UTILIZATION OF BEAN-MAIZE COMPOSITE MEAL TO IMPROVE MOTOR PERFORMANCE AND NUTRITIONAL STATUS OF HIV+ CHILDREN IN MOROGORO, TANZANIA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN HUMAN NUTRITION OF SOKOINE UNIVERSITY OF AGRICULTURE, MOROGORO, TANZANIA

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ABSTRACT

A four months study was done to investigate the efficacy of fortified bean-maize composite meal in improving nutritional and motor performance of 117 HIV+ children aged between 24 and 180 months, who were receiving medical and/or home-based care at WAVUMO and Faraja Trust Fund in Morogoro, Tanzania. The subjects received a bean-maize composite product (50 g per day) for a period of four months. Physical measurements (weight, height, LBM) and motor performance measurements (speed, power, coordination, grip strength and cardiovascular endurance) of the subjects were taken at baseline and monthly for four months. Information on dietary intake and use of ARV medication was also collected. Results showed that 6.25% of the study children aged between 24 and 108 months were wasted, 27.14% were underweight and 18.75% were stunted at the baseline visit. After feeding the proportion of wasting, underweight and stunting had decreased substantially. BMI-for-age of the children aged 109 and 180 months (N=70) increased slightly during the supplementation period. Fat mass and lean body mass increased slightly ($p>0.05$) during the supplementation. The results further revealed the significant improvement ($p\leq0.01$) in the grip strengths among study children. Power increased significantly ($p\leq0.01$) with age. Speed declined significantly ($p<0.05$) with time of supplemental feeding. Significant decline ($p\leq0.05$) in cardiovascular endurance, power and coordination was observed after feeding. Daily food intakes for children were below the RDI for energy, protein and other nutrients. Frequency of feeding was either two meals (29.2%) or three meals (71.8%) per day. 7.3% (N=117) of the children were taking ARV medication. This study concluded that, the bean-maize composite product was effective in improving the nutritional

status and motor performance of HIV+ children and thus recommended for promotion. The general public, NGOs and the government should support nutrition-based initiatives taken to care and support HIV+ children.

DECLARATION

I, JAMILA MWANKEMWA, do hereby declare to the Senate of Sokoine University of Agriculture that the work presented here is my own creation and has not been submitted for a degree award in any other University.

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The above declaration is confirmed

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DEDICATION

To the memory of my late mother Mrs. Baya Mwankemwa who passed away in January 2003. Mum, I miss your physical presence, love, guidance and sense of humour. May Almighty God rest your soul in eternal peace, Amen.

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LIST OF ABBREVIATIONS AND SYMBOLS

ACC/SCN	Administrative Committee on Coordination Sub-Committee on Nutrition
ADA	American Dietetic Association
AIDS	Acquired Immunodeficiency Syndrome
ART	Anti Retroviral Therapy
ARV	Anti Retro Viral
BHA	Beans for Health Alliance
CDC	Centers for Disease Control
CHO	Carbohydrates
DF	Dietary Fibre
EPIINFO	Word Processing, Database and Statistics for Public Health Software
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
FFM	Fat Free Mass
g	Gram
HAZ	Height for Age z-score
HIV	Human Immunodeficiency Virus
kcal	Kilocalories
kg	Kilogram
mg	Microgram
MTCT	Mother-to-child Transmission of HIV

MUAC	Mid Upper Arm Circumference
NACP	National AIDS Control Programme
NAIDS	Nutritionally Acquired Immune Deficiency Syndrome
NBS	National Bureau of Statistics
NCHS	National Center for Health Statistics
PLWHA	People Living With HIV/AIDS
PRB	Population Reference Bureau
RCQHC	Regional Centre for Quality of Health Care
RDI	Recommended Dietary Intake
SAAFOST	South African Association for Food Science and Technology
SARA	Support for Analysis and Research in Africa
Se	Selenium
TACAIDS	Tanzania Commission for AIDS
TDHS	Tanzania Demographic and Health Survey
UNAIDS	Joint United Nations Program on HIV/AIDS
UNCRC	United Nations Convention on the Rights of the Child
UNICEF	United Nations Children's Fund
WAZ	Weight for Age z-score
WHZ	Weight for Height z-score
WHO	World Health Organization
Zn	Zinc

CHAPTER ONE

INTRODUCTION

1.1 Background Information

At the end of 2001, 40 million people worldwide were living with HIV/AIDS, 95% of whom lived in developing world. Over 15 million Africans have died from AIDS, 2.2 million in 2001. Approximately 70% (about 28.5 million) of all HIV positive individuals in the world live in Sub-Saharan Africa (UNAIDS, 2003). Nine percent of the adults (ages 15-49) in sub-Saharan Africa are HIV positive and seven countries in this region have HIV prevalence greater than 20%. The life expectancy of individuals in Southern Africa has decreased significantly due to HIV/AIDS. The epidemic has left over 11 million orphans due to parental deaths from HIV/AIDS (UNAIDS/WHO, 2004). The adult HIV prevalence in Tanzania is 8% (UNAIDS, 2003). In 2005, Tanzania mainland was estimated to have 13 285 AIDS cases 21 regions. This resulted into a cumulative total of 205 773 reported cases since 1983 (NACP, 2005). In Morogoro region, AIDS has been spreading at a fast rate since 1990's. Between the year 1998 and 2000, the AIDS cases in Morogoro region increased eight times (NBS, 2002).

From a macro-economic perspective, there will be an anticipated 33% less economic growth by 2020 than there would be without HIV/AIDS, primarily due to loss of young adults in their most productive years (UNAIDS/WHO, 2004). The number of orphans will quadruple by 2020 with an associated negative impact on the economy. Progressive loss in income, increased health care expenditure and reduced agricultural production will lead to an overall increased burden of extended family.

This same extended family will be responsible for the increasing burden of orphan care as the epidemic unfolds. There would be a greater drift to urbanization leading to a significant decline in the rural population, leaving the elderly and young AIDS orphans in the rural areas. The consequences of HIV/AIDS pandemic are so great that it is threatening national, social and economic progress in all sub-Saharan Africa (UNAIDS/WHO, 2004).

In 1996, over 400 000 children under the age of 15 years contracted HIV. Ninety percent of these were infected from their HIV positive mothers. More than 30% of pregnant women are HIV positive in some urban populations. By the end of 2000 about 5 million children were infected with HIV, 30-50% through breast feeding. More than hundred percent increase in child deaths are projected by the year 2020 in the severely affected parts (UNAIDS/WHO, 2004).

Appropriate nutrition provides advantages in HIV infected persons. It improves fitness, it maintains body weight and tissues, and it also improves quality of life and maintains body functions and above all replenishes nutrient losses from repeated infections. Therefore promotion of appropriate nutrition to people living with HIV/AIDS becomes of crucial importance (Cimoth, 1997).

HIV infection increases energy requirements through increase in resting energy expenditure, reduction in food intake, nutrient malabsorption and complex metabolic alterations that culminate in weight loss and wasting. The effect of HIV on nutrition begins early in the course of the disease, even before an individual become aware that he or she is infected with the virus. Asymptomatic HIV-positive individuals require 10% more energy, and symptomatic HIV-positive individuals require 20-30% more energy than HIV-negative individuals of the same age, sex, and physical activity level (Babameto and Kotler, 1997; McCallan, 1999; Cimoth 1997).

Energy requirements in children can vary according to the type and duration of HIV related infection, and whether there is weight loss along with acute infection. Although the finding of increased resting energy expenditure in asymptomatic disease stage has not been reported in children, similar to asymptomatic HIV-infected adults, an average increase of 10% or more of energy intake is recommended to maintain growth (WHO, 2003). Based on clinical experience and existing guidelines to achieve catch-up growth in children irrespective of HIV status, energy intakes for HIV infected children experiencing weight loss need to be increased by 50 to 100% over established requirements for otherwise healthy uninfected children. Evidence to support specific recommendations for managing severe malnutrition in HIV-infected children is not yet available. However, in the absence of specific data regarding to HIV infection, WHO (2003) has given out some guidelines for managing severe malnutrition in HIV infected children. Further research is thus needed on the specific requirements of HIV-infected children.

Children living with HIV or born into families affected by HIV are a high-risk group with special needs. HIV-positive women have a higher incidence of pre-term and low birth weight deliveries and as a result, HIV-exposed infants may start life with impaired nutrition. HIV-positive infants experience slower growth rate and are at a greater risk of severe malnutrition. Studies show that, severe malnutrition in HIV-positive children can be reversed with hospital and home-based therapeutic feeding, though the time to recovery is longer than that of uninfected children (Bakaki *et al.*, 2001; Newell *et al.*, 2003).

1.2 Problem Statement and Justification

Acquired Immunodeficiency Syndrome (AIDS) leaves orphans in its wake. AIDS orphaned children have increased since the early nineties and the trend is expected to continue in the 21st century unless urgent measures are taken to curb the disease. Orphans are left on the care of their grand parents who often have limited access to resources. This leaves the orphans vulnerable to food insecurity, malnutrition and disease (UNICEF, 2001).

The Human Immunodeficiency Virus (HIV) progressively destroys the immune system allowing recurrent opportunistic infections, progressive debilitation, and death. Many nutrients are required to keep the immune system functioning at full capacity. Thus, it is not surprising that a deficiency of one or more key nutrients increases morbidity and mortality. However, there is little evidence to support that, providing the nutrients in excess of normally recommended amounts will enhance the immune system, i.e., more will not result in a better immune system in either a healthy person or one infected with HIV (Piwoz and Preble, 2000).

In times of food inadequacy, the body down regulates the immune defence to conserve some resources, which makes malnourished persons more susceptible to infections of all kinds including HIV. This emphasizes the relationship between malnutrition and HIV/AIDS. Malnutrition does not only influence disease patterns and death but also the negative effects of malnutrition are associated with HIV/AIDS (UNAIDS, 2003). Malnutrition reduces the quality of life due to HIV related complications, accelerates the progression of HIV to AIDS and decreases life expectancy. Insufficient dietary intake, malabsorption, diarrhoea and altered metabolism lead to nutritional deficiency in persons with HIV. These deficiencies cause increased oxidative stress and immune suppression. which hasten disease progress, increase HIV replication and increase morbidity and mortality (FAO, 2001).

Good nutrition is central to good health and human development and to long-term social, economic and environmental development. Without provision of adequate nutrition, other social and economic initiatives will be severely compromised. People living with HIV/AIDS in Africa often have marginal nutritional status or suffer from varying degrees of malnutrition prior to infection, general medical care and hygiene are inadequate and monies for special nutritional supplements are unavailable (Piwoz and Preble, 2000).

The impact of the pre-existing malnutrition on HIV susceptibility and disease progression is difficult to study, and knowledge in this area is still limited. Early studies (WHO, 2003) 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. Other studies showed that, clinical outcome was poorer and risk of death was higher in HIV-positive adults with compromised micronutrient status (WHO, 2003).

The nutritional aspect of HIV/AIDS has been a neglected dimension in the management and care of HIV/AIDS infected individuals. Most of the attention has been focused on the use of drugs in the treatment of HIV/AIDS. While the role of drugs, such as anti-retroviral treatment cannot be under-estimated, other more affordable and sustainable alternatives and adjuvants must be explored (WHO, 2003).

Globally, reports are showing that, a good diet is one of the simplest means of helping people living with HIV/AIDS and may even help delay the progression of the deadly virus (FAO, 2005). By bolstering the immune system and boosting energy levels, balanced nutrition can help the body fight against the ravages of the disease, prevent malnutrition and support drug treatment. Emerging evidence show that, eating beans contributes to improved health because they reduce risk of cancers (colon, breast, prostate); reduce risk of cardiovascular disease and reduce obesity and risk of Type II diabetes. They also provide important nutrients for growth, especially children (BHA, 2005). Beans are one of the best plant food sources with soluble dietary fibre. Bean protein is capable of bolstering the lean body mass, essential of rebuilding the muscle fat that gets lost in advanced stages of HIV.

Nutritional mitigation efforts should thus be part of the efforts to care for HIV infected people. This study was conducted to investigate the effects of a bean-maize composite meal in improving the nutritional and motor performances of children infected with HIV.

1.3 Research Objectives

1.3. 1 Overall objective

The overall objective of the study was to investigate the efficacy of bean-maize composite meal in improving motor performance and nutritional status of children infected with HIV/AIDS.

1.3.2 Specific objectives

(i) To determine the efficacy of bean-maize composite product in improving motor performance of HIV positive children

(ii) To assess the effect of bean-maize composite product on children's growth

(iii) To determine the effect of the product on the fat mass and lean body mass content of HIV+ children

1.4 Research Hypotheses

(i) Improvement in protein and energy nutriture from fortified bean-maize composite meal will improve strength, speed, power, coordination and cardiovascular endurance in HIV positive children.

(ii) Children eating fortified bean-maize composite product will maintain, or improve their WAZ (weight for age z-scores), WHZ (weight for height z-scores), HAZ (height for age z-scores) and BMI-for-age.

(iii) Children eating fortified bean-maize composite product will maintain, improve, or retain lean body mass more quickly and more fully.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Meaning of HIV/AIDS

Acquired Immunodeficiency Syndrome (AIDS) is the late stage of the illness triggered by long term infection with human immunodeficiency virus (HIV). AIDS leads to the death of lymphocytes responsible for protecting the body against viral, fungal and protozoan infections (NACP, 2000). A person receives an AIDS diagnosis when he or she has a CD4 cell count of less than 200 and/or certain opportunistic conditions common with advanced immune deficiency (CDC, 1994). These opportunistic conditions include tuberculosis, *pneumocystis carinii* pneumonia (PCP), *Mycobacterium avium* complex (MAC), AIDS dementia complex, AIDS wasting syndrome, invasive cervical cancer and Kaposi's sarcoma (KS). Death is not directly caused by HIV but one or more of these opportunistic conditions (Massele *et al.*, 1991).

2.2 The Situation of HIV/AIDS

2.2.1 Global situation of HIV/AIDS

The majority of people with HIV (some 95% of the global total) live in the developing world. The proportion is set to grow even further as infection rates continue to rise in countries where poverty, poor health care systems and limited resources for prevention and care fuel the spread of the virus (AVERT, 2004a). An estimated, 25 million adults and children were living with HIV in sub-Saharan Africa at the end of 2003, and an estimated twelve million children have been orphaned by AIDS. In 2003, 2.2 million people died from AIDS (UNAIDS/WHO, 2004).

According to UNAIDS/WHO (2004). 37.2 million adults and 2.2 million children were living with HIV at the end of 2004. This is more than 50% of the figures projected by WHO in 1991 on the basis of the data that were available.

During the year 2004, some 4.9 million people became infected with HIV, which causes AIDS. The year also saw 3.1 million deaths from AIDS - a high global total, despite antiretroviral (ARV) therapy, which reduced AIDS-related deaths in the richer countries. Deaths among those already infected will continue to rise for some years even if prevention programmes manage to reduce the number of new infections. With the HIV-positive population still expanding the annual number of AIDS, deaths can be expected to increase for many years, unless there is more effective provision of ARV medication that will slow the death rates (WHO, 2005).

About half of the people who acquire HIV become infected before they turn 25 years and typically die of AIDS before their 35th birthday. This age factor makes AIDS uniquely threatening to children. By the end of 2003, the epidemic had left behind 15 million AIDS orphans, defined as those having lost one or both parents to AIDS before reaching the age of 18. These orphans are vulnerable to poverty, exploitation and themselves becoming infected with HIV. They are often forced to leave the education system and find work, and sometimes to care for younger siblings or head a family (AVERT, 2004b).

In 2004, an estimated 640 000 children aged 14 years or younger became infected with HIV. In 2003, over 90% of newly infected children were babies born to HIV-positive women, who acquired the virus at birth or through their mother's breast milk (AVERT, 2004c). Of these, almost nine-tenths were in sub-Saharan Africa. Africa leads in mother to child transmission of HIV despite the evidence that HIV impairs women's fertility. Once infected, a woman can be expected to bear 20% fewer children than she otherwise would. Drugs are available to minimize the dangers of mother-to-child HIV transmission, but these are still often not reaching the places where they are most needed (AVERT, 2004d).

2.2.2 HIV/AIDS in Tanzania

HIV/AIDS is the most pressing social and health issue facing Tanzania (Population Reference Bureau – PRB, 2003). HIV has spread to all regions of mainland Tanzania and, at a slower rate, to Zanzibar. More than 2 million adults are living with HIV/AIDS. At least one out of nine adults is HIV-positive. Among women attending different antenatal care clinics on the mainland, 9.6 percent tested positive for HIV (PRB, 2003). Researchers have found even higher levels among blood donor (11% tested positive in 2001). Rates of HIV infection in larger towns and cities are often more than (about 3 times higher) in rural villages. Several smaller towns or trading centres and roadside settlements have HIV prevalence levels similar to larger towns and cities (PRB, 2003).

AIDS has become the leading cause of death among adults. Approximately 140 000 people died of AIDS in 2001 alone. As a result of HIV/AIDS, progress in child survival and life expectancy has been stalled or reversed. Childhood mortality stopped declining during the second half of the nineties, possibly due to AIDS. The current life expectancy for Tanzania is about 52 years; without AIDS, it would be 64 years (PRB. 2003).

As AIDS-related deaths have increased, the number of orphaned children has also grown. By the end of the 1990s, an estimated 960 000 children had lost their fathers, 525 000 had lost their mothers, and 165 000 children had lost both parents. The percentage of children who have lost both parents nearly doubled between 1996 and 1999 (PRB, 2003).

2.2.3 HIV/AIDS in Morogoro

The incidence of new cases of HIV/AIDS has increased in Morogoro region. In 1996 there were only 286 cases of HIV; the number increased to 2 295 new cases in the year 2000. This represents an 8.02% increase in four years (NBS, 2002). By the year 2000, 0.3% of the deaths in this region occurred as a result of AIDS; ranking tenth among the ten most commonly reported causes of morbidity in the region. It also ranked the fifth among the most common causes of mortality in the region, which accounts for 9.8% of the mortality cases (NBS, 2002). Findings from a joint research by TACAIDS, NACP and NBS showed that, Morogoro region contributed 5.4% of the extent of HIV infection in Tanzania, thus ranking thirteenth out of twenty one regions of the United Republic of Tanzania (TACAIDS, 2005).

2.2.4 HIV/AIDS situation among children

Worldwide, there are around 2.5 million children under the age of 15 who are HIV positive. In 2004 an estimated 640 000 children under 15 years became infected with HIV. The vast majority (more than 90% according to a 2003 statistic) acquired the infection from their mothers during pregnancy, birth or breastfeeding. At present, over 80% of HIV positive children live in Sub-Saharan Africa, but Asia and the Caribbean are also seeing increases in the number of children infected with HIV (UNAIDS/WHO, 2004).

Statistics and figures relating to the number of HIV positive children are only rough estimates as it is very difficult to get accurate figures. This is due to limited diagnostic services in many poor countries and lack of HIV monitoring for both children and adults (UNICEF, 2004).

In developing countries, child survival greatly improved in the 1980s and 1990s. This was through a combination of different healthcare programmes unrelated to HIV, such as immunization and oral rehydration therapy. The HIV/AIDS pandemic has reversed these gains in many countries. Since 1990, mortality rates for children under the age of five years have nearly doubled in Botswana, Zimbabwe and Swaziland (UNICEF, 2004).

In industrialized countries, where HIV infected infants have easy access to antiretroviral therapy (ART), more than 80% are still alive at the age of six. Some HIV positive children are now surviving into their twenties and having children of their own. It is a different situation in developing countries where children with HIV often die from common childhood diseases even before developing AIDS because HIV has weakened their immune system (UNAIDS, 1999).

Children living with HIV or born in families affected by HIV are a high-risk group with special needs. HIV-positive women have a higher incidence of pre-term and low birth weight deliveries and as a result, HIV-exposed infants may start life with impaired nutrition. HIV-positive infants experience slower growth and are at a greater risk of severe malnutrition. Studies (Bakaki *et al.*, 2001; Newell *et al.*, 2003) show that, severe malnutrition in HIV-positive children can be reversed with hospital and home-based therapeutic feeding, though the time to recovery is longer than with uninfected children.

The impact of HIV/AIDS on children is seen dramatically in the number of AIDS orphans that has now grown to 15 million worldwide. The death of a parent pervades every aspect of a child's life from emotional well being to physical security, mental development and overall health. But children suffer the pernicious effects of HIV/AIDS long before they are orphaned. Many children whose families are affected by HIV/AIDS. especially girls, are forced to drop out of school in order to work or care for their families. They face an increased risk of engaging in hazardous labour and of being otherwise exploited (AVERT, 2004c).

2.3 Children Infected With HIV/AIDS

Internationally, a child is defined as a person less than 15 years of age (UNCRC, 1998). However, many agencies and charities working with children focus on those under 15 years of age (Collings, 1998).

According to the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO), children and young adults (i.e., children under 25 years of age) accounted for over one third of the 40 million people living with HIV in 2001. As well, the majority of all new HIV infections in that year came from this age group. Four million children under the age of 15 had HIV since the epidemic began, most of whom (about 90 percent) became infected from their mothers during pregnancy, labour, birth, or breastfeeding. In 1998 alone, there were 590 000 new infections among children under the age of 15, and 2.5 million infections among children and youth in the 15-24 age group. Combined, this translates into 8 500 new infections among children and young adults everyday (UNAIDS/WHO, 2004).

HIV positive children can be divided into two main groups; children who acquire HIV from their mothers and live for most of their lives with the virus and children who become infected through consensual sex, sexual abuse or sexual exploitation. Children can also be infected through blood transfusions and the use of contaminated needles and syringes, but fewer are infected in this way (AVERT, 2004a).

Children are most likely to acquire HIV from their mothers during pregnancy, birth or breastfeeding (mother-to-child transmission). If a pregnant woman can be identified as being HIV positive before or during her pregnancy, medical treatments and interventions can reduce the chance of her passing the virus to her baby to as low as 2% (AVERT, 2004d). Children and teenagers can acquire HIV from sexual partners. Children and young people often receive inadequate sex education. This can be for religious, moral or cultural reasons or just lack of resources. Children and young people then lack the knowledge to protect themselves from HIV and are at a greater risk of becoming infected. They can also be infected with HIV through sexual abuse or sexual exploitation. Sexual abuse is a worldwide problem, but abused children are more at risk of contracting HIV in countries with high prevalence rates (UNAIDS, 1999).

2.4 HIV/AIDS and Nutrition

Nutrition refers to how food is utilized by the body for growth, development, replacement and repair of cells and tissues; for production of energy, warmth, movement and work. It is involved with carrying out chemical processes such as digestion, metabolism and maintenance; and also protection against disease and recovery from disease. Foods contain different nutrients that include water, macronutrients such as carbohydrates, proteins (or amino acids) and lipids that are needed in large amounts. Vitamins and minerals, which are needed in smaller amounts, are micronutrients. Both macro- and micronutrients are essential. They are needed in the right amounts and combinations for the body to function properly. Food also needs to be free from infectious organisms and harmful substances (Friis and Michaelson, 1998).

In the early stages of infection a person shows no visible signs of illness but later many of the signs of AIDS will become apparent, including weight loss, fever, diarrhoea and opportunistic infections (such as sore throat and tuberculosis). These infections can lower food intake because they both reduce appetite and interfere with the body's ability to absorb food. As a result, the person becomes malnourished, loses weight and is weakened (FAO, 2005). Good nutritional status is very important from the time a person is infected with HIV as it helps to maintain the health and quality of life of the person suffering from AIDS.

Nutrition and HIV/AIDS are strongly related to each other. Nutritional status may affect the progression of HIV disease in adults and the survival of HIV-infected people. The relationship between malnutrition and AIDS is well recognized, especially in Africa, where the disease was initially known as "slim disease" because of the classic wasting syndrome typically experienced by people with HIV infection (SARA, 2002). The relation between HIV and nutrition creates a vicious cycle summarized in Figure 1. HIV/AIDS has significant impacts on nutrition. In times of food inadequacy the body down-regulates the immune defence to some infections of all kinds including HIV; this emphasizes the relationship between malnutrition and HIV/AIDS (Collin, 2000). Malnutrition increases both the susceptibility to HIV infection and the vulnerability to its various impacts (Gillepsie *et al.*, 2001). It also reduces the quality of life due to HIV related complications, accelerates the progression of HIV to AIDS and decrease life expectancy (Collin, 2000).

HIV impairs the immune system, making the body vulnerable to various infections. To handle the HIV infections and the frequent other illnesses, the energy and nutrient needs are increased. If these increased needs are not met, malnutrition results. Malnutrition also contributes to immune impairment, which worsens the effects of HIV and thus encourages more rapid progression to AIDS. Malnutrition therefore can both contribute to and result from the progress of HIV. Good nutrition is therefore important because it increases resistance to infections and diseases, and improves energy, which makes a person stronger and more productive (SARA, 2002).

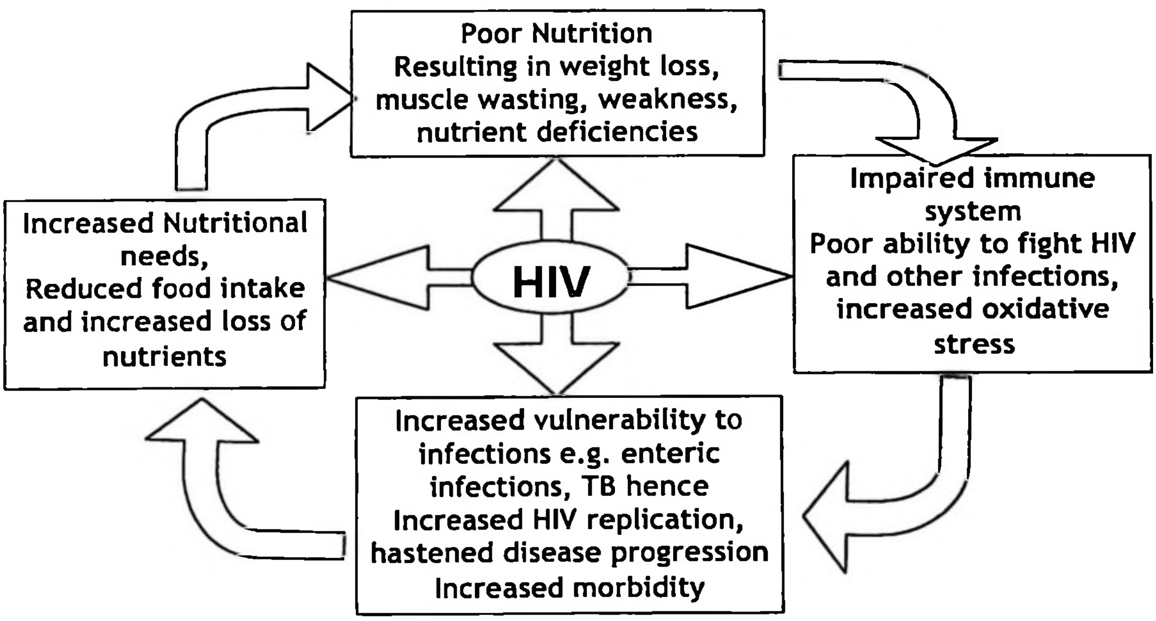

Figure 1: Vicious cycle of malnutrition and HIV
Source: RCQHC and FANTA (2003).

HIV infection essentially accelerates the vicious cycle of inadequate dietary intake and diseases that lead to malnutrition (as illustrated in figure 1), while malnutrition increases the risk of HIV transmission from mothers to babies and the progression of

HIV infection to AIDS (Piwoz and Preble, 2000). HIV infected individuals are more likely to suffer loss of appetite, and anorexia, thus reducing dietary intake at the very time when requirements are higher (Gillepsie, *et al.*, 2001). Research (ACC/SCN, 1998), shows that, the onset of the disease and even death might be delayed in well-nourished HIV-positive individuals, and diets rich in protein, energy and micronutrients help in building resistance to opportunistic infections in AIDS patients.

One of the possible signs of the onset of clinical AIDS is a weight loss of about 6-7 kg for an average adult. When a person is already underweight, a further weight loss can have serious effects. A healthy and balanced diet, early treatment of infection and proper nutritional recovery after infection can reduce this weight loss and reduce the impact of future infection (McCallan, 1999).

A person may be receiving treatment for the opportunistic infections and also perhaps combination therapy for HIV. These treatments and medicines may influence eating and nutrition. Good nutrition will reinforce the effect of the drugs taken. When nutritional needs are not met, recovery from an illness will take longer. In addition, good nutrition can help to extend the period when the person with HIV/AIDS is well and working (Schwarz, 1996).

2.5 Nutrition for HIV Infected Children

Different groups of PLWHA need to eat differently because they have different dietary requirements. Among the groups, children especially born to HIV positive mothers are at a high risk of malnutrition, illness and death. This may be due to HIV infection or inadequate care because of deteriorating health of one or both of their parents. It is important that these children receive adequate care in nutrition and health, and should be closely monitored. Their growth and development should be monitored regularly. Children with HIV/AIDS need great care and attention because their immune systems are weakened thus increasing risk of opportunistic infections, which can be severe. These children need extra energy, protein and other nutrients for growth, development, and for coping with HIV infection. Children requirements differ according to their age (Fields-Gardner and Ayoob, 2000).

2.5.1 Infants 0 to 6 months of age

At this stage, milk remains the only recommended food. It can be breast milk, home prepared or infant formula. Children in this stage should be fed on milk only. Since the babies in these first few months do not have enough enzymes to digest starch, infant feeding options should be followed for proper and safe feeding options. Also mothers should not breastfeed while at the same time giving other milk, juices or water (RCQHC/FANTA/LINKAGES, 2003).

2.5.2 Infants 7 to 24 months of age

All babies older than 6 months should be given complementary foods; these are foods of liquid form whether manufactured or locally prepared given in addition to breast milk or infant formula to satisfy the nutritional requirements of the child. Milk should still form an important part of the diet up to 2 years. Complementary foods commonly used are bulky and therefore need to be enriched so as to provide adequate proteins and other nutrients. A good diet for a child should be made from a variety of locally available foods and the child should be fed frequently at least five times a day. If the child is sick, frequency of feeding should be increased. It is important to give the child foods that are soft and easy to swallow, foods rich in vitamins and minerals, fermented foods such as yoghurts and clean and safe water for drinking. Furthermore, it is important to practice good hygiene and proper handling and active feeding (RCQHC/FANTA/LINKAGES, 2003).

2.5.3 Children 2 to 10 years of age

Children of infected with HIV need extra care. Their care takers should seek medical attention immediately when they are ill. Their growth should be monitored accurately by observing direction of the growth curve whether there is growth faltering. These children should be taken to clinics for growth monitoring, immunization and supplementation. Their mothers or caregivers should go for health education, feeding consultation and counselling (Highleyman, 2003). Most children in this group get nutrients from family foods. HIV infected children may suffer from metabolic problems resulting in poor nutrient absorption and utilization (Keating *et al.*, 1995). Attention should be given to ensure they get adequate nutrients to meet the increased requirements. It is therefore important to give variety of foods that are soft and easy to swallow, provide clean and safe water for drinking and give nutritious snacks e.g. fruits and nuts. Also foods should be enriched by adding milk, oil, nuts, sugar, margarine, germinated flour and honey. Give plenty of foods rich in vitamins and minerals, fermented foods such as yoghurts and practice active feeding of the baby (Bowers, 2002).

2.6 Nutritional Requirements of People Living With HIV/AIDS

Adequate nutrition is very important for people living with HIV/AIDS to maintain and prolong survival. Individual needs vary depending on nutritional status, extent of disease progression, severity of associated conditions and use of antiretroviral drugs. Patients with a good nutritional status are more likely to benefit from antiretroviral treatment and suffer fewer adverse effects (WHO, 2003).

HIV-infected individuals have higher nutritional requirements than normal, particularly with regard to protein - up to 50% increased and energy up to 15% (Gillepsie *et al.*, 2001). This suggests that, asymptomatic adults should consume 10% more energy to maintain body weight. Asymptomatic children may need a similar increase in energy intake to ensure growth. Even higher energy intakes (20-30% by adults; 50-100% by children) are required once HIV symptoms (e.g. weight loss, opportunistic infections) occur. Asymptomatic HIV-positive individuals require 10% more energy, and symptomatic HIV-positive individuals require 20-30% more energy than HIV-negative individuals of the same age, sex, and physical activity level (Babameto and Kotler, 1997; McCallan, 1999; Cimoth 1997). FANTA (2003) reaffirmed these figures and recommended that, micronutrient intakes of HIV positive individuals should be increased by 100%. Such high intakes however, may be neither possible nor appropriate during periods of acute illness. Conversely, WHO (2003) reported that, protein and fat requirements for PLWHA are probably not different from those of healthy individuals.

PLWHA should consume balanced, healthy diets that provide micronutrients at RDI levels. However, this may not be sufficient to correct the existing nutritional deficiencies. In such cases, they may need to take micronutrient supplements. A supplementation is recommended for infected children living in areas where deficiency is endemic, and routine iron/folate supplementation is encouraged for infected women during pregnancy (Seumo-Fosso and Cogill, 2003).

Although the nutritional needs for PLWHA change as the disease progresses, dietary guidelines are based on recommendations for healthy people. Supplementation plays an integral role to help meet the increased needs for macronutrients and micronutrients (Semba and Tang, 1999). Food supplements help to provide food for people with poor appetites or problems with eating, and for those who are food insecure at the household level (SAAFOST, 2003).

HIV infection increases energy requirements through increase in resting energy expenditure, reduction in food intake, nutrient malabsorption and loss, and complex metabolic alterations that culminate in weight loss and wasting. The effect of HIV on nutrition begins early in the course of the disease. even before an individual may be aware that he or she is infected with the virus (Sharpastone *et al.*, 1996).

Energy requirements in children can vary according to the type and duration of HIV related infection, and whether there is weight loss along with acute infection. Although the finding of increased resting energy expenditure in asymptomatic HIV has not been replicated in children, similar to asymptomatic HIV-infected adults, an average increase of 10% of energy intake is recommended to maintain growth (WHO, 2003). Based on clinical experience and existing guidelines to achieve catch-up growth in children irrespective of HIV status, energy intakes for HIV infected children experiencing weight loss need to be increased by 50 to 100% over the established requirements for healthy uninfected children. Evidence to support specific recommendations for managing severe malnutrition in HIV-infected children is not yet available. In the absence of specific data with regard to HIV infection, WHO guidelines (Table 1) are usually recommended for use. Research is needed on the specific energy requirements of HIV-infected children.

Table 1: Nutritional requirements of HIV/AIDS infected children

Nutrients	Requirements for HIV/AIDS children
Energy	Energy requirements are likely to increase by 10% to maintain growth in asymptomatic children.
	Energy intakes need to be increased by 50-100% over normal requirements in children experiencing weight loss.
Protein	Data are insufficient to support an increase in protein requirements due to HIV infection.
Fat	There is no evidence that fat requirements are different because of HIV infection.
Micronutrients	To ensure micronutrient intakes at RDA levels, HIV adults and children are encouraged to consume healthy diets.
	Dietary intake of micronutrients at RDA levels may not be sufficient to correct nutritional deficiencies in HIV-infected individuals

Source: WHO (2003)

2.7 Food Sources and Nutrient Content

No single food contains all the nutrients the body needs in the right quantities and combinations. Only breast milk contains the combination and quantity needed for a young baby. A nutritious diet is one that provides a variety of foods in adequate quantities and combinations to supply essential nutrients on a daily basis.

2.7.1 Energy-rich foods

2.7.1.1 Carbohydrates

The main sources of carbohydrates in the diet are staples and sugars. Staples make up the bulk of foods for the majority of the population. They include bananas, Irish potatoes, sweet potatoes, cassava, maize, sorghum, millet, yams and rice. Staples form the main part of the meal contributing the largest proportion of energy. They mainly supply carbohydrates that are important for providing energy. They may also provide some protein, vitamins and fibre. Staples alone cannot provide enough of the nutrients the body needs for optimal growth and repair. They need to be eaten in combination with other foods (George, 2004).

Sugars are also rich sources of energy. In Tanzania, sugar is normally eaten with other foods. Sugars and sugary foods include honey, jam, table/tea sugar, cakes and biscuits. Sugary foods also include most artificial fruit juices and sodas. Many of these drinks are not rich in other nutrients. Some fruit juices and artificial juices are too acidic and may be too strong for the stomach of a sick person.

Carbohydrates are important because they provide the body with quick, easily used energy. Carbohydrates help you maintain the energy balance so that your body does not have to draw on stored energy sources like fat and muscle (FAO, 2005).

PLWHA need to balance the amount of energy they eat as food with the amount of energy their bodies need for maintenance and to conduct daily activities. There may be a number of reasons why HIV+ individuals take in less food energy. Drugs or opportunistic illnesses may cause symptoms that make eating unappealing. Energy level may be low and a person may not be active enough to stimulate appetite or feel like preparing complete meals. Some drugs also alter sense of taste or smell, and this may, in turn, affect the diet (FAO/WHO. 2002).

2.7.1.2 Fats and oils

Fats and oils are rich sources of energy. One gram of fat provides twice the energy of one gram of carbohydrate. Therefore, people only need fats in small quantities. Fats also add flavour and taste to food. and thus stimulate appetite. They build body cells. help body processes, and are essential for absorption and utilization of fat-soluble vitamins. Excessive consumption of fat, however. predisposes individuals to obesity and coronary heart disease (WHO, 1990). Vegetable oils and fats are obtained from corn, simsim, sunflower. cottonseed, palm oil and margarine. Animal sources of oils and fats include lard, butter (including ghee), cheese. fatty meat and fish (including fish oil).

Fats and oils help in absorption and transportation of fat soluble vitamins (A, D, E and K) that is why they are recommended for people living with HIV/AIDS. However, they should be used in small quantities because they increase total fat levels in the blood. These may block the blood vessels. which may increase the risk of coronary heart diseases (RCQHC. 2004).

2.7.1.3 Dietary fibre

Fibre or roughage is needed in our food. Fibre is important for the movement of the bowels. However, it reduces the absorption of some nutrients like iron, zinc and other minerals. It is recommended that people at risk of anaemia (like pregnant women, young children and PLWHA) should take foods rich in fibre with caution. Too much fibre also makes foods for children bulky and may limit the amount of energy and other nutrients that are available in their foods (WHO, 1990). The best source of fibre is from vegetables and fruits.

2.7.2 Body-building foods

Proteins are referred to as body-building foods. They are essential for cell growth. Proteins support the function and formation of the general structure of all tissues, including muscles, bones, teeth, skin and nails. There are two main types of proteins: plant proteins and animal proteins. Proteins are important to HIV+ people because they are the primary component of muscle, and play a crucial part in many of our metabolic processes. When HIV+ people lose weight, they often lose muscle. This is called muscle wasting. It is important for PLWHA to eat enough protein to prevent their bodies from using the energy stored in their bodies as muscle. Research also suggests that a high protein diet and regular exercise may help people with HIV avoid muscle wasting. Eating more protein may also help PLWHA regain lost muscle mass. It is important for PLWHA to take in protein from many different foods, so that you get a variety of amino acids. A few studies have shown that some people with HIV have low levels of some amino acids (FANTA, 2003).

2.7.2.1 Plant protein sources

These include beans and peas of different varieties, green-grams, groundnuts, soybeans and simsim. Plant protein sources also provide vitamins and minerals. Emerging evidence show that eating beans contributes to improved health because they reduce risk of cancers (colon, breast, prostate); reduce risk of cardiovascular disease and reduce obesity and risk of Type II diabetes. They also provide important nutrients for growth, especially children (BHA, 2005). Beans are one of the best plant foods with soluble dietary fibre. Beans prepared for consumption contains 70% moisture and provide approximately 120 kcal per 100g on wet basis. Both dietary fibre and calories are provided by carbohydrates in beans (Swanson, 1991).

Beans contain several essential nutrients, namely carbohydrates, proteins, lipids, vitamins and minerals. Sixty percent of dry weight and twenty percent of the wet weight of bean seed are carbohydrates. Protein concentration of dry beans varies from 18 to 30%. Beans contain one to three percent lipid materials on a dry weight basis and are also excellent sources of B vitamins and a good source of mineral calcium, iron, zinc, copper and magnesium. In addition, beans are low in sodium (Nchimbi and Maeda, 1989).

2.7.2.2 Animal proteins

The main animal foods that provide proteins are meat, milk (and milk products such as cheese, yoghurt and fermented milks), fish and eggs. Animal proteins are sources of high quality proteins, but also provide vitamins and minerals. Major micronutrients provided include the B vitamins, vitamin A and minerals such as iron.

calcium and copper. Animal products provide additional energy too especially from the fat fraction.

2.7.3 Protective foods

Fruits and vegetables are known as protective foods because they provide vitamins and minerals that are key in strengthening the immune system. They are important part of healthy and nutritious diets. Fruits and vegetables supply vitamins and minerals. which are substances required by the body in small amounts for its normal physiological functions. Vegetables and fruits are also major sources of fibre and roughage required for bowel movement and to prevent constipation. They add taste, flavour and colour to our meals and contain useful immune substances (Hebert, 2000). Common vegetables include: Amaranths, spinach, turnips, swisschard. pumpkin leaves, cowpea leaves. carrots, cassava leaves, and green peppers.

The deep yellow or orange coloured fruits are richer in pro-vitamins A, particularly beta-carotenes than other fruits. Such fruits include avocadoes, mangoes, pawpaws, pumpkin, passion fruits, pineapples and jackfruits. Oranges, lemons and other citrus fruits are rich sources of vitamin C (Baker, 1999).

Many studies have shown vitamin and mineral deficiencies among people with HIV. Significant deficiencies in vitamins A, B1, B6. B12. C, E and folate have been observed in some people, as well as deficiencies in the minerals iron, selenium, magnesium and zinc. HIV+ people who are deficient in vitamins A, the B vitamins. E and the mineral selenium have been observed to get ill more quickly than those without deficiencies. It may not be possible for some HIV+ people to take in enough vitamins and minerals from their food. This is particularly true if you are having problems eating enough in general. You may also be having problems absorbing vitamins, and this may not be obvious. For these reasons, many people with HIV choose to take supplements. There are no studies which prove a cause and effect relationship between vitamin supplements and improved health in HIV+ people who have no signs of deficiency. Only in cases of deficiency have supplements been proven beneficial. However, studies surveying HIV+ people who take nutritional supplements show that these people live longer and have more signs of a healthy immune system. Virtually all dieticians now recommend a multivitamin with minerals to their HIV+ clients (FAO, 2005).

2.7.3.1 Vitamins

Some vitamins are water-soluble (e.g. the vitamin B group and vitamin C) and should be consumed continuously as the body does not store them but excretes any excess taken. Other vitamins (A, D, E and K) are fat soluble, implying that the vegetables should be prepared with some oil/fats for efficient absorption and utilization by the body (Latham, 2002).

2.7.3.2 Minerals

Minerals are needed for the functioning of immune system. Important minerals include iron, selenium, zinc, iodine, calcium and copper (Latham, 2002). Minerals are required for production of various enzymes, hormones and biochemical mediators for regulation of biological processes. They are required for energy production, synthesis of RNA and DNA and for providing protection against reactive oxygen-free radicals. They are required for promotion of physical growth, sexual maturation and neuromotor development. A number of minerals (iron, zinc, selenium and copper) are recognized to boost both cell-mediated and humoral immune defences of the body. That is why they are very important for PLWHA (Huang *et al.*, 2003).

2.7.4 Water

Water is an important component of the body and its functions. People should drink boiled and filtered water if possible. Mineral water is another option for those who can afford it. Water is also found in tea. soups, milk, juices and fruits. However, one should not rely on tea, coffee and alcoholic drinks as sources of water, as they can interfere with absorption of nutrients and may interact poorly with medicines. Tea and coffee should be taken in moderation. Alcohol can damage the ability of the body to fight disease. Alcohol should be either avoided or taken in very small quantities. Alcohol is contraindicated with most of the ARVs. Some alcoholic beverages like beer contain a lot of sugar and yeast that may be harmful to a sick person. Alcohol can also interact with medicines to create harmful side effects (George, 2004).

2.8 Nutrition for PLWHA

Nutritional requirements differ according to the progression of HIV infection to AIDS. Good nutrition helps the body to fight back opportunistic infections and other conditions and help the body to stay stronger during medication. It is important for PLWHA to be very careful and try to meet nutritional requirements at different stages of AIDS progression (The Republic of Uganda, 2004).

2.8.1 Asymptomatic HIV stage

An asymptomatic infected person is the one who does not show any signs but may just be feeling tired. At such stage, building stores of essential nutrients, maintaining body weight and lean body mass is very important. At this stage, PLWHA need to practice a healthy lifestyle by eating adequate, wide variety of foods to meet the increased demand for energy, protein, vitamins and minerals. They should also do exercises to stimulate appetite and build lean body mass. Also, they should ensure food safety and good personal and environmental hygiene to prevent food and waterborne diseases. They should also avoid or limit alcohol consumption (SARA, WHO and Common Wealth, 2003).

2.8.2 Symptomatic HIV stage

At this stage, some health problems may be experienced such as sour mouth and throat and diarrhoea. Infections put extra demands on the weakened immune system and increase the body's requirements for energy, protein and other nutrients. The illness and medication used may cause loss of appetite, or eating may be painful. At this stage, PLWHA need to minimize the consequences of illness itself and poor food intake by maintaining dietary intake during the illness, increase nutrient intake for recovery and weight gain and continuing with physical activities (Republic of Uganda, 2004). They also need to manage the symptoms that affect food intake, observing healthy lifestyle, maintaining food safety and hygiene, and seeking medical attention immediately.

2.8.3 Advanced stage of HIV/AIDS

At this stage, the immune system is completely weakened and serious infections occur. Weight loss or wasting of muscles becomes a serious problem and diarrhoea becomes persistent. This person needs to be assisted by other family members physically, mentally, emotionally and spiritually. Opportunistic infections that affect appetite, food intake and utilization should be treated and food intake should be maintained during periods of acute illness and depressed appetite. HIV patient should be supported to keep physically active, observe healthy lifestyle and maintain food safety and hygiene (FAO/WHO, 2002).

2.9 Assessment of Nutritional Status

Nutritional problems are complex in their etiology and the type of information that can be useful is the assessment of the nutritional status (Gibson, 1990). Nutritional assessment refers to as interpretation of information obtained from dietary, biochemical, anthropometrics and clinical studies (Saito and Mark, 1999). The information is then used to determine the health status of individuals or population groups as influenced by their intake (Gorstein, 1989).

The goal of nutritional assessment and intervention is to improve nutrition status, prevent further complications, and enhance the child's quality of life and survival. The nutritional assessment is important to gather information on the current nutrition status and adequacy of the diet and to identify risk factors for developing nutritional complications. The earlier and more consistently this can be done the better. The information gathered is usually interpreted to identify problems that put the children at increased nutrition risk and to design the best intervention with caregivers. The assessment helps to capture information about changes in nutritional status i.e. weight for age (WAZ) weight for height (WHZ) and height for age (HAZ), changes in eating behaviours associated with food availability, feeding patterns, and appetite changes and morbidity which result in nutritional changes (FANTA, 2003).

2.9.1 Dietary assessment methods

Dietary and nutritional assessments are essential part of comprehensive HIV care both before and during ARV treatment (WHO, 2005). It involves measuring the quantity and quality of foods consumed, one to several days or assessing the pattern of food consumed during the previous days or months. The first stage of nutritional assessment involves dietary assessment. On this assessment, dietary intake may appear to meet nutritional needs but conditioning factors (such as disease states) may interfere with the ingestion, digestion, absorption, and/or utilization of nutrients (Gibson, 1990).

2.9.2 Anthropometric measurements

Nutritional anthropometry is the measurement of the variation of physical dimensions and the gross composition of human body at different age levels and degrees of nutrition (Gibson, 1990). In practice, anthropometry is the most useful tool for assessing nutritional status of children because disturbances in health and nutrition, regardless of etiology invariably affect child growth (Joosje *et al.*, 1997). The anthropometric measurements that are most commonly used for assessing the nutritional status are growth parameters like weight, height, mid upper arm circumference and age and body composition measures (fat mass and fat free mass or lean body mass). Anthropometric indicators are globally used as the basis for assessing growth and nutritional status in children. The anthropometric indices that are used as criteria for assessing nutritional status are weight-for-age (WAZ), height-for-age (HAZ) and weight-for height (WHZ). These indices are compared with the recommended reference for healthy populations (WHO, 2005). The body of a child living with HIV/AIDS may suffer weight loss caused by inadequate food intake, which may result in depleted energy stores from fat and protein from muscles. This will affect the anthropometrics i.e. WAZ, HAZ and WHZ.

2.9.3 Biochemical methods

Biochemical methods measure the nutrient or its metabolite in body fluids or variety of other components that have relation to nutritional status. Nutritional deficiencies may be detected due to either the reduction of its levels or its metabolites in certain tissues or body fluids (static tests) or by functional tests i.e. physiological or behavioural changes of functions dependent on specific nutrients (Gibson, 1990).

2.9.4 Clinical methods

Clinical methods use physical examinations to detect signs and symptoms associated with undernutrition. Since signs and symptoms are non-specific and only develop during the advanced stages of nutritional depletion, diagnosis of nutritional deficiencies should not rely exclusively on clinical methods (Gibson, 1990). The methods should be backed-up with either biochemical or anthropometric measurements.

2.10 ARV Use

Children need antiretroviral therapy to reduce viral load and delay disease progression. However, ARVs may have side effects (nausea, vomiting, diarrhoea, constipation, and changes in taste) that may affect the dietary intake of the infected children. The side effects may be caused by the interaction between foods or nutrients and the drugs (WHO, 2005). Side effects should be managed to ensure continued food intake and adherence to medication regimens. Nutrition actions that service providers can take in care and support are of crucial importance to reduce these side effects (Moore and Chaisson, 1999). HIV-infected children are more likely than non-HIV-infected children to experience growth failure and face an increased risk of death. These risks require early intervention and continual follow up.

2.11 Children Motor Performance Tests

HIV infected children are known to have reduced exercise capacity, which impacts on their motor performance, quality of life and survival. However, the exercise limitation is due only in part to their immune suppression. The exact reasons for the exercise impairment are currently unknown. However, recent studies suggest that nutritional status and/or muscle function may play important roles (Parkinnen and Rintala, 2006).

Impairment of children's motor performance might limit participation in family and community life. Identification of motor impairments is thus important in support of early intervention to prevent limitations in children's occupational performance (Barbosa *et al.*, 2006). The motor performance test can improve diagnostic procedure in children infected with HIV/AIDS (Beld *et al.*, 2006).

Motor performance tests of children are usually compared to age and gender on four gross motor subtests: total balance, ball skills, locomotor and object control (Pabreja, 2005). These tests include the selected locomotor and object control skills that are given to a child in order to show proficiency in a number of motor skills in classrooms, on playgrounds and out in games. The locomotor skills include; running, galloping, hopping, leaping, horizontal jumping, skipping and sliding. Object control skills include striking, ball bouncing, catching, kicking and over arm throwing (Evaggelinou *et al.*, 2002). Benefice *et al.*, (1999) grouped motor performance tests in three items, i.e., arm coordination, gross motor coordination and motor fitness items. The later include endurance run, shuttle run, distance throw, standing long jump and grip strength. Performances vary with age, sex and nutritional status. Body dimensions explain a significant part of variance of motor performance and stature is the main predictor. Chronic undernutrition reflected by reduced body size and perhaps muscle mass in HIV infected children is an important determinant of the motor performance of preschool children.

The acquisition of motor skills is regarded as an essential component of growth and proficiency in learning and failure to acquire these skills should be acknowledged as a challenge similar to difficulties in other domains (Cantell and Kooistra, 2002). These tests are given to children based on specific age groups. Pre-school children have different motor performance tests as compared to school children. Children perform better in a comfortable situation, therefore the tests should be done in non-threatening and enjoyable environment for the child in order to maximise the child's performance (McCauley, 2004).

2.12 HIV/AIDS and Body Composition Measures

The body is composed of two chemically distinct components: fat mass and fat free mass (also known as lean body mass). Fat mass is the most severely affected body compartment in HIV/AIDS (Sharpstone *et al.*, 1996). Paton *et al.*, (1997), using 4 different techniques, found that, the weight loss of a group of adult patients with symptomatic HIV infection was not due to excessive fat free mass catabolism, but was due to undernutrition. Therefore, assessment of FFM in HIV-infected patients might prove useful in predicting survival (Kotler *et al.*, 1997), in clinical staging (Forsyth *et al.*, 1996), and in evaluating responses to both nutritional and pharmacologic interventions (Kotler *et al.*, 1990; Henderson *et al.*, 1994).

Children infected with HIV show decreases in fat-free mass (lean body mass) compared to uninfected children. This is usually seen among children (especially boys) depicting normal rates of growth. This may be associated with high viral load that is associated with decreased proportion of free fat mass; host immune response to the replication of the virus, which may increase the basal metabolic demands (and thus increased energy expenditures) in HIV-infected children (Bailey *et al.*, 1999). Unlike in adults. hypermetabolism is rarely reported in HIV-infected children. However, the lack of hypermetabolism may partly result from a lower amount of fat free mass, which is preferentially decreased in children infected with HIV, especially those with growth failure (Apardi, 2000).

Malnutrition is a frequent finding in HIV-infected children and wasting syndrome is among the criteria for including these children in clinical category C (severely symptomatic) according to the Center for Disease Control and Prevention (CDC) classification system (CDC, 1994). At present, the pathogenesis of weight loss or growth failure in HIV infection is largely speculative; many factors, including poor oral intake, malabsorption and hypermetabolism, may be involved. Loss of fat and fat-free mass (FFM) could both contribute to body weight loss. Young HIV-infected children usually have significantly less lean body mass (as assessed by midarm circumference and triceps skinfold thickness) than normal healthy children of similar age (Miller *et al.*, 1993). These observations suggest that, a preferential loss of FFM occurs early in the disease progression and that protein-energy malnutrition, is the most important mechanism of weight loss (Ott *et al.*, 1993).

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter presents the description of the study area, types of and source of data, sample size and location, questionnaire design, sampling techniques and analytical tools used in data analysis.

3.2 Description of Morogoro Urban District

3.2.1 Geographical location

The study was carried out in Morogoro Urban district, which is one among six districts in Morogoro region. This district is the smallest covering an area of 260 square kilometres, which accounts for 0.4% of the total regional land area. Other districts are Ulanga, Mvomero, Kilosa, Kilombero and Morogoro rural. Morogoro Urban district is surrounded by Morogoro rural district. It has one division and 19 wards (NBS, 2002).

3.2.2 Population and ethnicity

According to the 2002 population census (NBS, 2002) the district has a population of 227 921 of which 113 092 were males and 114 839 were females. Due to urbanization, the population is mixed with Luguru as a dominant ethnic group (NBS, 2002).

3.3 Rationale for Choosing the Study Area

Morogoro urban district was chosen because it has a number of organizations dealing with care, counselling and support of people living with HIV/AIDS. Among those organizations, Faraja Trust Fund and WAVUMO have been chosen because they have enrolled a considerable number of children infected with HIV/AIDS who are the group of interest in this study.

3.4 Subject Population

The optimal sample size for this study was estimated to be 160 subjects. This number was determined by the using the Case Control Approach in STATCALC (EPIINFO, 2002) package using 95% Confidence Interval and a Power of 80%. The final sample for the study was 117 subjects [73 (62.4%) came from WAVUMO and 44 (37.6%) from Faraja Trust Fund]. This sample was comprised of children aged 24 to 180 months who were receiving social and medical care at the two centres namely WAVUMO and Faraja Trust Fund.

3.5 Study Design

3.5.1 Sample selection

All HIV positive children (aged between 24 and 180 months) receiving social, medical care and/or home-based care at WAVUMO and Faraja Trust Fund in Morogoro, Tanzania were eligible to participate in the study. Those who desired to be in the study were stratified based on age and gender. The subjects were receiving a fortified bean-maize composite meal that was made based on the WHO/UNICEF recommendations for four months (WHO, 2005).

3.5.2 Bean-based food

The bean-based supplementary food was formulated according to the WHO/UNICEF recommendations (WHO, 2005) [of low cost; fortified with commonly deficient minerals and vitamins; 'ready to feed'; prepared from locally produced ingredients]. The expectation was that, the bean-based composite food would support more lean body mass growth and improve the nutritional status of the HIV infected children.

3.5.2.1 The composition of bean-based food

The composition of the bean-based food (per 100 g) is shown in Table 2.

Table 2: Composition of the bean-based food

Ingredients	Bean product (g)
Maize	23.52
Bean	55.48
Soybeans	5.50
Vegetable oil	4.50
Sugar	4.00
Cassava	5.20
Salt (iodized)	0.30
Mineral/Vitamin premix	1.00
Baking soda	0.50
Total	100.0

3.5.3 Product distribution

Each child was provided with 50 g of the product per day. Each child and the care giver were given verbal instructions on how to prepare the product for consumption. Instructions were given for the product to be taken as an evening snack preferably at 4:00 pm. This was done in order to avoid substitution of the normal meal with the product.

3.6 Data Collection

Physical measurements of the subjects were taken at baseline and monthly for four months. The biomarkers for nutrition improvement included weight, height, protein/calorie intake, lean body mass and motor performance. Information on the level of physical activity and the use of ARV drugs were also explored.

3.6.1 Weight and height

Inadequate weight gain and height velocity or weight loss (particularly loss of lean body tissue) are important indicators of nutritional risk in individuals with HIV, especially children. Weight and height are therefore important measures to assess growth as well as nutritional status. Weight for age, weight for height and height for age z-scores were used to determine the extent of undernutrition, wasting and stunting, respectively.

Height was measured with a pocket stadiometer (CMS weighing equipment Ltd. London. NW OHH, UK), the stadiometer was accurate to 1mm. A digital Tanita body composition analyzer (BF-350 Model – Tanita Corporation of America. Inc) scale accurate to 1kg was used to measure weight. These measurements were taken without shoes and with minimal clothing. Scales were zeroed before each measurement and were frequently calibrated. The results were then compared with the children of similar age and charted basing on International Growth Charts.

3.6.2 Lean body mass

Poor muscle development and/or muscle wasting are cardinal features of all forms of protein energy undernutrition, especially in early childhood. Recently, it has been shown that, fat free mass is an excellent predictor of muscularity in pre- and pubertal children (Suttmann *et al.*, 1995). These parameters are practical and easy to obtain, and have shown to be reliable (Wheeler *et al.*, 1998). In this study, percentage body fat was determined by bioelectrical impedance method using body composition analyzer (BF-350 Model, made by Tanita Corporation of America Inc.) Lean body mass (LBM) was calculated by subtracting percentage body fat from 100.

i.e., LBM = (100 - BF) %

Where: - LBM = Lean Body Mass

BF = Body fat

3.6.3 Motor performance

Motor performance including speed, power, strength and cardiovascular endurance are generally affected by poor muscle development, muscle wasting and loss of lean body mass in undernourished children, particularly those infected with HIV. These were assessed using a selection of motor performance tests. Power was determined by using the standing long jump with a two feet take off and landing. Power and coordination were determined using the tennis ball throw for a distance (metres) and grip strength was determined by kilograms registered after pulling a handle in a hand dynamometer (Model 78011, Lafayette Instrument Company, Indiana). Speed was assessed as the time taken to complete a 20 metre dash and cardiovascular endurance was determined as the distance ran in three minutes. The first three tests included three trials and the best of the three was recorded on the motor case table at baseline and monthly for four months. The distances were measured by Oxford–foot metre strip (Model KE 03 Z, Made in England) and time was recorded by a digital quartz timer (Model KK 2808, Made in China).

3.6.4 Food intake

A 24-hour recall method was used to assess usual food intake. This information was collected in presence of a caregiver. This was done by filling a dietary intake questionnaire (Appendix II a) for three days, one weekend day and two weekdays selected at random by a caregiver. The dietary intake questionnaire was translated to

Swahili language for easy understanding and comprehension by the respondents (Appendix II b).

3.7 Statistical Analysis

The collected data were entered into the statistical programme, SPSS version 11.5 for analysis. Anthropometric indices (WAZ, WHZ and HAZ) were calculated by using EPIINFO Package 2002 and compared with WHO reference population. Differences in baseline measurements between the age groups and within the study visits were assessed for statistical significance using one-way ANOVA. Appropriate adjustments for these differences were taken into account during the analysis of data. Paired t-test was used to compare the growth parameters, lean body mass and motor strength measurements.

3.8 Ethical Consideration

Permission to conduct this research was obtained from the National Institute for Medical Research (NIMR) Ethics Committee in Tanzania. Caregivers and/parents had to fill an agreement before their children were enrolled into the study.

3.9 Confidentiality

All subjects were identified through their services centres and assigned identity numbers. These numbers were used to identify the subjects during data collection. There was no use of names in the data entry, analysis or reporting.

3.10 Other Variables

The use of ARV drugs of the subjects was obtained from interview records with the children caregivers monthly for four months.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter presents results and discussion of the findings. It describes the nature of the HIV infected children and how supplemented feeding with high protein/calorie diet improved their nutritional status and motor performances. The results were grouped into the following subsections: background characteristics of the respondents, nutritional status of the children, children's body compositions, motor performance tests, ARV medication and food intake assessment.

4.2 Background Characteristics of the Children

4.2.1 Age and gender of the children

The age distribution of the assessed children ranged between 24 and 180 months (Table 3).

Table 3: Distribution of age and sex of sample

	Boys		Girls		Total	
Age (months)	No.	%	No.	%	No.	%
24-59	4	3.4	7	6.0	11	9.4
60-89	10	8.5	15	12.9	25	21.4
90-119	4	3.4	6	5.1	10	8.5
120-149	15	12.9	17	14.5	32	27.4
150-180	20	17.1	19	16.2	39	33.3
Total	53	45.3	64	54.7	117.0	100.0

While HIV based undernutrition affects mainly preschool age children, lost ground cannot be entirely made up in school age (Aneja, 1998). In this study, most of the HIV infected children (33.3%, n = 117) were school age children with ages between 150 and 180 months (Table 3). Results also showed that, the proportion of girls infected with HIV/AIDS (54.7%, n = 64) was greater than that of boys (45.3%, n = 53).

4.2.2 Weights and heights of the studied children

Table 4 summarises the mean weights and heights of the study children (N = 117).

Table 4: Mean weights (kg) and heights (m) of the studied children

	Age (months)				One-way ANOVA
	24 – 60	61 – 108	109 – 180	Total	F
	(N = 20)	(N = 28)	(N = 69)	(N = 117)	(Combined)
Mean weights (kg)					
Baseline	13.64	21.05	34.25	27.57	2.237 (ns)
1 month	15.18	20.43	32.68	26.97	2.205 (ns)
2 months	13.90	21.51	31.46	26.11	1.363 (ns)
3 months	13.85	21.23	31.12	24.74	1.437 (ns)
4 months	12.48	20.45	32.61	25.52	0.929 (ns)
Mean heights (m)					
Baseline	0.95	1.18	1.42	1.28	1.564 (ns)
1 month	0.99	1.16	1.40	1.28	1.231 (ns)
2 months	0.96	1.18	1.39	1.27	0.820 (ns)
3 months	0.97	1.17	1.36	1.32	2.410 (ns)
4 months	0.90	1.16	1.39	1.23	0.996 (ns)

**: $p \leq 0.05$, ***: $p \leq 0.01$, ns = not significant ($p > 0.05$)

Mean weights of the studied children ranged from 12.48 to 15.18 kg for the age group 24-60 months, 20.43 to 21.51 kg for the age group of 61-108 months and 31.12 to 34.35 kg for the age group 109-180 months. Overall mean weights ranged between 24.74 and 27.57 kg. The mean heights ranged from 0.90 to 0.99 m, 1.16 to 1.18 m and 1.36 to 1.42 m for the age groups of 24-60 months, 61-108 months and 109-180 months, respectively.

The mean weights and heights were not significantly different ($p > 0.05$) among the age groups and within the visits. This means that, utilization of the bean-based composite food did not alter their weights and heights over the four months supplementation period. The reason for this could be the episodes of opportunistic infections especially diarrhoea, appetite loss, difficulty eating, infections and side effects of medication.

4.3 Nutritional Status of Children

Nutritional status of the studied children was assessed by using standard deviation z-scores as indicators of anthropometric measurements and these were compared with standard references recommended by World Health Organization (WHO, 1995). WHO has recommended different indicators for children aged 9 years or less from those who are above nine years (adolescent ages). For children aged 0-9 years, WHO (1995) recommends the use of standard deviation z-scores (WAZ, WHZ and HAZ) while for children aged 10-15 years (adolescents), WHO (1995) recommends the use of Body Mass Index (BMI) for the age. Out of the 117 sampled children 48 were at the age of 2-9 years while 69 were in the age range 10-15 years.

4.3.1 Weight-for-height z-scores (WHZ)

Table 5 summarizes the weight-for-height z-scores (WHZ) of the studied children.

Table 5: Weight-for-height z-scores (WHZ) of the studied children

Sex of the children	Age group (months)	Normal (-2SD) - (+2 SD) %	Moderate wasting <(-2SD) - (-3 SD) %	Severe wasting <(-3 SD) %
Baseline				
Female	24 - 60	83.3 (n=11)	0.0 (n=0)	16.7 (n=2)
	61 - 108	93.3 (n=14)	6.7 (n=1)	0.0 (n=0)
Male	24 - 60	87.5 (n=7)	0.0 (n=0)	12.5 (n=1)
	61 - 108	90.9 (n=11)	9.1 (n=1)	0.0 (n=0)
Total	24 - 108	89.6 (n=43)	4.2 (n=2)	6.3 (n=3)
1 month				
Female	24 - 60	100.0 (n=7)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0 (n=12)	0.0 (n=0)	0.0 (n=0)
Male	24 - 60	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
Total	24 - 108	100.0 (n=27)	0.0 (n=0)	0.0 (n=0)
2 months				
female	24 - 60	100.0 (n=5)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0 (n=10)	0.0 (n=0)	0.0 (n=0)
male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	75.0 (n=3)	25.0 (n=1)	0.0 (n=0)
	24 - 108	95.5 (n=21)	4.5 (n=1)	0.0 (n=0)
3months				
Female	24 - 60	100.0 (n=6)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0 (n=13)	0.0 (n=0)	0.0 (n=0)
Male	24 - 60	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0 (n=5)	0.0 (n=0)	0.0 (n=0)
Total	24 - 108	100.0 (n=28)	0.0 (n=0)	0.0 (n=0)
4 months				
Female	24 - 60	80.0 (n=4)	20.0 (n=1)	0.0 (n=0)
	61 - 108	87.5 (n=7)	12.5 (n=1)	0.0 (n=0)
Male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	100.0(n=5)	0.0 (n=0)	0.0 (n=0)
Total	24 - 108	90.5(n=19)	9.5 (n=2)	0.0 (n=0)

Results revealed that 6.3% (n = 48) of the studied children had severe wasting at baseline. The number of wasted children was reduced to zero during the study period. Proportion of moderately stunted children were 4.2% (n = 48) at baseline survey and zero percent during the first month. On the second month the level was 4.2% (n = 22) and zero percent in the third month. The proportion was 9.52% (n = 21) at the fourth month of supplemental feeding. The trend in the moderate wasting was inconsistent. This suggested that the supplemental feeding did not have much influence and maybe other factors were masking the effect of the diet.

Proportion of severe wasting for the children aged 24-60 months was reduced from 4.2% (n = 48) to zero on the course of the study period. Similarly the proportion of severe wasting for the children aged 61-108 months was reduced from 2.1% (n = 48) at baseline to zero during the study period. The proportion of the severely wasted children observed during the baseline survey was higher at both age groups than that reported by the Tanzania 2004 Demographic and Health Survey (TDHS) in which prevalence of severe wasting was 0.4% for children aged 24-60 months and 0.3% for children aged 61-108 months (NBS and ORC Macro, 2005). Since wasting indicates deficit in tissue and fat mass compared with amount expected in a child for the same height, higher values may have resulted from failure to gain weight or from actual weight loss due to the HIV/AIDS complications. With enrichment of the bean-based composite food, children showed noticeable changes as evidenced by the decrease in the proportion of wasted children to below that observed by TDHS (2004).

The proportion of moderately wasted children of 24-60 months was zero at baseline survey and remained constant at the first, second and third months but picked-up to 4.8% (n = 21) during the fourth month. For the age group of 61-108 months, the proportion of moderate wasting was 2.1% (n = 48) at baseline, 0.0% (n = 27) at first month, 4.5% (n = 22) at second month and 0.0% at the third and the fourth month of the study period. Although there was a slight increase in proportion of severely wasted children at the second month, there were considerable decreases in these proportions to below the levels observed by TDHS (2004). The prevalence of severe wasting at national level was reported at 3.7% for children aged between 24 and 60 months and 3.2% for children aged 61-108 months (NBS and ORC Macro, 2005). The reasons for the proportions observed in this study may be reduced food intake as a result of appetite loss, difficulty in eating, infections, side effects of medication. Also may bc resulted from poor absorption of nutrients that may be due to recurrent/chronic diarrhoea and HIV caused intestinal cell damage.

More females in this study (4.2%, n = 48) were severely wasted at baseline than males. This proportion declined to zero at the course of the study period. The proportion of severely stunted males in this study was 2.1% at baseline. The proportions of severely wasted females and males were higher than the national level of 0.3% for females and 0.4% for males (NBS and ORC Macro, 2005). Moderately wasted females in this study were 2.1% (n = 48) at baseline, which declined to zero on the course of the study period. The proportion however, increased to 9.5% (n = 21) in the fourth month. For males the proportion of moderately wasted children was 2.1% (n = 48) at baseline, 0.0% (n = 27) at first month, 4.6% (n = 22) at second month, and decreased to zero at the third and fourth months. According to TDHS (2004), proportion of moderately wasted children at national level was 2.7% for females and 3.3% for males (NBS and ORC Macro, 2005). These results indicated that, the nutrition status of HIV infected children could be improved by consuming the bean-based composite diets.

4.3.2 The Height-for-Age z-score (HAZ)

The height-for-age z-score (HAZ) reflects achieved linear growth for age. Low height-for-age indicates a child whose height for age is below minus two standard deviation (-2 SD) from the median of reference population. It also reflects chronic undernutrition referred to as stunting.

Table 6 summarizes the nutritional status of the children aged between 24-108 months using height-for-age z-score index.

Table 6: Height-for-age z-scores (HAZ) for the studied children

Sex of the children	Age group (months)	Normal (-2 SD) - (+2 SD) %	Moderate stunting <(-2 SD) - (-3 SD) %	Severe stunting <(-3 SD) %
Baseline				
Female	24 - 60	75.0 (n=9)	8.3 (n=1)	16.7 (n=2)
	61 - 108	76.5 (n=13)	17.6 (n=3)	5.9 (n=1)
Male	24 - 60	62.5 (n=5)	12.5 (n=1)	25.0 (n=2)
	61 - 108	72.7 (n=8)	27.3 (n=3)	0.0 (n=0)
Total	24 - 108	72.9 (n=35)	16.7 (n=8)	10.4 (n=5)
1 month				
Female	24 - 60	57.1 (n=4)	28.6 (n=2)	14.3 (n=1)
	61 - 108	83.3 (n=10)	8.3 (n=1)	8.3 (n=1)
Male	24 - 60	75.0 (n=3)	25.0(n=1)	0.0 (n=0)
	61 - 108	50.0 (n=2)	50.0 (n=2)	0.0 (n=0)
Total	24 - 108	70.4 (n=19)	22.2 (n=6)	7.4 (n=2)
2 months				
Female	24 - 60	20.0 (n=1)	40.0 (n=2)	40.0 (n=2)
	61 - 108	80.0 (n=8)	10.0 (n=1)	10.0 (n=1)
Male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	50.0 (n=2)	50.0 (n=2)	0.0 (n=0)
Total	24 - 108	63.6 (n=14)	22.7 (n=5)	13.6 (n=3)
3 months				
Female	24 - 60	33.3 (n=2)	50.0 (n=3)	16.7 (n=1)
	61 - 108	76.9 (n=10)	15.4 (n=2)	7.7 (n=1)
Male	24 - 60	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
	61 - 108	80.0 (n=4)	20.0 (n=1)	0.0 (n=0)
Total	24 - 108	71.4 (n=20)	21.4 (n=6)	7.1 (n=2)
4 months				
Female	24 - 60	40.0 (n=2)	40.0 (n=2)	20.0 (n=1)
	61 - 108	75.0 (n=6)	12.5 (n=1)	12.5 (n=1)
Male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	60.0 (n=3)	40.0 (n=2)	0.0 (n=0)
Total	24 - 108	66.7 (n=14)	23.8 (n=5)	9.5 (n=2)

Table 6 data indicate that, 10.4% (n = 48) of the study children were severely stunted, 16.7% (n = 48) were moderately stunted while 72.9% had normal height-for-age at baseline survey. Percentage of the severely stunted children was reduced from 10.4 (n = 48) to 7.4% (n = 27) at first month, 13.6% (n = 22) at second month, 7.1% (n = 28) at third month and 9.5% (n = 21) at the fourth month. The proportion of stunted children observed in this study was lower than that reported in TDHS (2004).

According to TDHS (2004), prevalence of moderately stunted children at national level was 43.3% while for severe stunting was 15.6%. This is lower than that observed in this study i.e. 16.7% (n = 48) at baseline, 22.2% (n = 27) after one month, 22.7% (n = 22) after two months, 21.4% (n = 28) after three months and 23.8% (n = 21) after four months. In contrast, the proportion of stunted children observed was higher than the level for Morogoro region in which 10.6% of children were reported to be severely stunted while 38.8% were reported to be moderately stunted (NBS and ORC Macro, 2005).

In this study, more female children were stunted relative to their male counterparts. Prevalence of moderate stunting among females was 8.3% (n = 48) at baseline, 11.1% (n = 27) at first month, 13.6% (n = 22) at second month, 17.9% (n = 28) at third month and 14.3% (n = 21) at fourth month. For male children, the prevalences were 8.3% (n = 48), 11.1% (n = 27), 9.1% (n = 22), 3.6% (n = 28) and 9.5% (n = 21) at baseline, first, second, third and fourth months, respectively. Prevalence of severely stunted female children were 6.3% (n = 48) at baseline survey, 7.4% (n = 27) after one month, 13.6% (n = 22) after two months, 7.4% (n = 28) after three months and 9.5% (n = 21) after four months while severely stunted male children were 4.2% (n = 48) at baseline and zero at first, second, third and fourth months of the study period. According to TDHS (2004) prevalence of moderate stunting at national level for female children was 36.8%. This level is higher than that observed in this study. Similarly TDHS (2004) reported higher prevalence of moderate stunting among male children, which is 38.6% at national level (NBS and ORC Macro 2005). Stunting decreases with age that is why prevalence of stunting was higher at the ages between 6 and 59 months. Severe stunting at national level is 12.0% and 13.6% for female and male children respectively (NBS and ORC Macro 2005).

Percentage of severely stunted children of the age between 24-60 months was 8.3% (n = 48) at baseline survey, 3.7% (n = 27) after one month, 9.1% (n = 22) after two months, 3.6% (n = 28) after three months and 4.8% (n = 21) after 4 months. Moderately stunted children of the same age was 4.2% (n = 48) at baseline survey, 11.1% (n = 27) after one month, 9.1% (n = 22) after two months, 10.7% (n = 28) after three months and 14.3% (n = 21) after four months. TDHS (2004) reported higher values of moderate stunting among children aged 24-60 months than that observed in this study. National prevalence of moderate stunting is 34.7% while moderate stunting observed in this study was 7.1% (n = 48) at baseline, 11.1% (n = 27) at first month. 9.1% (n = 22) at second month, 10.7% (n = 28) at third month and 9.5% (n = 21) at the fourth month. Severe stunting of the same age group at national level is 10.2% (NBS and ORC Macro, 2005) lower than levels observed in this study, which were 10.4% (n = 48) at baseline and 13.6% (n = 22) at the second month, but higher than levels of 7.4% (n = 27) at first month, 7.1% (n = 28) at third month and 9.5% (n = 21) at fourth month.

For the age group 61-108, results revealed that, prevalence of severely stunted children was 2.1% (n = 48) at baseline, 3.1% (n = 27) at one month, 4.5% (n = 22) at two months. 3.6% (n = 28) at three months and 4.8% (n = 21) at four months. These proportions were lower than those reported by TDHS (2004) (15.0%) at national level. Moderate stunting for children aged 61-108 months was 12.5% (n = 48) at baseline, 11.1% (n = 27) at one month, 13.4% (n = 22) at two months, 10.7% (n = 28) at three months and 14.3% (n = 21) at four months. These values were lower than those reported by TDHS at national level (38.5%) for the age group between 61 and 108 months.

4.3.3 The weight-for-Age z-score (WAZ)

The weight-for-age z-score (WAZ) reflects the effects of both acute (wasting) and chronic (stunting) undernutrition. Low weight-for-age indicates a child whose weight for age is below minus two standard deviation (-2 SD) from the median of reference population. Table 7 summarizes the nutritional status of the children aged between 24-108 months using weight-for-age z-score index.

Table 7: Weight-for-age z-scores (WAZ) for the studied children

Sex of the children	Age group (months)	Normal	Moderate underweight	Severe underweight
		(-2SD) - (+2 SD)	<(-2SD) - (-3 SD)	<(-3 SD)
		%	%	%
Baseline				
Female	24 - 60	66.7 (n=8)	25.0 (n=3)	8.3 (n=1)
	61 - 108	88.2 (n=15)	11.8 (n=2)	0.0 (n=0)
Male	24 - 60	100.0 (n=8)	0.0(n=0)	0.0 (n=0)
	61 - 108	72.7 (n=8)	27.3 (n=3)	0.0(n=0)
Total	24 - 108	81.3 (n=39)	16.7 (n=8)	2.1 (n=1)
1 month				
Female	24 - 60	71.4 (n=5)	28.6 (n=2)	0.0 (n=0)
	61 - 108	100.0 (n=12)	0.0 (n=0)	0.0 (n=0)
Male	24 - 60	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
	61 - 108	50.0 (n=2)	50.0 (n=2)	0.0 (n=0)
Total	24 - 108	82.5 (n=23)	14.8 (n=4)	0.0 (n=0)
2 months				
Female	24 - 60	20.0 (n=1)	40.0(n=2)	40.0(n=2)
	61 - 108	100.0 (n=10)	0.0 (n=0)	0.0 (n=0)
Male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	75.0 (n=3)	25.0(n=1)	0.0 (n=0)
Total	24 - 108	77.3 (n=17)	13.6 (n=3)	9.1 (n=2)
3months				
Female	24 - 60	33.3 (n=2)	50.0 (n=3)	16.7 (n=1)
	61 - 108	84.6 (n=11)	15.4 (n=2)	0.0 (n=0)
Male	24 - 60	100.0 (n=4)	0.0 (n=0)	0.0 (n=0)
	61 - 108	80.0 (n=4)	20.0(n=1)	0.0 (n=0)
Total	24 - 108	75.0 (n=21)	21.4 (n=6)	3.6 (n=1)
4 months				
Female	24 - 60	60.0 (n=3)	20.0 (n=1)	20.0 (n=1)
	61 - 108	87.5 (n=7)	12.5 (n=1)	0.0 (n=0)
Male	24 - 60	100.0 (n=3)	0.0 (n=0)	0.0 (n=0)
	61 - 108	80.0 (n=4)	20.0 (n=1)	0.0 (n=0)
Total	24 - 108	80.9 (n=17)	14.3 (n=3)	4.8 (n=1)

Table 7 data indicate that, 2.1% (n = 48) of the studied children were severely underweight, 16.3 (n = 48) were moderately underweight while 81.25% (n = 48) had normal weight for age at the baseline survey. Percentage of severely underweight children was reduced to zero during the first month of supplementation and remained constant for children of 61-108 months throughout the study period. The proportion of severely underweight children of the age between 24 and 60 months was reduced from 2.1% at baseline to zero at first month, but increased to 9.1% (n = 22) at the second month. The number was further reduced to 3.6% (n = 28) at the third month and at the fourth month the proportion of severely underweight children rose to 4.8% (n = 21). There were no cases of severely underweight children for the age group of 61-108 months throughout the study period. The proportion of severely underweight children observed was higher than that reported in the Tanzania Demographic and Health Survey (2004). According to TDHS (2004), prevalence of severe underweight at national level was 0.4% for the age group 24-60 months and 0.3% for the age group 61-108 months (NBS and ORC Macro, 2005). Higher proportions of underweight children were observed in this study could be due to low energy intake, which is the possible cause of weight loss among people living with HIV/AIDS.

Proportions of moderately underweight children were 16.7% (n = 48) at baseline, 14.8% (n = 27) at first month, 13.6% (n = 22) at second month, 21.4% (n = 28) at third month and 14.3% (n = 21) at the fourth month. For the age group 24 to 60 months, proportions of moderately underweight children were 6.3% (n = 48) at baseline 7.4% (n = 27) at first month, 9.1% (n = 22) at second month, 10.7% (n = 28) at third month and 4.8% (n = 21) at the fourth month. The proportion of moderately underweight children in the age group 61-108 months was 10.4% (n = 48) at baseline, 7.4% (n = 22) at one month, 4.55% (n = 27) at two months, 10.71% (n = 28) at three months and 9.52% (n = 21) at the fourth months. Prevalence of moderately underweight children among the age groups 24-60 months and 61-108 months in this study was lower than that reported by TDHS (2004). NBS and ORC Macro (2005) reported prevalence of 21.0% for moderately underweight for 24-60 months children and 22.2% among moderately underweight children for age group 61-108 months

Based on sex, more female children were underweight compared to their male counterparts. At baseline 2.1% (n = 29) of females were severely underweight and reduced to zero at first month but increased to 7.4% (n = 29) at second month, 3.6% (n = 29) at the third month and 4.8% (n = 29) at fourth month. There were no male children who were severely underweight. According to TDHS (2004) report the proportion of females who were severely underweight was 2.7% while for male children was 3.3%. Likewise, more female children were moderately underweight than male children.

4.3.4 Nutritional status using BMI-for-age

According to WHO (1995), BMI-for-age is recommended for screening overweight and underweight status in all children 10-15 years of age. Table 8 shows the mean BMI-for-age of the sample children.

Table 8: BMI – for – age of the studied children

Sex	BMI categories			
	Normal (18.5 - 25)	Mild underweight (17.5 – 18.5)	Moderate underweight (16 – 17.5)	Severe underweight (<16)
Baseline				
Females	25.7% (n=9)	11.4% (n=4)	17.1% (n=6)	45.7% (n=16)
Males	14.3% (n=5)	17.1% (n=6)	22.9% (n=8)	45.7% (n=16)
Total	20.0% (n=14)	14.3% (n=10)	20.0% (n=14)	45.7% (n=32)
1 month				
Females	38.9% (n=7)	5.6% (n=1)	22.2% (n=4)	33.3% (n=6)
Males	4.3% (n=1)	21.7% (n=5)	21.7% (n=5)	52.2% (n=12)
Total	19.5% (n=8)	21.7% (n=6)	22.0% (n=9)	43.9% (n=18)
2 months				
Females	25.0% (n=4)	6.3% (n=1)	12.5% (n=2)	56.3% (n=9)
Males	5.6% (n=1)	11.1% (n=2)	22.2% (n=4)	61.1% (n=11)
Total	14.7% (n=5)	8.8% (n=3)	17.6% (n=6)	58.8% (n=20)
3 months				
Females	36.8% (n=7)	5.3% (n=1)	21.1% (n=4)	36.8% (n=7)
Males	0.0% (n=0)	36.4% (n=4)	18.2% (n=2)	45.5% (n=5)
Total	23.3% (n=7)	16.7% (n=5)	20.0% (n=6)	40.0% (n=12)
4 months				
Females	33.3% (n=4)	8.3% (n=1)	25.0% (n=3)	33.3% (n=4)
Males	0.0% (n=0)	36.4% (n=4)	36.4% (n=4)	27.3% (n=3)
Total	17.4% (n=4)	21.7% (n=5)	30.4% (n=7)	30.4% (n=7)

Table 8 data indicates that, 45.7% (n = 70) of the studied children were severely underweight at baseline survey, 43.9% (n = 41) at one month, 58.8% (n = 34) at two months, 40.0% (n = 30) at three months and 30.4% (n = 23) at four months of supplemental feeding.

Proportion of children who were moderate underweight were 20.0% (n = 70) at baseline survey, 22.0% (n = 41) at first month, 17.6% (n = 34) at second month, 40.0% (n = 30) at third month and 30.4% (n = 23) at fourth month.

The proportion of mild underweight was 14.3% (n = 70) at baseline, 21.3% (n = 41) at one month, 8.8% (n = 34) at two months, 16.7% (n = 30) at three months and 21.7% (n = 23) at the fourth month. These proportions of underweight children (severe, moderate and mild) based on BMI-for-age were inconsistent. This implies that, although the bean-composite meal was given to these children for four months, slight changes were observed in their BMI-for-age (Table 8). This could be due to inadequate food intake and some episodes of opportunistic infections associated with HIV/AIDS.

4.4 Body Composition Measures of the Studied Children

Table 9 data show the mean lean body mass (percent) of the studied children.

Table 9: Mean lean body mass percentage of the studied children

	Age groups (months)					Total	One-way ANOVA
	24 – 59 (n = 11)	60 – 89 (n = 25)	90 – 119 (n = 10)	120 – 149 (n = 32)	150 – 180 (n = 39)	N = 117	F (Combined)
Baseline	93.19	88.26	86.42	88.93	85.77	87.87	1.756 (ns)
1 month	96.90	87.55	87.68	87.30	86.91	87.70	2.205 (ns)
2 months	95.30	88.10	87.12	87.82	88.17	88.33	1.363 (ns)
3 months	96.53	85.56	86.52	86.05	86.72	86.74	2.237 (ns)
4 months	95.60	86.05	88.78	80.93	86.08	85.73	0.929 (ns)

**: $p \leq 0.05$, ***: $p \leq 0.01$, ns = not significant ($p > 0.05$)

The mean lean body mass (%) was not significantly different (p>0.05) among the age groups and within the visits. This means that, utilization of the bean-based composite food did not alter their percentage lean body mass over the four months supplementation period. This could be associated with high viral load, which usually increases the basal metabolic demands (and thus increased energy expenditures) in HIV-infected children (Bailey *et al.*, 1999). A study on protein utilization by HIV+ children revealed that, lean body mass increases with a long term nutrition rehabilitation (ADA, 2004). Therefore, the increase in the mean lean body mass (%) could have been significant if the feeding would have been done for a period longer than four months.

For the total fat mass, there was no statistical variation (p>0.05) observed among the age groups and between the visits except for the fourth month (Table 10).

Table 10: Mean total body fat mass percentage of the children

%Body fat	Age groups (months)					Total	One-way ANOVA
	24 – 59	60 – 89	90 – 119	120 – 149	150 – 180		F
Visit	(n = 11)	(n = 25)	(n = 10)	(n = 32)	(n = 39)	N = 117	(Combined)
Baseline	6.81	11.77	13.58	11.07	12.91	11.69	2.275 (ns)
1 month	3.10	12.44	12.33	12.70	13.44	12.40	2.219 (ns)
2 months	4.70	11.90	12.88	12.18	11.18	11.50	1.386 (ns)
3 months	3.47	14.58	13.48	13.48	13.25	13.14	2.304 (ns)
4 months	4.40	14.05	11.22	12.38	13.93	12.36	2.945 **

**: $p \leq 0.05$, ***: $p \leq 0.01$, ns = not significant (p>0.05)

Since percentage body fat is the predictor of lean body mass (i.e. Lean Body Mass = 100% - %Body Fat); the percentage body fat mass was expected to decrease with increasing lean body mass of the HIV infected children over a long term nutrition rehabilitation (ADA, 2004). In this study, significant difference ($p \leq 0.05$) started showing up at the fourth month of supplementation, suggesting that percentage body fat could have been significant if the feeding would have been done for longer periods.

4.5 Motor Performance of the Studied Children

Motor performance was assessed using a selection of motor performance tests. These tests were speed, power, muscle strength, coordination and cardiovascular endurance.

4.5.1 Speed

Table 11 data show the speed (seconds) used to complete running a 20 m dash. There was no significant difference (p>0.05) in the running speed among the age groups and within the study visits.

Table 11: Mean speed (seconds) to complete a 20 m dash

Speed (sec)	Age groups (months)					Total	One-way ANOVA
	24 – 59	60 – 89	90 – 119	120 – 149	150 – 180		F
Visit	(n = 11)	(n = 25)	(n = 10)	(n = 32)	(n = 39)	N = 117	(Combined)
Baseline	7.45	6.92	7.33	7.53	7.05	7.22	0.374 (ns)
1 month	7.33	5.47	7.00	6.36	6.37	5.56	1.448 (ns)
2 months	6.00	5.29	5.80	5.95	5.13	5.56	0.723 (ns)
3 months	6.00	4.44	5.50	5.11	4.83	4.96	1.659 (ns)
4 months	5.00	4.60	4.40	5.07	4.33	4.70	0.269 (ns)

**: p≤0.05, ***: p≤0.01, ns = not significant (p>0.05)

In this study, speed declined significantly (p>0.05) with time of supplemental feeding. The speed ranged between 7.53 and 6.92 seconds at baseline and the range declined to 5.07 and 4.33 seconds at the end of the four month of supplementation.

Studies on speed performance among children have produced contradictory results (Ferro-Luzzi, 1999; Ghesquière and Eeckels, 1994; Parizkova, 1994; Parizkova, 1997). A study by Ferro-Luzzi (1999) showed that, the 20 m running speed was mostly influenced by the age of the child. On this study however, the age of the child did not seem to influence their running speed. Similarly, a study of underprivileged children showed that. children from poor families had better speed performance compared to their peers from affluent families (Parizkova, 1994). On the other hand, children from poor areas had lower functional capacities than those from well to do areas, but this difference disappeared when their height was taken into account (Ghesquière and Eeckels, 1994). These studies however, involved school age children, and variability in their performance could be explained by the degree and form of growth retardation (Parizkova, 1997). The HIV infected children in this study had smaller speed performance than those reported in the other mentioned studies, which were done by healthy school aged children. Growth retardation that occurs in HIV+ could have attributed to the low speed performance observed. HIV and its complications may result in poor muscle development and/or muscle wasting especially in early childhood. This could have also attributed to the observed low speed of the studied children.

4.5.2 Power

Power was measured by using standing long jump with a two feet take-off and landing. The distance covered was recorded in metres. Table 12 shows the distance (metres) covered in a long jump by the age of the child.

Table 12: Mean power (m) distribution of the studied children

Visit	Age groups (months) 24 – 59 (n = 11)	60 – 89 (n = 25)	90 – 119 (n = 10)	120 – 149 (n = 32)	150 – 180 (n = 39)	Total N = 117	One-way ANOVA F (Combined)
Baseline	0.37	0.89	1.26	1.26	1.40	1.14	20.508 ***
1 month	0.50	0.90	1.13	1.39	1.51	1.23	20.352 ***
2 months	0.52	0.78	1.10	1.24	1.13	1.04	8.837 ***
3 months	0.35	0.93	1.23	1.30	1.19	1.09	15.205 ***
4 months	0.49	0.99	1.29	1.38	1.25	1.16	7.416 ***

**: $p \leq 0.05$, ***: $p \leq 0.01$, ns = not significant ($p > 0.05$)

Results showed that, there were significant variations ($p \leq 0.01$) in the standing long jump distance among age groups and within the visits. This observation was similar to that reported by Benefice (1990) in which undernourished Senegalese children showed better standing long jump performances than speed performances. At baseline survey, power increased with age and ranged between 0.37 and 1.40 m, and was improved to between 0.49 and 1.38 m at the end of four months feeding. Since the power indicated the use of leg muscle, and the trend of power was getting better, this indicated improvement of the muscle mass over the four months of supplementation.

4.5.3 Power and coordination

Power and coordination was assessed using the tennis ball throw towards a given direction and the distance measured in metres. Detailed power and coordination measures are summarised in Table 13.

Table 13: Mean values of power and coordination in metres

	Age groups					Total	One-way ANOVA
Visit	24 – 59 (n = 11)	60 – 89 (n = 25)	90 – 119 (n = 10)	120 – 149 (n = 32)	150 – 180 (n = 39)	N= 117	F (Combined)
Baseline	0.41	1.10	1.92	1.37	1.62	1.36	6.931 ***
1 month	0.57	0.82	0.98	1.22	1.23	1.07	3.584 **
2 months	0.41	0.69	0.81	0.77	0.96	0.78	3.856 **
3 months	0.55	0.82	1.09	1.17	1.05	0.99	4.918 ***
4 months	0.57	1.11	1.36	1.19	1.28	1.16	2.987 **

**: $p \leq 0.05$, ***: $p \leq 0.01$, ns = not significant ($p > 0.05$)

Mean values of power and coordination ranged between 0.41 m and 1.92 m at baseline and 0.57 m and 1.28 m at the fourth month visit. There was a significant decline in the power and coordination across the feeding period among the various age groups. Similar findings of the tennis ball throwing distance were seen in malnourished Senegalese children where the children showed a decline in the throwing of a tennis ball as a result of poor muscle development caused by their low nutritional status (Benefice, 1990).

4.5.4 Grip strength

Grip strength was measured by pulling a handle in a hand dynamometer. The strength was recorded in kilograms. Table 14 data summarise the grip strengths (kg) of the studied children.

Table 14: Distribution of grip strengths (kg) among the studied children

Visit	Age groups 24 – 59 (n = 11)	60 – 89 (n = 25)	90 – 119 (n = 10)	120 – 149 (n = 32)	150 – 180 (n = 39)	Total N = 117	One-way ANOVA F (Combined)
Baseline	1.09	4.96	7.80	9.94	12.05	8.63	31.376 ***
1 month	3.33	6.53	10.25	12.27	15.37	11.00	19.598 ***
2 months	3.50	6.21	10.40	12.94	14.84	10.91	15.634 ***
3 months	1.75	6.69	10.00	13.44	14.67	10.57	16.585 ***
4 months	1.48	7.20	9.60	13.71	13.17	10.44	10.404 ***

**: p≤0.05, ***: p≤0.01, ns = not significant (p>0.05)

Mean grip strengths (kg) ranged from 1.09 to 12.05 kg at baseline and 1.48 to 13.71 kg at the last visit. The measurements revealed a significant improvement (p≤0.01) in the grip strengths among various age groups and between the study visits, except for children in the age group 24-59 months. A study conducted in Mexico showed similar results in which grip strengths of children increased with age and on the course of feeding (Malina and Bushang, 1995).

4.5.5 Cardiovascular endurance

Cardiovascular endurance was measured by the distance (metres) the child could run in three minutes. The mean cardiovascular endurance measurements (metres) are summarized in Table 15.

Table 15: Mean cardiovascular endurance (metres) of the sample children

Visit	Age groups 24 – 59 (n = 11)	60 – 89 (n = 25)	90 – 119 (n = 10)	120 – 149 (n = 32)	150 – 180 (n = 39)	Total N = 116	One-way ANOVA F (Combined)
Baseline	270.90	442.28	429.50	411.97	337.03	382.66	3.920 **
1 month	191.00	443.89	410.00	386.64	364.16	392.14	2.377 (ns)
2 months	190.00	428.86	386.64	402.89	365.67	383.79	3.200 **
3 months	203.00	457.71	403.67	388.21	374.42	394.55	2.632 **
4 months	198.20	410.08	401.67	415.16	330.40	357.17	3.263 **

**: p≤0.05, ***: p≤0.01, ns = not significant (p>0.05)

Although there are no studies reported on the cardiovascular endurance, the results from the present study showed that, cardiovascular endurance declined significantly ($p \leq 0.05$) with time. The trend indicated that, cardiovascular endurance of the children did not improve for the entire study period. This suggested that, children continued to wear out even with food supplementation. This could be due to poor muscle development associated with HIV and its complications.

In summary, HIV infected children in this study performed well in three out of the five motor performance tests. The well performed tests were power, power and coordination and grip strength. With this performance, there is enough evidence to suggest that, improvement in protein and energy nutriture from bean-based composite foods improved strength, power, and power and coordination in HIV positive children.

4.6 Food Intake

4.6.1 Types of food taken

Table 16 presents the foods generally consumed by the studied children.

Table 16: Food intake of the children studied

Food intake		Frequency	Percentage
Breakfast	Plain tea	59	50.4
	Tea + pancakes	32	27.4
	Tea + doughnuts	20	17.1
	Tea + boiled cassava	5	4.2
	Porridge	1	0.9
	Total	**117**	**100.0**
Lunch	Stiff porridge + vegetables	32	27.4
	Stiff porridge + sardines	27	23.1
	Stiff porridge + beans	13	11.1
	Stiff porridge + meat +vegetables	9	7.8
	Rice + beans	9	7.8
	Rice + meat	6	5.1
	Cooked bananas + meat	6	5.1
	Stiff porridge + fish	5	4.2
	Stiff porridge + meat	5	4.2
	No lunch	5	4.2
	Total	**117**	**100.0**
Dinner	Rice + beans	32	27.4
	Rice + green peas	23	19.5
	Rice + fish	18	15.3
	Stiff porridge + meat	9	7.8
	Stiff porridge + vegetables	9	7.8
	Cooked bananas + meat	9	7.8
	Stiff porridge + beans	6	5.1
	Rice + meat	6	5.1
	Stiff porridge + fish	5	4.2
	Total	**117**	**100**
Feeding frequency	3 meals per day	84	71.8
	2 meals per day	33	29.2
	< 2 meals per day	0	0.00
	Total	**117**	**100.0**

During breakfast, 50.4% (n = 117) of the assessed children took plain tea, 27.4% (n = 117) took tea with pancakes while 17.1% (n = 117) drunk tea with doughnuts. The remaining 4.2% (n = 117) drank tea with boiled cassava whereas 0.9% (n = 117) ate porridge for breakfast (Table 16). These results indicated that, low protein foods were eaten during breakfast.

The dominant food during lunch was stiff porridge '*ugali*'; which was taken with vegetables (27.4%), sardines (23.1%), beans (11.1%), meat (4.2%) and fish other than sardines (4.2%). Stiff porridge was also taken in a combination with meat and leafy vegetables (7.8%). Other foods that were taken during lunch were rice with beans (7.8%), rice with meat (5.1%) and cooked bananas with meat (5.1%). Four percent (n = 117) of the children did not take any food for lunch. Leafy vegetables consumption during lunch was outstanding but when taken with cereals alone causes insufficient protein intake. Also, the quantity of vegetables taken with cereals may not be so high to meet the basic requirements for protein and essential micronutrients.

For dinner, the dominant food taken was rice served with beans (27.4%), green peas (19.5%), fish (15.3%) and meat (5.1%). Children also used stiff porridge for dinner. This was served with meat (7.8%), with leafy vegetables (7.8%), beans (5.1%), cooked bananas (7.8%) and/or fish (3.9%). Based on the results, modest intake of protein sources was reported during dinner but the quantity was not enough.

The common vegetables that were eaten by the studied children included amaranthus leaves, cowpea leaves, cabbage, spinach, *Cochrus spp.* "mlenda" and potato leaves. Fruits commonly taken were ripe bananas, oranges, avocadoes and tangerines. However, these varied with season. Children were taking neither vitamin nor mineral supplements.

4.6.2 Frequency of feeding

Table 16 data showed that, 71.8% (n = 117) of the assessed children were eating three meals per day whereas 29.2% (n = 117) were eating two meals per day. No child was reported to eat more than three meals per day. Children in this study were eating less number of meals than the number of meals recommended for the HIV infected children. A child who is infected with HIV/AIDS needs to eat six to seven meals per day depending on age and stage of the disease. For asymptomatic children of the age between 2 to 9 years, six meals (three balanced meals and three nutritious snacks) are recommended per day. Symptomatic children of the same age need to eat seven meals (four balanced meals and three nutritious snacks) per day. Asymptomatic children of the same age with wasting syndrome are advised to eat as the symptomatic children but they are advised to eat small frequent meals (not less than seven times per day) because they are ill too often and cannot eat large amounts of meals at once (COUNSENUTH, 2006).

4.6.3 Mean dietary intake

Twenty four hour dietary recall method was used to assess usual food intake. The total cooked food volume of each of the preparations was recorded in terms of standard cups, bowls and plates. The quantity of each preparation consumed by each individual was assessed in terms of cups and the quantity of left-over food recorded. The energy and protein contents of the diets were calculated using food composition table for use in Africa (FAO, 1998).

Individual food consumption was obtained by recalling foods (including snacks) and beverages consumed in the previous 24 hours. Food consumption was recorded in three days, two weekdays and one weekend day. The average daily consumption of calories, protein and other nutrients was determined by using food composition tables. Composition levels were compared with the Recommended Dietary Intakes (WHO, 1985). Table 17 data shows the average energy and other nutrient intake for the studied children.

Table 17: Daily intakes of energy (kcal) and other nutrients for studied children

Age (months)	Day	Energy (Kcal)	Fat (g)	Protein (g)	CHO (g)	DF (g)	Fe (mg)	Zn (mg)	Se (µg)
All									
24 - 60	1	1090.0	40.0	21.0	107.0	7.9	4.0	5.0	41.0
	2	1100.0	30.0	20.0	114.0	6.2	4.0	7.0	41.0
	3	980.0	47.0	23.0	117.0	7.0	3.0	6.0	41.0
Mean		1056.6	41.3	21.3	112.7	7.0	3.7	6.0	41.0
61 - 84	1	1025.0	30.0	20.0	100.0	9.2	7.0	8.0	40.0
	2	1104.0	33.0	19.0	98.0	8.0	6.0	8.0	37.0
	3	1200.0	39.0	21.0	120.0	7.4	8.0	8.0	45.0
Mean		1109.7	34.0	20.0	106.0	8.2	7.0	8.0	40.7
85 - 120	1	1210.0	40.0	24.0	100.0	12.3	16.0	10.0	98.0
	2	1209.0	40.0	27.0	124.0	14.0	16.0	10.0	103.0
	3	1190.0	40.0	22.0	188.0	10.0	15.0	10.0	111.0
Mean		1203.0	40.0	24.3	137.3	12.1	15.7	10.0	104.0
Boys									
121 - 144	1	1200.0	31.0	48.0	168.0	11.0	12.0	12.0	120.0
	2	1287.0	33.0	40.0	200.0	13.0	11.0	11.0	100.0
	3	1190.0	35.0	46.0	170.0	17.0	12.0	14.0	125.0
Mean		1225.7	33.0	44.7	179.3	13.7	11.7	12.3	115.0
145 - 180	1	1298.0	37.0	42.0	124.0	11.0	9.0	10.0	134.0
	2	1288.0	40.0	51.0	131.0	21.0	10.0	14.0	139.0
	3	1312.0	40.0	40.0	120.0	16.0	9.0	17.0	132.0
Mean		1299.3	39.0	44.3	125.0	16.0	9.3	13.7	135.0
Girls									
121 - 144	1	1280.0	50.0	47.0	160.0	12.0	16.0	20.0	160.0
	2	1229.0	48.0	53.0	148.0	18.0	16.0	18.0	153.0
	3	1230.0	53.0	50.0	129.0	20.0	16.0	25.0	140.0
Mean		1246.3	50.3	50.0	145.7	16.7	16.0	21.0	151.0
145 - 180	1	1220.0	49.0	43.0	151.0	14.0	14.0	21.0	200.0
	2	1245.0	47.0	46.0	142.0	17.0	17.0	27.0	210.0
	3	1220.0	42.0	44.0	160.0	19.0	19.0	20.0	189.0
Mean		1228.3	46.0	44.3	151.0	16.7	16.7	22.7	199.7

Recommended daily intakes for boys and girls younger than 120 months are the same for boys and girls. However, RDIs differ among boys and girls as the children grow. Mean daily intakes for children aged between 24 and 60 months were 1056.0 kcal (energy), 41.3 g (fat), 21.3 g (protein), 112.7 g (carbohydrate), 7.0 g (dietary fibre), 3.7 mg (Fe), 6.0 mg (Zn) and 41.0 µg (Se). For children aged 61-84 months, their mean daily intakes were 1009.7 kcal (energy), 34.0 g (fat), 20.0 g (protein), 106.0 g (carbohydrate), 8.2 g (dietary fibre), 7.0 mg (Fe), 8.0 mg (Zn) and 40.7 µg (Se).

For children aged 85-120 months, mean daily intakes were 1203.0 kcal (energy), 40.0 g (fat), 24.3 g (protein), 137.3 g (carbohydrate). 12.1 g (dietary fibre), 15.7 mg (Fe), 10.0 mg (Zn) and 104.0 μg (Se).

Mean daily intakes for boys of the age group 121-144 were 1225 kcal (energy), 33.0 g (fat), 44.7 g (protein), 179.3 g (carbohydrate), 13.7 g (dietary fibre), 11.7 mg (Fe), 12.3 mg (Zn) and 115.0 μg (Se). Mean daily intakes for girls of the same age group were 1246.3 kcal (energy), 50.3 g (fat), 50.0 g (protein), 145.7 g (carbohydrate), 16.7 g (dietary fibre), 16.0 mg (Fe), 21.0 mg (Zn) and 151.0 μg (Se). Mean daily intakes for boys of the age group 145-180 were 1299.3 kcal (energy), 39.0 g (fat), 44.3 g (protein), 125.0 g (carbohydrate), 16.0 g (dietary fibre), 9.3 mg (Fe), 13.7 mg (Zn) and 135.0 μg (Se). Mean daily intakes for girls of the same age group were 1228.3 kcal (energy), 46.0 g (fat), 44.3 g (protein), 151.0 g (carbohydrate), 16.7 g (dietary fibre), 16.7 mg (Fe), 22.7 mg (Zn) and 199.7 μg (Se). The consumption of calories, fat, dietary fibre, total carbohydrate, protein, iron, zinc and selenium (Table 17) were much lower than the RDI (Table 18).

Table 18: Nutrient requirements and safe levels of intakes for various nutrients

Age (months)	Nutrients					
	Energy (Kcal)[1]	Fat (g)[1]	Protein (g)[1]	Iron (mg)[1]	Zinc (mg)[2]	Selenium (μg)[2]
All						
24 - 60	1600	27 – 62	26	7	7	90
61 - 84	1820	30 – 71	30	10	12	150
85 - 120	1900	32 – 74	34	12	23	280
Boys						
121 - 144	2120	35 – 82	48	12	26	290
145 - 180	2250	38 – 88	59	18	34	400
Girls						
121 - 144	1905	32 – 74	49	11	26	290
145 - 180	1955	33 - 76	59	20	34	400

Source: [1]WHO (1985), [2]National Academy of Sciences (2001)

The recommended Dietary Intakes for the age group 24-60 months are 1600.0 kcal (energy), 27-62 g (fat), 26.0 g (protein), 7.0 mg (Fe), 7.0 mg (Zn) and 150.0 μg (Se). For the age group 61-84, the RDIs are 1820.0 kcal (energy), 30-71 g (fat), 30.0 g (protein), 10.0 mg (Fe), 12.0 mg (Zn) and 150.0 μg (Se). The RDIs for the age group 85-120 months are 1900.0 kcal (energy), 32-74 g (fat), 49.0 g (protein), 11.0 mg (Fe), 26.0 mg (Zn) and 290.0 μg (Se).

The RDIs for boys of the age group 145-180 months are 2250.0 kcal (energy), 38 - 88 g (fat), 59.0 g (protein), 18.0 mg (Fe), 34.0 mg (Zn) and 400.0 μg (Se). RDIs for girls of the same age group are 1955.0 kcal (energy), 33-76 g (fat), 59.0 g (protein), 20.0 mg (Fe), 34.0 mg (Zn) and 400.0 μg (Se).

Although energy requirements increase by 10% to maintain growth in asymptomatic HIV infected children, and by 50-100% for those experiencing weight losses, the requirements were not met by these children even at the normal levels. This was also true for the other nutrients. Inadequate nutrient intake could be a result of many factors: food availability (whether from local production or other sources), poor quality foods and access to food (i.e., their capacity to produce or purchase). In addition, educational levels and cultural values also play a role in shaping food habits, consumption patterns and food supply systems in general.

4.7 ARV Medication

The children under study needed antiretroviral therapy to reduce viral load and delay progression of HIV infection to AIDS. However, ARVs may have side effects (nausea, vomiting, diarrhoea, constipation, and changes in taste) that may affect the dietary intake. The side effects may be caused by the interaction between food or nutrients and the drugs. Side effects should be managed to ensure continued food intake and adherence to medication regimens (FANTA, 2004).

In this study, 8.5% (N = 117) of the children were receiving ARV. The ARVs used were Nevirapine (NVP), Lamivudine (3TC), Efavirenz (EPV) and Stavudine (D4T). The remaining children (92.5%, N = 117) were not taking ARV drugs. Efavirenz must be taken with low fat diet/meal which may affect food intake. NVP, 3TC, D4T and EPV all have common side effects of vomiting, nausea and dizziness which affects food intake (FANTA, 2003). No child was reported to have any side effect caused by the interaction between the bean-maize composite food and the ARVs.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study elucidated that, with the intervention of protein and energy nutriture in the bean-maize composite food, it was possible to improve three out of the five motor performance tests (i.e., power, grip strength and power and coordination) of the HIV infected children. The results further revealed that, there were inconsistent data in nutritional status of the children in terms height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) during the study period. However, the food improved BMI-for-age of the children in the period of four months. Fat mass and fat free mass were not significantly improved by the supplementation with the bean-maize composite meal. A longer time of intervention was probably needed to observe improvement in the fat free mass and in motor performance.

5.2 Recommendations

Based on the findings of the study, the following recommendations were drawn: -

a) For improvement of nutritional status and motor performance of HIV infected children, continuous supply of highly nutritious foods to the children (especially for those in the centres) is emphasized.

b) The general public, non-governmental organizations and the government itself should support nutritional based initiatives to care and support children infected with HIV/AIDS.

c) Formulation of foods for this special group of people living with HIV/AIDS seems essential. Locally produced staples including beans need to be exploited for sustainable food supply for this group of people in the country.

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APPENDICES

Appendix I: Child Information

1.0 General Information

1.1 Participant ID ....

Visit Code ....

Date of visit ....

1.2 Gender

1. Female

2. Male

1.3 Age/Date of birth [ ] years [ ] day [ ] month [ ] year

2.0 Growth Parameters and Indices

2.1 Weight (kg)

2.2 Height (m)

W/H ....

W/A ....

BMI ....

3.0 Body Composition Measures

3.1 Percentage body fat ....

3.2 Lean body mass ....

4.0 ARV Medication

4.1 Is the subject taking any ARV Drugs?

1 = Yes (Go to question 14)

2 = No (If no, STOP)

4.2 Specify the type(s) of ARV prescribed and their dosage per day in mg.

Type of ARV	Dose/day in mg
1.	
2.	
3.	
4.	

5.0 Children Motor Performance Tests

#	Performance measure	Physical Activity	Response			
5.1	**Speed**	The time in minutes taken to complete a 20 metre dash	.... Minutes			
5.2	**Power**	The distance in metres subject jumps in a standing long jump with both feet together in take-off and landing	1	2	3	Best of 3
5.3	**Power & Coordination**	The distance in metres that the subject completes tennis ball throw	1	2	3	Best of 3
5.4	**Grip Strength**	Kilograms registered after squeezing a handle in a dynamometer	1	2	3	Best of 3
5.5	**Cardiovascular endurance**	The distance in metres the subject runs in 3 minutes	.... Metres			

Appendix II (a): Dietary Intake Questionnaire

1.0 We are interested in finding out about the types of foods and other compounds (including supplements) that you and your family consumed over the past 24 hours.

Time of day	**Food Items**	**Amount/ Portion**

2.0 How many meals do you take per day?

3.0 Are you taking any dietary supplements. vitamins, and or minerals?

4.0 If yes:

a. At least once/day ………………..

b. At least 2 -3 times/week ………………..

c. At least once/week ………………..

d. Others (Specify)

5.0 Please specify the type of dietary supplements, vitamins, minerals that you take …………………… ……………………

…………………… ……………………

Appendix II (b): *Historia ya Chakula*

1.0 Tunahitaji kujua aina za vyakula na virutubisho vingine (ikiwemo vitamini na madini) ambavyo familia yako ilikula katika masaa 24 yaliyopita. (jaza kwa siku 3 - wikiendi 1 na siku 2 za katikati ya wiki)

Muda (mfano asubuhi)	Vyakula	Kiasi

2. Unakula milo mingapi kwa siku?

3. Unatumia virutubisho vingine mbali na Chakula kama vitamini au madini?

4. Kama ndio katika swali la pili: Ni kwa kiasi gani :-

   a. Mara moja kwa siku ....

   b. Mara 2 hadi 3 kwa wiki ....

   c. Mara moja kwa wiki ....

   d. Vinginevyo (elezea)

5. Taja virutubisho unavyotumia.