%)	5 (1.0%)	7 (1.4%)	5 (1.0%)	4 (0.8%)
Dermatitis	43 (8.7%)	43 (8.7%)	40 (8.1%)	40 (8.2%)	41 (8.3%)	38 (7.7%)
Malaria	28 (5.6%)	28 (5.7%)	71 (14.4%)	81 (16.4%)	104 (21.1%)	83 (16.8%)
Upper respiratory tract infections	0 (0.0%)	0 (0%)	6 (1.2%)	7 (1.4%)	9 (1.8%)	7 (1.4%)
No infection	268 (53.9%)	267 (53.9%)	229 (46.5%)	209 (42.3%)	199 (40.4%)	227 (46.3%)
Total	497 (100%)	495 (100%)	493 (100%)	493 (100%)	493 (100%)	493 (100%)

4.4.2.1 Occurrence of Infections among HIV Sero-positive Patients

T-test was used to establish if there was any significant difference in immune status measures between those who had suffered infections and those who had not at baseline. Of these indicators, only platelet levels were associated with infection (278559.11 cells/mm^3 vs. 252614.26 cells/mm^3, t-test = 2.93 df = 979.15, p = 0.003). However, there was no statistically

significant difference in the mean WBC, although the level was below the normal range as illustrated in Table 4.20.

Table 4.20: Mean Values of the Immune Status Measures by Occurrence of Infections among HIV Sero-patients

(n= 497)

Immune Status Measures	Status of Infection	Mean (± SD)	Normal values	t	Sig
WBC (cells/mm3)	Suffered infection	5605.01 (± 2593.36)	4,000-11,000	0.04	0.970
	Not suffered	5597.21 (± 3772.49)			
Platelets (cells/mm3)	Suffered infection	278559.11(±145665.04)	130,000-440000	2.93	0.003*
	Not suffered	252614.26 (±132416.43)			

Key: * α= 0.05, WBC = White Blood Cells

4.4.2.2 Nutritional Status Indicators, Nutrient Status Indicators and Pattern of Infections

Assessment of nutrient status indicators was performed twice: at the beginning and at the end of the study and monthly for BMI. BMI and nutrient status indicators (haemoglobin, creatinine and MCV) were assessed in those who had and those who had not suffered infections during the study period using t-test. Results show that of these variables only BMI was associated with infection (t-test = -3.97, df = 2665, p < 0.0001). The BMI of the HIV patients with infections was lower (21.04 ± 3.70) but within the normal range of 18.5-24.9kg/m^2 as shown in Table 4.21.

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Table **4.21:** Mean Values of Nutritional Status Indicator and Nutrient Status Indicators by Infections in HIV Sero-positive Patients

(n=497)

Nutrient Status Indicators	Status of Infection	Mean (± SD)	Normal values	t	Sig
BMI (kg/m^2)	Suffered infection	21.05 (± 3.70)	18.5-24.9	-3.97	0.000*
	Not suffered	21.67 (± 4.65)			
Haemoglobin (g/dL)	Suffered infection	11.14 (± 3.97)	12-18	-0.27	0.785
	Not suffered	11.18 (± 2.29)			
Creatinine (mg/dL)	Suffered infection	0.63 (± 20.29)	0.6-1.5	-0.07	0.978
	Not suffered	0.63 (± 20.12)			
MCV (fL)	Suffered infection	85.05 (±14.80)	79-100	0.002	0.999
	Not suffered	85.05 (± 15.82)			

Key: * α= 0.05, BMI = Body Mass Index, MCV = Mean Corpuscular Volume

Total energy and specific nutrients were compared in those who had and those who had not suffered infections during the study period using t-test. Results show that of these variables, only thiamine and niacin intakes were associated with infection (t-test = -2.93, df = 997.73, p = 0.003) and thiamine (t-test = -2.032, df = 2881.64, p = 0.042). The calcium 519.18 (± 320.59) and iron 10.48 (±3.23) intake for those with infections was higher despite there being no significant difference as shown in Table 4.22.

Table 4.22: Mean Values of Nutrient Intake by Infections in HIV Sero-positive Patients

(n= 497)

Nutrients	Infections	Mean (± SD)	Normal Values	t	Sig
Energy (kcal)	Suffered infection	1608.06 (±858.86)	2100-3000	-1.14	0.254
	Not suffered	1639.00 (± 608.26)			
Protein (g)	Infected	39.50 (± 11.94)	46-56	-1.17	0.241
	Not infected	40.01 (± 1.83)			
Iron (mg)	Infected	10.48 (±3.23)	8-18	0.25	0.802
	Not infected	10.45 (± 3.20)			
Calcium (mg)	Infected	519.18 (± 320.59)	1200	0.32	0.747
	Not infected	515.40 (± 317.20)			
Vit A (IU)	Infected	4805.64 (± 5736.15)	17000	-0.10	0.919
	Not infected	4829.34 (± 6787.31)			
Vit C (mg)	Infected	51.21 (± 25.75)	75-90	-1.55	0.121
	Not infected	52.66 (± 25.11)			
Thiamine (mg)	Infected	1.68 (± 0.67)	1.1-1.2	-2.03	0.042*
	Not infected	1.73 (± 0.71)			
Riboflavin (mg)	Infected	0.45 (± 0.41)	1.1-1.3	-0.32	0.751
	Not infected	0.45 (± 0.40)			
Niacin (mg)	Infected	10.19 (± 4.12)	14-16	-2.93	0.003*
	Not infected	10.65 (± 4.30)			

* α= 0.05

4.4.2.3 Nutrient Status, Nutrient Intake and Episode of Diarrhoea in HIV Sero-positive Patients

Assessment of the episodes of diarrhoea was performed twice: at the beginning and at the end of the study for nutrient status indicators and immune status measures (305 episodes) and monthly

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for BMI and nutrient levels (922 episodes). There was no statistically significant difference in the nutrient intake between those who had suffered episodes of diarrhoea and those who did not in the mean values of nutrient status and nutrient intake. There was no association between diarrhoea episodes and haemoglobin, creatinine or MCV. Even as this was the case, those who suffered episodes of diarrhoea had lower intakes of calcium compared to those who did not (0.65 ±0.22) as shown in Table 4.23.

Nutritional status assessed by BMI was associated with diarrhoea episodes ($21.06 kg/m^2$ vs. $21.47 kg/m^2$, t-test = -2.186, df = 1396.44 p=0.029). Of all the nutrients assessed only thiamine, niacin and calcium were associated with diarrhoea episodes (495.11mg vs. 527.46mg, t-test = -2.617, df = 1877.48, p = 0.009), thiamine (1.64mg vs. 1.73mg, t-test = -3.345, df = 2006.35, p = 0.001) and niacin (10.16mg vs. 10.52mg, t-test = -2.141, df = 1790.45, p = 0.032), as shown in Table 4.23.

Table 4.23: Mean Values of Nutrient Status Indicators, Nutritional Status and Nutrient Intake across Episodes of Diarrhoea in HIV Sero-positive Patients

Characteristics	Health Status	Episodes	Normal value	Mean (± SD)	t	Sig
Nutrient Status						
Haemoglobin (g/dL)	Diarrhoea	305	12-18	11.02 (±2.31)	-1.01	0.315
	No diarrhoea	685		11.21 (±3.57)		
Creatinine (mg/dL)	Diarrhoea	305	0.6-1.5	0.65 (±0.22)	1.74	0.082
	No diarrhoea	685		0.62 (±0.20)		
MCV (fL)	Diarrhoea	305	79-100	85.06 (±15.84)	0.01	0.995
	Did not diarrhoea	685		85.05 (±15.84)		
BMI and Nutrient levels						
BMI (kg/m^2)	Diarrhoea	922	18.5-24.9	21.06 (±5.03)	-2.19	0.029*
	No diarrhoea	2042		21.47 (±3.73)		
Energy (kcal)	Had diarrhoea	922	2100-3000	1612.04 (±985.94)	-0.448	0.662
	Did not diarrhoea	2042		1627.00 (±616.67)		
Protein (g)	Had diarrhoea	922	46-56	39.56 (±11.87)	-0.55	0.581
	Did not diarrhoea	2042		39.82 (±11.89)		
Iron (mg)	Had diarrhoea	922	8-18	10.42 (±3.17)	-0.57	0.571
	Did not diarrhoea	2042		10.49 (±3.24)		
Calcium (mg)	Had diarrhoea	922	1200	495.11 (±305.55)	-2.62	0.009*
	Did not diarrhoea	2042		527.46 (±324.39)		
Vitamin A (IU)	Had diarrhoea	922	17000	4586.38 (±5520.28)	-1.44	0.151
	Did not diarrhoea	2042		4920.87 (±6556.08)		
Vitamin C (mg)	Had diarrhoea	922	75-90	51.23 (±26.02)	-0.94	0.345
	Did not diarrhoea	2042		52.20 (±25.20)		
Thiamine (mg)	Had diarrhoea	922	1.1-1.2	1.64 (±0.63)	-3.35	0.001*
	Did not diarrhoea	2042		1.73 (±0.71)		
Riboflavin (mg)	Had diarrhoea	922	1.1-1.3	0.44 (±0.38)	-1.00	0.317
	Did not diarrhoea	2042		0.45 (±0.42)		
Niacin (mg)	Had diarrhoea	922	14-16	10.16 (±4.19)	-2.14	0.032*
	Did not diarrhoea	2042		10.52 (±4.22)		

Key: * α= 0.05, BMI = Body Mass Index, MCV = Mean Corpuscular Volume

Immune status measures were assessed in patients with and without diarrhoea. Further analyses demonstrated that, none of the immune status measures were associated with diarrhoea. WBC and platelet count was within the normal range however, the CD4 cell count (those who suffered 429.73 ±262.98 and those who did not 434.52 ±255.32) and CD4 percentage (those who suffered 19.19 ±8.70 and those who did not 19.53±9.50) were below normal range as shown in Table 4.24.

Table 4.24: Mean Values of Immune Status Measures by Episodes of Diarrhoea

Immune Status Measures	Health Status	Episodes	Normal value	Mean (± SD)	t	Sig
WBC	Diarrhoea	305	4000-11000	5543.09 (±3218.96)	0.840	0.401
(cell/mm^3)	No diarrhoea	685		5731.41 (±3273.68)		
Platelets	Diarrhoea	305	130000-440000	262993.77 (140044.76)	-0.389	0.679
(cell/mm^3)	No diarrhoea	685		266741.19 (±139679.67)		
CD4 cell count	Diarrhoea	305	500	429.73 (±262.98)	0.270	0.787
(cell/mm^3)	No diarrhoea	685		434.52 (±255.32)		
CD percentage	Diarrhoea	305	30-60	19.19 (±8.70)	0.530	0.596
(%)	No diarrhoea	685		19.53(±9.50)		

* α= 0.05, Episodes denotes the number of times one had diarrhoea in the sample population during the study period

4.5 Association of Nutrition, Infection and Immune Factors

The study focused on the mild (<200 cells/mm^3), moderate (200-499 cell/mm^3) and severe >500 cells/mm^3) categories in establishing the association between CD4 cell categories and nutrient intake, nutrient status, nutritional status, BMI and infections among HIV sero-positive patients. In use of linear regression to analyze the differences adjustments for food programme and ARVs was considered as the two were potential confounders in this study. Adjusting for food programme and ARVs did not have much difference from the crude results of nutrient status indicators, immune status measures, BMI and infections. However, there were differences in protein intake between moderate and severe that increased by 0.005gm (p=0.015), calcium intake between mild and moderate decreased by 0.329mg (p=0.005) and between mild and severe decreased by 0.016gm (p=0.019), vitamin A intake between mild and moderate increased by 2.278IU (p=0.029) and riboflavin intake between mild and severe there was a significant difference (p=0.029) and between moderate and severe there was no change but there was a significant difference (0.012)

4.5.1 Nutrient Intake and CD4 Cell Count Category among HIV Sero-positive Patients

When nutrient intake was assessed and compared to the normal ranges in all the groups, most of the patients seemed to have met the RDA for all nutrients except thiamine intake (78.9%) that had majority above the RDA in all the groups as illustrated in Table 4.25.

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Table 4.25: HIV Sero-positive Patients by Nutrient Intake and CD4 Cell Count Categories

(n = 497)

| Nutrients | Normal range | CD4 Cell Count Category | | | |
| | | Mild[1] | Moderate[2] | Severe[3] | Total |
		No (%)	No (%)	No (%)	No (%)
Energy (Kcal)	2100-3000				
< 2100		116 (74.3%)	205 (81.3%)	74 (83.1%)	395 (79.4%)
2100 - 3000		40 (25.7%)	43 (18.7%)	15 (16.9%)	102 (20.6%)
> 3000		0 (0.0%)47	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Protein (g)	46-56				
< 46		93 (59.6%)	171 (67.9%)	58 (65.2%)	322 (64.8%)
46 – 56		57 (36.5%)	72 (28.6%)	28 (31.5%)	157 (31.6%)
> 56		6 (3.9 %)	9 (3.5%)	3 (3.3%)	18 (3.6%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Iron (mg)	8-18				
< 8		53 (34.0%)	99 (39.3%)	30 (33.7%)	182 (36.6%)
8 – 18		103 (66.0%)	150 (59.5%)	59 (66.3%)	312 (62.8%)
> 18		0 (0.0%)	3 (1.2%)	0 (0.0%)	3 (0.6%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Calcium (mg)	1200				
< 1200		152 (97.4%)	251 (99.6%)	88 (98.9%)	491 (98.8%)
> 1200		4 (2.6%)	1 (0.4%)	1 (1.1%)	6 (1.2%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Vitamin A (IU)	17000				
< 17000		154 (98.7%)	250 (99.2%)	88 (98.9%)	492 99.0%)
> 17000		2 (1.3%)	2 (0.8%)	1 (1.1%)	5 (1.0%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Vitamin C (mg)	75-90				
< 75		119 (76.3%)	198 (76.6%)	65 (73.0%)	382 (76.9%)
75 – 90		34 (21.8%)	44 (17.4%)	17 (19.1%)	95 (19.1%)
> 90		3 (1.9%)	10 (4.0%)	7 (7.9%)	20 (4.0%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)
Thiamine (mg)	1.1-1.2				
< 1.1		29 (18.6%)	45 (17.9%)	13 (14.6%)	87 (17.5%)
1.1 – 1.2		5 (3.2%)	10 (3.9%)	3 (3.4%)	18 (3.6%)
> 1.2		122 (78.2%)	197 (78.2%)	73 (82.0%)	392 (78.9%)
Total		156 (100%)	252 (100%)	89 100%)	497 (100%)
Riboflavin (mg)	1.1 – 1.3				
< 1.1		151 (96.8%)	244 (96.8%)	85 (95.5%)	480 (96.6%)
1.1 – 1.3		0 (0.0%)	2 (0.9%)	0 (0.0%)	2 (0.4%)
> 1.3		5 (3.2%)	6 (2.3%)	4 (4.5%)	15 (3.0%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)

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Niacin (mg)	14-16			
< 14		135 (86.5%)	232 (92.1%)	78(87.6%)	445 (90.0%)
14 – 16		15 (9.6%)	15 (6.0%)	8 (9.0%)	38 (7.6%)
> 16		6 (3.9%)	5 (1.9%)	3 (3.4%)	14 (2.4%)
Total		156 (100%)	252 (100%)	89 (100%)	497 (100%)

Key: [1] > 500cells/mm^3,　　[2] 200 - 499cells/mm^3,　　[3] < 200cell/mm^3

4.5.1.1 Association between Nutrient Intake and CD4 Cell Count Category over the Study Period

Linear regression was used to establish if there was any difference between nutrient intake and CD4 cell count categories (mild, moderate and severe) of groups of individuals over six months. There was a significant difference between the groups in calcium intake between mild and moderate (p=0.005) with a decreased of 88mg and between mild and severe (p=0.019) a decreased of 96.7mg. There was a decrease of 1279.6IU in Vitamin A intake between the mild and moderate (p=0.030) and an increase of 0.10mg in riboflavin intake between mild and severe (p=0.038) and an increase of 0.12mg between moderate and severe (p=0.012) as illustrated in Table 4.26.

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Table 4.26: Differences in Nutrient Intake across CD4 Cell Count Category

Nutrient	Category	Mean difference	Confidence Interval (CI)	Sig
Energy (Kcal)	Mild/moderate	113.83	-241.607, 13.986	0.081
	Mild/severe	31.337	-197.79, 135.117	0.712
	Moderate/severe	82.332	-72.177, 236.840	0.296
Protein (g)	Mild/moderate	-0.965	-3.331, 1.402	0.424
	Mild/severe	2.616	-0.470, 5.702	0.096
	Moderate/severe	3.581	-1.402, 3.331	0.424
Iron (mg)	Mild/moderate	0.344	-0.297, 0.985	0.292
	Mild/severe	0.449	-0.387, 1.285	0.292
	Moderate/severe	0.105	-0.671, 0.881	0.791
Calcium (mg)	Mild/moderate	-88.136	-149.207, -27.066	0.005*
	Mild/severe	-95.688	-175.320, -16.055	0.019*
	Moderate/severe	-7.551	-81.468, 66.366	0.841
Vitamin A (IU)	Mild/moderate	-1279.632	-2432.382, -126.882	0.030*
	Mild/severe	-578.915	-2082.034, 924.204	0.450
	Moderate/severe	700.717	-694.525, 2095.959	0.324
Vitamin C (mg)	Mild/moderate	-1.566	-6.413, 3.281	0.526
	Mild/severe	-2.423	-8.743, 3.897	0.452
	Moderate/severe	-0.857	-6.723, 5.009	0.7774
Thiamine (mg)	Mild/moderate	0.064	-0.069, 0.196	0.345
	Mild/severe	0.059	-0.113, 0.232	0.500
	Moderate/severe	0.004	-0.164, 0.156	0.957
Riboflavin (mg)	Mild/moderate	-0.013	-0.088, 0.062	0.738
	Mild/severe	0.104	0.006, 0.201	0.038*
	Moderate/severe	0.116	0.026, 0.207	0.012*
Niacin (mg)	Mild/moderate	-0.627	-1.443, 0.189	0.133
	Mild/severe	0.247	-0.817 1.311	0.649
	Moderate/severe	0.247	-0.113, 1.862	0.083

Key: * α= 0.05, Mild = CD4 cell count> 500 cells/mm^3, Moderate = CD4 cell count between 200 and 499 cells/mm^3, Severe < 200 cells/mm^3

4.5.1.2 Association between Nutrient Status and CD4 Cell Count Category over the Study Period

Linear regression was used to establish if there was any difference between nutrient status measures and CD4 cell count categories (mild, moderate and severe) of groups of individuals

over six months. There was a significant difference between the groups in creatinine levels between mild and moderate (p=0.006) with a decrease of 0.47mg/dl and between mild and severe (p=0.017) with a decrease of 0.53mg/dl as shown in Table 4.27.

Table 4.27: Differences in Nutrient Status Measures across CD4 Cell Count Category

Nutrient Status Indicator	Category	Mean difference	Confidence Interval (CI)	Sig
Haemoglobin (g/dl)	Mild/moderate	-0.308	-0.986, 0.369	0.372
	Mild/severe	0.012	-0.872, 0.895	0.980
	Moderate/severe	0.320	-0.500, 1.140	0.444
MCV (fL)	Mild/moderate	-0.033	-1.102, -1.036	0.952
	Mild/severe	0.119	-1.275, 1.513	0.867
	Moderate/severe	0.152	-1.142, 1.445	0.818
Creatinine (mg/dl)	Mild/moderate	-0.470	-0.803, 0.138	0.006*
	Mild/severe	-0.530	-0.964, 0.096	0.017*
	Moderate/severe	-0.059	-0.462, 0.343	0.772

Key: * α= 0.05, MCV – Mean Corpuscular Volume, Mild = CD4 cell count> 500 cells/mm^3, Moderate = CD4 cell count between 200 and 499 cells/mm^3, Severe < 200 cells/mm^3

4.5.1.3 Body Mass Index across CD4 Cell Count Category

In this study a patient was considered malnourished if they had a BMI of >18.5kg/m^2, normal at a BMI of 18.5-24.9kg/m^2, overweight at a BMI of 25-29.9kg/m^2 and obese at a BMI of <30kg/m^2. Most of the patients 396 (79.68%) had a BMI of 18.5kg/m and above. Of these, patients with a BMI >18.5kg/m were 20.8% in the mild, 43.6% in the moderate and 35.6% in the severe categories. BMI between 18.5-24.9kg/m^2 were 28.5% in the mild, 52.2% in the moderate

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and 18.9% in the severe categories. BMI between 25-29.9kg/m^2 were 36.9% in the mild, 50.8% in the moderate and 12.3% in the severe categories. BMI >30kg/m^2 were 20.8% in the mild, 43.6% in the moderate and 35.6% in the severe categories as shown in Figure 4.3. There was an inverse relationship between BMI and severity of immune status.
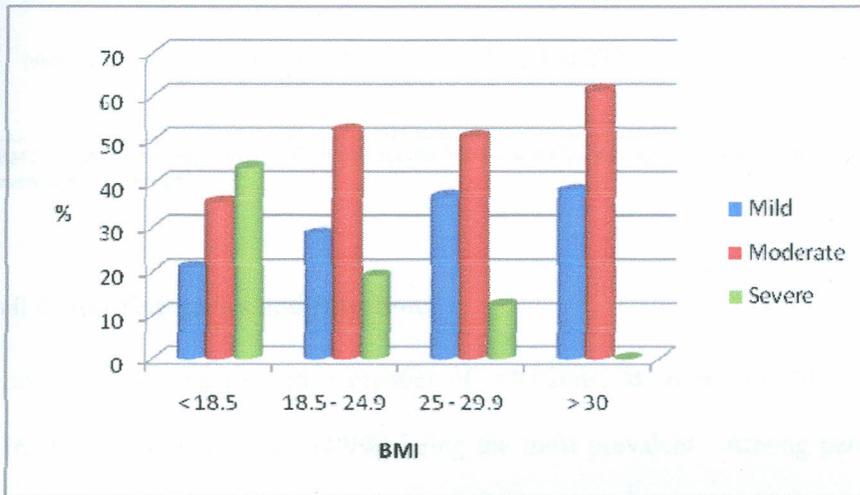
Figure 4.3: BMI by CD4 Cell Count Category

4.5.1.4 Association between BMI and CD4 Cell Category

Linear regression was used to establish if there was any difference between BMI and CD4 cell count categories (mild, moderate and severe) of groups of individuals over six months. There was no significant difference between the groups in BMI although there was a decrease of 0.57kg/m^2 between mild and severe (p=0.257) as illustrated in Table 4.28.

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Table **4.28:** Differences in BMI across CD4 Cell Count Category

BMI	Category	Mean difference	Confidence Interval (CI)	Sig
BMI (kg/m^2)	Mild/moderate	0.060	-0.692, 0.813	0.875
	Mild/severe	-0.567	-1.548, 0.414	0.257
	Moderate/severe	0.821	1.183, 0.237	0.056

Key: * α= 0.05, BMI – Body Mass Index, Mild = CD4 cell count> 500 cells/mm^3, Moderate = CD4 cell count between 200 and 499 cells/mm^3, Severe < 200 cells/mm^3

4.5.2 CD4 Cell Count Categories and Infections

The patients in the study experienced a number of infections, as shown in Table 4.29 with pneumonia (16.1%) and tuberculosis (14.9%) being the most prevalent. Among patients with CD4 cell count less than 200 mm^3, the most prevalent infections were pneumonia 38 (28.4%) and tuberculosis 39 (29.1%). The number of patients with CD4 counts of >500 cells/mm^3, 200 – 499 cells/mm^3 and <200 cells/mm^3 were 15 (0.5%), 27 (12.2%) and 38 (28.4%) respectively.

Table 4.29: HIV Sero-positive Patients by Infections and CD4 Cell Count Category at Baseline

(n = 497)

	CD4 Cell Count Category			
Type of infection	Mild[1] No (%)	Moderate[2] No (%)	Severe[3] No (%)	Total No (%)
Pneumonia	15 (0.5%)	27 (12.2%)	38 (28.4%)	80 (16.1%)
Tuberculosis	17 (11.9%)	18 (8.2%)	39 (29.1%)	74 (14.9%)
Candidiasis	2 (1.4%)	1 (0.5%)	1 (0.7%)	4 (0.8%)
Dermatitis	12 (8.4%)	23 (10.5%)	8 (6.0%)	43 (8.7%)
Malaria	9 (6.3%)	6 (7.3%)	3 (2.2%)	28 (5.6%)
Respiratory tract infections	0 (0%)	0 (0%)	0 (0%)	0 (0%)
No infection	88 (61.5%)	135 (61.3%)	45 (33.6%)	268 (53.9%)
Total	**143 (100%)**	**220 (100%)**	**134 (100%)**	**497 (100%)**

Key: [1] > 500cells/mm^3,   [2] 200 - 499cells/mm^3,   [3] < 200cell/mm^3

4.5.2.1 Association between Infections and CD4 Cell Category

Linear regression was used to establish if there was any difference between infections and CD4 cell count categories (mild, moderate and severe) of groups of individuals over six months. There was no significant difference between the groups in the frequency of infection between groups as illustrated in Table 4.30.

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Table **4.30:** Infections across CD4 Cell Count Category

Infections	Category	Mean difference	Confidence Interval (CI)	Sig
Infections	Mild/moderate	0.133	-0.165, 0.430	0.381
	Mild/severe	0.160	-0227, 0.548	0.417
	Moderate/severe	0.028	-0332, 0.388	0.880

Key: * α= 0.05, Mild = CD4 cell count> 500 cells/mm^3, Moderate = CD4 cell count between 200 and 499 cells/mm^3, Severe < 200 cells/mm^3

4.6 Focus Group Discussions

Fifty six females and twenty six males participated in the Focus Group Discussions (FGDs). The discussants were selected using simple random sampling technique, where 8 participants (optimal number for an FGD) for each focus group discussion were purposively selected. Their ages ranged from 18 to 60 years and a high proportion of the participants had attended primary school only. The monthly household income ranged between kshs 1500 - 2000 ($19 - 25). Most of the female patients (>70%) were engaged in business. A total of 8 focus group discussions were held. Content analysis technique was used to analyze the data generated from the FGDs.

4.6.1 Knowledge

Knowledge of HIV and perceptions of risk for HIV infection are essential for making behavioural choices that reduce risk of acquiring and transmitting HIV. Knowledge of one's HIV status is essential for accessing HIV care, treatment and prevention services. There were six questions asked to test the discussants' knowledge on HIV management. All the discussants in

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the 8 focus groups reflected knowledge of a good understanding of what AIDS is and had heard about it from: fellow patients, AIDS education programs e.g. television, radio or clinic and neighbours. The discussants conceded that when they hear the word AIDS, death comes to their mind and this was an idea that they got from relatives. Discussants in six of the eight focus groups involved were aware of the dietary requirements of PLWHAs in general and majority got this information from reading materials from either relatives or friends.

Despite having the health talk sessions, majority were not aware of the types of foods important for the management of HIV infection. It is notable that the female participants had better knowledge on nutrition compared to the male participants. These results reveal that there is need to reach men and educate them on importance of nutrition. In two of the groups discussants were able to mention five types of food important in HIV infection, while the other six group discussants were only able to mention just a few. All the focus groups had information on the related complications that arise during HIV infection. They were able to mention tuberculosis and pneumonia as examples.

The discussants reported that they had heard of nutrition counselling. All discussants in the eight focus groups reported that the Information, Education and Communication (IEC) materials were not available for the patients but they are used by the psychosocial workers for health talks. The discussants mentioned that during the health talk sessions at the AMPATH clinic, they are given advice on the general management of HIV but with no emphasis on nutrition. All the discussants indicated that consuming nutritious foods made a HIV positive person healthy by protecting them from illnesses. Discussants in three focus groups further cited healthy body as specific

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outcomes of giving nutritious foods. All the discussants believed that nutritious foods give an HIV positive person the energy to be healthy. In addition, the discussants in two focus groups also mentioned that good foods would improve blood circulation and that this in turn, would make a person healthy.

Using a food pyramid chart, the participants were asked to relate nutrients to food sources. No one in any of the groups were able to relate any nutrients to food sources, although several females were able to list some nutrients (iron, calcium, vitamin A, carbohydrate, fat and protein) as they had heard the information from the psychosocial workers and nutritionist in the clinic. Compared to male participants, majority of the female participants were able to relate foods to their general nutrient content. For example, rice, *ugali* and tubers (cassava, sweet potatoes) were cited to contain carbohydrate and starch while meat, poultry and eggs were cited to provide protein in the diet. Compared to the male participants, the female participants were better in relating foods to general functions (e.g. give energy, good for blood and strengthen bones and teeth, (Ministry of Health, 2007). While discussants in two focus groups cited rice as food that promotes human health, only one group mentioned that foods such as rice, fish, meat and chicken provide energy and protein to support human health. All the discussants mentioned that nutrition can help improve health status. They cited HIV condition as being one of the diseases. In general, the female participants were more aware of the relationship between foods or nutrients and diseases and were able to provide more examples of food-disease relationship than males. Personal hygiene of an individual at home (inside and surroundings) and foods for consumption (e.g. wash food items before cooking or eating) were identified in all groups as important contributors to good health. A majority of the participants reported that consuming

nutritious foods influenced their health status. Fruits and vegetables were mentioned by three groups as important for health.

4.6.2 Attitude and Perceptions

Several areas were tested in regards to the participants' perceptions of HIV and AIDS. The questions in the focus group discussions were directed towards determining the perception of HIV and AIDS, and prevention methods. Four questions were directed towards the perceptions of HIV and AIDS and the methods of transmission. AIDS brought about feelings of fear there is no cure for AIDS which meant, it only leads to death. Discussants in five groups mentioned that they talked to their partners about HIV and AIDS while discussants in seven talked to their friends about the same topic. The information about HIV and AIDS was received from different sources: school, books, magazines, friends, television, and HIV and AIDS education programs. The discussants were able to name the major HIV transmission methods: needles, razor blades, sexual contact, and blood transfusions. The consequences of AIDS were reported to be death and distress to the family. The HIV prevention methods mentioned were: condom use, no sexual contact, self-control, avoid sex workers and multiple sex partners, go to the doctor, get the blood tested, use new needles, and new razor blades.

Six questions were asked to determine the patient's attitude towards dietary management of HIV infection (Appendix 9). All discussants appreciated the education and awareness provided by the programs with one-to-one contact found to be very useful. HIV and AIDS prevention programs were looked upon as useful and important. All the discussants cited that diet was important in

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HIV infection but they did not have the economic ability to maintain the diet. Discussants in six groups mentioned that they did not have enough energy to carry out their daily activities.

4.6.3 Beliefs and Cultural Practices

There were two open-ended questions used to address cultural practices (Appendix 9). All the discussants agreed that there were many cultural practices that encouraged the spread of HIV in the region. This included wife inheritance, ritual cleansing (sex between a widow and a ritual cleanser is a cultural practice amongst the Luo tribe where a widow upon the death of her husband is expected to have sex with a "cleanser" in order for her to be allowed to remarry); farming calendar (this is the practice where sex comprises part of rituals carried out before planting where the father begins, then the eldest son and so on then the trend follows again before harvesting); 'Jaboya' ("sex for fish trade" culture, which is common among beach communities around Lake Victoria. Due to scarcity of fish and cultures that stop women from fishing, fishermen take advantage of the situation and conditionally sell fish to the women fishmongers in exchange of sex and other favors. To ensure a consistent supply of fish for their trade, these women become "wives" to the 'Jaboya'- (fishermen boyfriends) and any new fishmonger would not get fish unless she gets one) and 'Abila' (has many connotations in the Luo language generally described as an ancestral shrine or a council of Luo elders where people in their communities go for consultations on cultural issues. In this context, it means a common house by the beach, where fishermen live together when they are off shore, and this is where their friends-both male and female come to visit them. 'Jaboya' and 'Abila' together stand for sexual practices among fishermen and fishmongers in these communal housing structures. The male participants strongly agreed to wife inheritance while the female did not agree to it. The

reason given by the male participants was that there would be continuity of family with inheritance from a relative.

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CHAPTER FIVE: DISCUSSION

This chapter discusses the results obtained from the study. The discussions are organized by objectives and integrated. This chapter also discusses results with support from previous studies.

5.1 Demographic Characteristics

The patients were mostly females with a ratio of male to female 1:4 and mean age of 39 years ($\pm$ 10.5). Majority of the patients were aged between 31 – 40 years (31.4%). Majority of the patients had low level of education and were mainly from Winam and Maseno Divisions of Kisumu County with an average family size of between 6-10 members as shown in Table 4.1. NASCOP et al., (2008) reports a decline in female HIV prevalence, which could be attributed to either decreased infection or increased death in this sub-group. However, in this study lower females per males infected may not support a decline given the fact that they were out patients in a health facility. Most people are productive between the ages of 31 – 49 years and above 50 years of age an individual's economic activity begins to decline (KNBS & ICF Marco, 2010). This implies that food procurement by these patients may decline, thus resulting in food insecurity in households. There was no significant difference between males and females for marital status, education level and occupation but there was a significant difference for age and family size. There were more females in their reproductive age compared to the males.

Age and marital status may combine to influence one's responsibility of meeting their food needs and that of their household members. This may imply that households with spouses may have a better economic situation since both parents could contribute towards various economic activities in the household. This study established that 44.5% of participants were married and 42.9% widowed. According to NASCOP et al., 2008, in Kenya, nearly 2 out of 3 Kenyans ages 15 – 64

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are in a union (married or cohabitating). The number of divorced and separated among patients in this study was low (4.2%). This is consistent with a study that showed marriages in the rural areas are relatively stable unlike in the urban areas (Mburugu, 1994).

Twenty seven percent of the participants had primary education while 64.8% had no formal education. The level of education influences one's ability to make decisions regarding use of available resources as well as determining ability of one to provide for their needs and that of the household (Mburugu, 1994).   This may also affect their motivation to acquire nutrition information thus may result in poor health and nutrition practices. Secondary level education enables one have a better capacity to seek, acquire and internalize new ideas on food and nutrient intake. College or university education facilitates better understanding of the importance of nutrition in the management of HIV infection (Mburugu, 1994). The low literacy levels among the patients could be attributed to high numbers with primary level education in the area (Ministry of Finance and National Planning, 2002). This agrees with a study reported in Tanzania that reveals that the prevalence HIV infections are now concentrated among those with the lowest levels of education (Hargreaves & Howe, 2010).

5.1.2 Socio-economic Characteristics

In this study majority of the patients had a monthly income of Kshs <2000 monthly and majority engaged in farming or business as an economic activity. This implies that majority of the HIV patients earned less than one dollar ($ 90) a day and is classified as poverty threshold or poverty line by the World Bank (World Bank, 1990). Income affects the family's purchasing power and access to food. Thus patients with less income may not be able to purchase food that will satisfy

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the nutrient needs of the HIV condition. A study by Food and Agriculture Organization (FAO) in Kenya found out that 20% of rural families do not have enough income to afford a basic adequate diet to meet their nutritional needs and therefore suffer from "Food Poverty" (FAO/WHO, 1992). In 1997, the overall poverty line was placed at Kshs 1239 ($ 15.49) per month per adult in rural areas and Kshs 2648 ($ 33.10) in urban areas (Ministry of Planning and National Development, 2003). A World bank analysis of 72 countries showed that at the national level, both low per capita income and unequal distribution of income are associated with high rates of HIV infection (UNAIDS, 2002).

Food poverty in Kenya has grown since the 1970's and varies regionally with Nyanza and Western Provinces containing about 60% of the food poor, (World Bank, 1990). Even though 77.1% owned land while 22.9% had no land, the current study found out that the types of crops cultivated were mainly cereals (68.0%) like maize. Maize is the popularly consumed staple and a constant source of calorie to a number of the patients. This agrees with the FAO/WHO 1992 findings that for an average rural household about 50% of the food consumed is derived from own farm production.

5.2 Immune Integrity

The mean CD4 cell count was 431cell/mm^3 with a CD4 percent 19.3%. CD4 cell count is the most used index of the level of cell mediated immunity in HIV infected patients. In this study, there were more females in WHO stage 1 and WHO stage 2 compared to males. This might be due to the female tendency to seek health care early, during the disease process thus preventing them from progressing into stage 4. On the contrary, males have poor health seeking behaviour

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and many may have reported too late thereby progressing into the stage 4. The results showed that majority of the patients had a compromised immune system. This is consistent with a study reported in Great Britain in a hospital among HIV adult patients where majority of the patients had a mean CD4 cell count of between mean 200 – 500 cells/mm^3 (Ly Mee et al., 1997).

The male patients had a significantly lower CD4+ lymphocytes count than the female patients. Relatively high CD4+ cell count among the female patients might be due to the WHO stage of disease progression. There is a higher fatality rate in males than females, that is females live longer with HIV than males (McCutchan, 2008). These gender differences in CD4 lymphocyte counts suggest a delay of initiation of therapy in men compared with women. If this delay unfavourably influences progression, treatment guidelines should be revised so that men can benefit equally from HAART (Highly Active Anti Retroviral Therapy). Duration of infection has been shown to be a major predictor of CD4+ lymphocyte count and disease progression among HIV infected adults (Begtrup et al., 1997). Previous studies have reported that a CD4% of 10%, - 20% corresponds broadly to a CD4 cell count of 100 - 200, cells/mm^3, for the purpose of clinical prediction (Ly Mee et al., 1997). However, in this study a CD4 cell count between 314 - 462 cells/mm^3 corresponded to a CD4 % of between 15-20%. Since CD4+ percentage (%) is used to determine the number of CD4 cells this could mean that there is immunosuppression among the patients in this study.

This study established that majority of the patients were within the normal range for WBC and platelets. A decreased WBC can leave a person vulnerable to various pathogens and cancers

(Begtrup *et al.*, 1997). In an HIV patient Decreased WBC (leukopenia) can leave a person more vulnerable to various pathogens and cancers.

5.3 Food Consumption Patterns

This study revealed that majority of the patients had difficulty in accessing food. Majority of the patients owned land yet the area cultivated seemed not sufficient to meet their nutritional needs. The difficulty in accessing food among the patients may be attributed to the inability to produce food and lack of enough income to purchase food. The pattern of these results is in agreement with research results reported by Onyango *et al.*, 2009, in which households affected with HIV and AIDS had difficulty in accessing food. Food availability and good nutrition are thus essential for keeping people living with HIV healthy for longer time (Luder *et al.*, 1995). A stronger, healthier body can better resist the opportunistic infections, that affect people living with HIV, especially in resource-poor settings where preventive health care is not often available (Gibson, 1990).

5.3.1 Food Variety

The findings of this study showed that there was variety in the consumption of food from some of the food sources. However it is generally understood that no food contains all necessary nutrients and that variety in the diet is needed to ensure a balanced diet. The most commonly consumed foods on a daily basis were from vegetables and cereals sources. The foods consumed and the frequency of consumption determines an individual's food security status (Kotler, 2000). Therefore if the food consumption and frequency is low the HIV sero-positive patient may become more food insecure. The results suggest that majority of the patients consumed a variety

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of foods from the vegetables sources daily and this may be due to the vegetables being available and affordable compared to the other sources of food like animal proteins. It may be envisaged that the difficulty in accessing food among the patients may have contributed to them not consuming a variety from protein sources. Food variety may be associated with one's economic ability to purchase different types of foods items from different food sources. Those with low income may stick to the few cheaper foods available, and this limits variety in the diet among the poor people (Friis & Michaelsen, 1998). Monthly income can be a strong and significant predictor of food variety among HIV patients. However, in this the monthly income was below the average of one Dollar (1$ = 80 Ksh) a day, (UNDP, 2002) and majority had a nutrient intake. A study by Stewart, 2003 reported that daily servings of the same food from each food source may not be enough, but that one should choose variety within food sources because the characteristic nutrients in each group vary greatly for individual foods.

5.3.2 Food and Nutrient Intake

Majority of the patients had three meals per day during the study period though in the month of June majority of the patients had two meals. Reduced meal frequency may translate into reduced intake which in turn affects the health and survival of an HIV-infected person thus increasing immunosuppression. HIV impairs nutritional status by undermining the immune system, as well as nutrient intake, absorption and use (Tang & Smit, 2005). Malnutrition can exacerbate the effects of HIV and hasten AIDS-related illnesses in people living with HIV.

As observed in this study, the mean energy intake is lower than the RDA for both male and female patients. The patients may have been consuming a variety of carbohydrate sources but not

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amounts to meet their dietary needs. This does not agree with findings as reported by Hogg *et al.*, (1995) that in a study in South Africa most HIV-infected patients had energy and protein intakes that met at least 67% of the recommended daily amount. However, most of these patients had indications of low intake of vitamins C, A, D and B_6 and of zinc, iron and calcium. This is probably due to their high consumption of carbohydrate sources like maize meal, which contains only low levels of these nutrients.

The results in this study are consistent with findings by Onyango *et al.*, (2009) that only 48.3% met the RDA for energy among HIV sero-positive patients. Energy intake is related to the stage of the infection, rapid weight loss, anorexia, opportunistic infections, malabsorption and altered metabolism (Dworkin *et al.*, 1985). Thus it is clear that HIV-infected patients are at increased nutritional risk. This may thus be viewed as a bad trend for patients with low energy intake. The lower than RDA energy intake observed in this study could put patients at risk of energy related effects of HIV such as wasting. Energy requirements increase significantly as the HIV disease progresses (WHO, 2001). The higher energy intake assists to a certain degree in reducing wasting and improves the well-being of the patients (Macallan, 1999).

Both male and female patients had a mean protein intake lower than the RDA. The results differ from the findings by Watson (1994), which reports a mean protein intake in HIV-positive patients that was higher than the RDA. Studies carried out on HIV-infected patients in the Free State province of South Africa and in Boston (USA) reported that a majority of the patients had a protein intake that met at least 67% of the RDA (Dannhauser *et al.*, 1999). The low intake of protein observed in this study may be associated with the patient's economic ability.

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In this study, the majority of patients had low intake of micronutrients that was < 90% or lower than the RDA. The study also established that the intake of calcium, vitamin A and riboflavin in both males and females was less than RDA. The female patients had higher intake of most of the nutrients compared to the males except iron intake. Studies have shown that some minerals/trace elements may be key factors in maintaining health despite human immunodeficiency virus infection and in reducing mortality. Based on the average usual intake of the patients higher values than the RDA were identified for thiamine in both male and female and iron in male in this study population. Each of the mineral/trace elements examined in this study may contribute to the general well-being of HIV-infected persons. Calcium has been shown to reduce diarrhoea in HIV-positive/AIDS patients (Hammond, 2004). In this study, the mean calcium intake in both male patients and female patients lower than the RDA. Therefore, the results obtained from this study tend to suggest that patients with a high dietary intake might be able to replace lost calcium and in turn reduce the burden of diarrhoea.

Iron is essential for the formation and functioning of red blood cells, and vitamin C is known to promote the absorption of iron. In male patients, the iron intake was higher than the RDA, nonetheless the females had a lower intake. Iron is one of the micronutrients that is commonly deficient in HIV infection. As mentioned earlier, the female population had an inadequate intake of iron as opposed to the male population. The reason for this discrepancy is not clear, but it may be related to the fact that iron is lacking in women's food due to a lack of knowledge, consuming foods/diets deficient in iron or because of extra demands during the menstrual cycle, women need extra iron until they pass the menopause stage (Miret *et al.,* 1998).

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Tang et al., (1993) observed a slower progression of disease and reduced risk of mortality with an increased intake of riboflavin, thiamine and vitamin C. Vitamin C has been found to affect immune function in several ways (Watson, 1994). It can stimulate the production of interferons; the protein that protect cells against viral attack. However, the dietary intake of vitamin C was below the RDA among the participants in this study. There is evidence that increased intakes of vitamin C may help to reduce the risk of diseases associated with increased oxidative stress (Watson, 1994). It is therefore envisaged that the inadequate vitamin C intake reported among the patients in this study is not beneficial to the patients.

Although, the greater percentage of patients in this study had a higher thiamine intake than the RDA, it should be noted that even a mild state of deficiency of this vitamin could result in an altered immune function, especially in patients who are not on antiretroviral drugs. As HIV infection progresses, coupled with opportunistic infections and metabolic demand, HIV-infected individuals may be unable to meet their required nutritional needs. This is also reflected in this study as majority of the patients were not able to meet the RDA for the nutrients addressed. This may be due to decreased oral intake, decreased nutrient absorption, increased nutrient requirements and changes in metabolism and nutrient transport, which could steadily result in greater inadequacy of these vitamins.

The dietary intake of vitamin A in this study was lower than the RDA for most of the patients. Tang et al. (1993) reported that 12% - 19% of HIV-positive patients at various stages of HIV infection show vitamin A inadequacy that is more prevalent in women than in men. However, this study established that the females had a higher intake of vitamin A compared to the males.

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Studies have shown that there is a relationship between the dietary intake of vitamin A and immune function (Macallan *et al.,* 1993). High dietary intake of vitamin A may be related to metabolic demand during the acute phase of HIV infection, or an increased dietary intake, while the low intake could probably be associated with a more rapid progression to AIDS (Macallan, 1999).

5.4 Nutrient Status

The patients had lower levels of haemoglobin but creatinine and MCV levels were within the normal ranges. With low haemoglobin levels, there may be poor healing and less efficient organ function resulting in anaemia. The low haemoglobin levels may have arisen due to the HIV infection because the MCV values were within the normal ranges (Gibson, 2005). Haemoglobin concentrations may be affected by other factors like parasitic infections e.g. malaria which was prevalent in this study in the month of June. The creatinine levels were lower among the females compared to the males. This may be a normal physiological difference as muscle mass is lower and declines faster in HIV-infected adults (Yarasheski *et al.,* 2011).

5.5 Body Composition

The mean BMI (21.7kg/m^2) for the entire study sample was above the cutoff 18.5kg/m^2 for malnutrition in HIV infection. Weight loss is very common in HIV and AIDS and has been correlated with disease progression and mortality (Kotler *et al.,* 1989). During weight loss in HIV and AIDS the proportion of body stores that are lost, be they protein, fat or carbohydrate depends on the underlying nutritional state and the dietary intake (Cuff, 1990). Malnutrition is

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frequent and a marker for poor prognosis among HIV-infected patients (Kotler *et al.*, 1989). Weight loss strongly predicts illness or death among people with HIV and increased energy expenditure is one factor associated with HIV-related weight loss. There was a significant difference in the BMI between the male and female patients. The female patients had a higher BMI than the male patients. Even at moderate levels, malnutrition has been shown to have a detrimental impact on HIV outcome (Chlebowski *et al.*, 1989). This association has been related to survival independent of the CD4 cell count (Guenter *et al.*, 1993). The mean BMI of the patients was $20.5kg/m^2$ in male and $21.7kg/m^2$ in female. However this seems lower compared with population norms for the United States among adult HIV patients, where mean BMI has been estimated as $25.9kg/m^2$ for adult males (Allison *et al.*, 2002) and 26.3 for adult females (Zhu *et al.*, 2003).

This study shows that 20.3% of participants had severe malnutrition with a BMI $< 18.5kg/m^2$. These results confirm that malnutrition is an important issue in the management of HIV-infected patients. The changes in weight may be related to decreased food intake or increased whole-body protein turnover (Macallan *et al.*, 1993). Severe malnutrition has long been known as an independent risk factor for infections (Kotler *et al.*, 1989), including opportunistic infections in HIV sero-positive patients (Guenter *et al.*, 1993). The life expectancy of HIV-infected patients is related, among other parameters, to their nutritional status (Kotler *et al.*, 1989). Increased BMI is associated with an increased CD4 cell count and with lower rates of the events that characterize the progression of HIV disease (Forrester *et al.*, 2001). Weight and body composition, in relation to the CD4 cell counts, (Forrester *et al.*, 2001). In this study it was observed that majority of the patients in the severe category (CD4 < 200 cell/mm^3) had a BMI of

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less than $18.5kg/m^2$. Those in the mild and moderate categories had a higher percentage of patients with a BMI above 30 kg/m^2 (38.5% mild and 61.5% moderate). There were very few patients with BMI > $30kg/m^2$ with CD4 cell count < 200 cells/mm^3, no patients in the severe category with a BMI > 30 kg/m^2 and it may be envisaged that they may have been experiencing weight loss related to a decrease in body fat. The male patients mean BMI was within the normal range but lower than that of the females over the entire study period. This may be expected in this study based on the fact that majority of the males were in WHO stage 3 and 4 which is characterized by weight loss.

5.6 Pattern of Infections

The most prevalent infections experienced by the patients included diarrhoea, tuberculosis and pneumonia. HIV related malnutrition has several causes (Macallan, 1999), including but not limited to a decrease in food intake, the effects of opportunistic infections (Lefrancois, 1991), metabolic inefficiencies due to cytokine activity and diarrhoea. Malnutrition itself can induce immunodepression and worsen HIV-related immunodepression (Raiten, 1991). Once HIV has weakened the immune system, various infections can take hold, some of which can affect appetite and ability to eat. Individuals with a CD4 cell count lower than 200 cells/mm^3 have the greatest risk of developing opportunistic infections. This means that when HIV-infected patients develop the infection, their condition has progressed to AIDS (Niyongabo et al., 1999). This study established that majority of the patients were in WHO Stage 3 and the average CD4 cell count was 431cells/mm^3. This may suggest the reason why pneumonia and tuberculosis were the most prevalent opportunistic infections as these are symptoms of WHO stage 3.

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This study established that 31% of the patients either suffered from pneumonia or tuberculosis. The patients also had respiratory tract infections especially from the month of April to July and this may be attributed to the cold season at this time of the year in Kenya. Tuberculosis (TB) has been associated with malnutrition in HIV patients (De Cock *et al.,* 1992). As observed in this study the patients with infections had a significantly lower BMI compared to those without. These findings are in agreement with a study in Burundi conducted among adults with tuberculosis, including pulmonary, extrapulmonary and disseminated infection that suggested those infected with HIV had significantly lower weight, BMI and fat-free mass compared with individuals without infections (Niyongabo *et al.,* 1999). Moreover, there appears to be a relationship between BMI, host immune function and the natural history of HIV in adults with tuberculosis (De Cock *et al.,* 1992). HIV patients have an increased risk of developing TB because they have weakened immune systems. Host resistance to TB is dependent on cell mediated immune response, which is compromised in HIV positive individuals. One study found that HIV replicates faster when tuberculosis is also present (Kant *et al.,* 1995). Infections may affect the nutritional status of an individual suffering from HIV and AIDS in various ways, such as a reduction in food intake and nutrient absorption and by increasing the utilization and excretion of proteins and micronutrients (Semba & Tang, 1999).

In this study diarrhoea was the most prevalent infection among the HIV patients. Diarrhoea is one of the major infections among HIV patients and is well recognized as an important component of HIV related morbidity. Majority of the HIV sero-positive patients in this study were at an advanced stage of HIV disease (AIDS) as confirmed by clinical staging and CD4 level (Suresh *et al.,* 2006). Diarrhoea was experienced by over 50% of AIDS patients at some time

during the course of their illness. It is an important cause of morbidity and mortality in up to a quarter of all HIV sero-positive patients (Sande & Volberding, 1997). Diarrhoea is the most common gastrointestinal (GI) symptom in patients with HIV. There was a difference in nutrient intake between the patients who had episodes of diarrhoea and those who did not and this may be due to nutrient loss in those who had diarrhoea. Diarrhoea was associated with low nutrient intake especially calcium which is known to reduce the burden of diarrhoea in HIV infection. Malaria was more prevalent in the month of June and this may be attributed to this being rainy and cold season of the year.

5.7 Association of Nutrition, Infection and Immune Factors

HIV impairs nutritional status by undermining the immune system, as well as nutrient intake, absorption and use (Tang & Smit, 2005). There was a difference between groups in nutrient intake of calcium, vitamin A and riboflavin. A decrease of 88mg in calcium intake was observed between the mild and moderate categories and 95.7mg between mild and severe categories. Calcium is not widely distributed in foods though milk and milk products are readily available in food (Gibson, 2005). In this study the participants consumed a variety of cereal sources which is not a rich source of calcium. Vitamin A intake decreased by 1279.61IU between mild and moderate categories. There is a relationship between vitamin A and immune function and HIV infection may cause malabsorption of vitamin A (Sivakumar & Reddy, 1975). Vitamin C intake decreases by 2.423mg between the mild and severe categories and by 0.857mg between moderate and severe categories. About 70% - 90% of vitamin C is absorbed when daily intakes range from 30 to 180mg (Kallner *et al.,* 1979). Riboflavin intake increased by 0.01mg between mild and severe categories and by 0.012mg between moderate and severe. Major sources of

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riboflavin are milk and milk products which was not often consumed by the patients. The food programme may have had an influence in the nutrient intake of vitamin A, vitamin C, calcium and riboflavin but a larger sample size would have brought out the differences better.

There was a biological difference in creatinine level with a decrease of 0.47mg/dl between mild and moderate and between mild and severe a decrease of 0.53mg/dl. Infection result in an apparent increase in urinary creatinine (Walser, 1987). Some investigations suggest that each gram of creatinine excreted in a 24 hour urine sample represents a constant weight of about 18-20kg of fat-free muscle (Cheek, 1968; Heymsfield *et al.,* 1983; Cheek *et al.,* 1996). BMI decreased by $0.57kg/m^2$ between mild and severe categories. This is expected as there is wasting observed in the severe category. BMI changes very slowly with age (Gibson, 2005), therefore a change in BMI of close to $1kg/m^2$ is of concern among the sample population in this study considering that they are HIV sero-positive.

WBC decreased by 565cells/mm^3 between mild and moderate categories, by 595.24cells/mm^3 between mild and severe categories and by 30.04565cells/mm^3 between moderate and severe categories. A WBC increase often indicates that a person is actively fighting an infection or has recently received a vaccine. Decreased WBC (leukopenia) can leave a person vulnerable to various pathogens and cancers (Raiten, 1991). Significant differences were not noted with infections as there was an increase from one category. This could mean that patients were more predisposed to infections considering that their immune status is compromised in HIV infection.

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Adjusting for crude results in this study for food programme and ARVs did not have much difference in BMI, nutrient status indicators, immune status and infections between groups.

5.8 Knowledge, Attitude, Beliefs and Practices on Nutrition Management of HIV Infection

This study established that the participants had knowledge on nutrition management of HIV infection and this was seen more among the female participants. The participants were appreciated the education and awareness by various programme in the hospital. The participants conceited to the fact that there were cultural beliefs and practices within different communities. The positive attitude towards awareness of education information may be due to the fact that health talk sessions conducted is part of the preparation for treatment before patients are started on ARV drugs in most of the treatment centres at the AMPATH clinic Chulaimbo Sub-district hospital. Majority of the HIV patients had little information on nutritional management of HIV infection and this could have contributed to the inadequate intake of most of the nutrients besides other factors like infections and economic status. It was established that the male patients did not have adequate nutrition information and this is reflected in the results of the nutrient intake. There is therefore need to reach men and educate them on nutritional information. The proportion of the males compared to the females in this study was lower. This may be attributed to the fact that men do not have enough information on the importance of seeking medical care in the early stages of HIV infection, (NASCOP *et al.,* 2008). The spread of the HIV infection may be attributed to cultural practices such as wife inheritance (Abila, 2004). This is in line with the findings of this study in which some of the cultural beliefs are still practiced. Some of these practices may contribute to re-infection which predisposes one to a more compromised immune status.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

The main purpose of this study was to assess the association of nutrition, infections and immune factors in HIV sero-positive adults with the hope that the Comprehensive Care Clinics (CCCs) can use the findings to improve the effectiveness of nutrition management of HIV infection. This study found differences between immune factors and nutrient intake among HIV sero-positive patients at Chulaimbo sub-district hospital.

1. Most of the patients were between 31 and 40 years (17.7% males and 82.3% females), had an income of between kshs 1500 - 2000 per month. The economic activities included agricultural and non-agricultural e.g. small businesses like the sale of fish, mats, clothes and vegetables.

2. Most of the HIV patients were symptomatic in WHO clinical stage 3 with a CD4 cell count of less than 500 cells/mm^3; this is an indication of immunosuppression in the patients. The female patients had a significantly higher CD4 cell count than the male patients. Most of the male patients were in WHO stage 3 and WHO stage 4.

3. Generally, the nutrient intakes were lower than the RDA. This was across all the three categories especially the micronutrient intake. There was inadequate nutrient intake reported in most of the patients although majority (55.3%) had three meals per day.

4. The patients in this study had all the nutrient status (haemoglobin, creatinine and MCV) measures within the normal range even though the results show that the values for the males were slightly higher than the females.

5. There were 20.3% HIV-infected adults in this study who were malnourished using the WHO cut-off for underweight ($<18.5 kg/m^2$). Such malnutrition was noted between the mild and severe categories where there was a decrease of $1 kg/m^2$.

6. Majority of patients suffered infections during the study period. The most prevalent of these infections was gastrointestinal infections followed by tuberculosis and pneumonia.

7. Most of the patients had an inadequate nutrient intake irrespective of the CD4 cell count category. Majority were within the normal range for BMI, creatinine level and MCV.

8. Nutrition knowledge plays an important role in infection prevention and control in HIV sero-positive patients. It was established that the male patients did not have adequate nutrition information and this is reflected in the results of the nutrient intake.

6.2 Recommendations

In view of the results from this study, the following recommendations are suggested so as to improve the nutritional status among HIV sero-positive patients.

1. Screening especially for CD4 cell count, WBC and platelets count should be done at least after six months as this is not the case for all the patients in the Comprehensive Care Clinics (CCC) at Chulaimbo Sub-district hospital.

2. There are a number of programmes in the AMPATH clinic at Chulaimbo Sub-district hospital, which include the food programme and income generating projects among others. The patients can be educated on nutrition management of HIV infection with help from the nutritionist during the health talk sessions as currently the health talks are general and do not focus on nutrition issues.

3. There is need to conduct several nutrient status tests on nutrient status and not only the routine full haemogram that gives results on limited nutrient levels. For example to determine iron deficiency there are several indicators that can reveal iron status of a patient.

4. Weighing and taking patient's height to generate Body Mass Index (BMI) should be part of the routine for the HIV patients, as currently it is only the weight measurement that is done.

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5. Issues such as importance of optimizing and maintaining nutritional status and early treatment of opportunistic infections may be incorporated during the health talks.

6. There is need to have nutrition interventions immediately the patients are enrolled in the Comprehensive Care Clinics (CCCs) as the results from this study show that nutrition is key at all stages of infection.

7. There is need for policy makers to review the campaign strategies on HIV infection targeting men on the importance of seeking medical and nutrition care early. This can be achieved through the outreach department at the hospital as they make the routine visits to the patient's help homes.

6.3 Suggestions for Further Studies

There are important issues that this study was not able to address due to its scope. In this view the following are recommended for further research in the area of nutritional status among HIV sero-positive patients:

- A longitudinal study would give a better understanding of the interaction between nutrition, infection and immune factors in HIV sero-positive persons.
- The high percentage of HIV sero-positive patients with an inadequate dietary intake of most nutrients is of great concern in this study and therefore needs further research.

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