NUTRITIONAL STATUS AND GROWTH PATTERN OF HIV POSITIVE CHILDREN RECEIVING AND NOT-RECEIVING ANTIRETROVIRAL TREATMENT IN DARES SALAAM, TANZANIA.

BY

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ABSTRACT

This study was undertaken to assess the nutritional status and growth pattern of HIV positive children receiving and not-receiving anti- retroviral treatment in Dar es salaam. Specific objectives to assess the nutritional status and growth pattern of children receiving and not receiving ARV treatment. Anthropometric measurements were taken which were height and weight. Biomarkers of HIV i.e. CD4 count were taken at baseline and at the end of the study. The study revealed that HIV positive children receiving ARV were growing slightly better ($p > 0.05$) in WAZ, HAZ and WHZ than their counterparts not receiving ARV. The study further revealed that, HIV + children who were receiving ARVs had slightly higher ($p > 0.05$) CD4 and CD4:CD8 ratio compared to their peers not receiving ARVs. It showed that ARVs had small effect on growth of both boys and girls who were taking ARVs and multivitamin combinations. HIV+ children receiving not receiving ARVs followed similar patterns of growth, although the children receiving ARVs had slightly higher z-scores of weight for age and weight for height. HIV infection is a strong risk factor for mortality among children in Tanzania. It was concluded from this study that, although ARVs appeared to have beneficial effect on weight gain, the effect was insignificant. Since all children were receiving multivitamin supplementation, a good nutrition would produce the same effect even if ARVs are not provided. Provision of good nutrition, including supplementation with multivitamin and minerals in a viable, safe and practical approach in the management of HIV+ children. Due to side effects associated with the use of ARVs which are nevertheless designed for adults use of dietary approach is highly recommended for the HIV+ children. This study showed that, use of dietary approach is just as good as using ARVs.

DECLARATION

I, KOKULETAGE KAMUZORA, do declare to the senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted nor concurrently being for a higher degree award in any other University.

________________________________ ________________________________

KOKULETAGE KAMUZORA Date

MSc. Human Nutrition

The above declaration is confirmed

________________________________ ________________________________

Prof. T.C.E. Mosha Date

Supervisor

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DEDICATION

I dedicate this work to my family who laid the foundation of my education.

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ACRONYMS

AIDS	Acquired Immuno Deficiency Syndrome
HIV	Human Immuno Deficiency Virus
e.g.	For example
AZT	zidovudine
3TC	lamivudine
ddI	didanosine
d4T	stavudine
ddC	zalcitabine
NVP	nevirapine
USAID	United States Agency for International Development
WHO	World Health Organisation
UNAIDS	Joint United Nation Programme on HIV/AIDS
HAART	Highly Active Anti-Retroviral Therapy.
NRTI	Nucleotide Reverse Transcriptase Inhibitors
ART	Antretroviral Treatment

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Children with HIV infection have been recognized since 1983 in Tanzania and AIDS is becoming one of the leading causes of death among infants and children in the country. An estimated 600 000 children become infected with HIV world wide per year. Most of these children live in Africa where prevalence of HIV in pregnant women in several areas exceeds 35% (UNAIDS, 1998). In a recent review of literature it is estimated that 40 million people worldwide have been infected with HIV, of whom 80% live in Sub-Saharan Africa (UNAIDS, 2004). Clinically nearly 25% of children infected with HIV have a rapid course of manifestation of AIDS within one year. The rate of progression to full AIDS reflects in part the level of care, nutrition and concurrent infections. It is estimated that 50% of infected children die before they reach 2 years.

At birth majority of the children do not show signs of HIV infection however there are some that develop obvious signs and symptoms of the disease such as failure to thrive, wasting, acute respiratory infections, persistence diarrhoea, recurrent and severe bacterial infection, excessive crying and oral candidiasis. With overlapping signs and symptoms of tuberculosis, malnutrition and other infections, it becomes very difficult even to recognize these conditions. In Tanzania HIV Infected people are 1.6 million, AIDS deaths are 160 000 per year and AIDS Orphans are 980 000. As the largest country in East Africa, Tanzania bears a large share of the global epidemic, with an estimated HIV prevalence of

8.8 percent among adults aged 15-49 (WHO, 2004). Though nearly 160 000 deaths were attributed to HIV/AIDS in 2003, it is estimated that only one in five cases are actually reported, grossly understating the extent of the epidemic. Of the 800 000 women who gave birth in health care facilities, 13.3 percent were HIV-positive and among the women attending antenatal clinics (ANCs) in 2002, 9.6 percent were HIV-positive (WHO, 2004).

The nutritional implications of HIV infection for children often are more devastating than those for adults, simply because children have the added nutritional demands for growth and development. If the supply of any essential nutrient is insufficient, growth retardation or other functional deficits occur. Compromised nutrition also increases the risk of infection and prolongs recovery from acute illness. Children with HIV infection experience nutritional problems during the course of their illness. Poor weight gain, failure to thrive, slowed linear growth, growth stunting, malnutrition, and wasting are common in children with HIV infection and AIDS. These also do require tests to determine their CD4 and CD8 counts. Determination of CD4 and CD8 is done in order to:

(a) Asses the degree and speed of immune deterioration

(b) To define decision point to start ART

(c) Decide timing of prophylaxis for opportunistic infections and

(d) Monitoring the efficacy of treatment

1.2 Problem Statement and Justification

In Tanzania nutritional problems exist with different prevalence in various locations. According to the social economic profile ten commonly reported causes of mortality in children are anaemia, intestinal parasites, pneumonia, upper respiratory infections, malaria, diarrhoea and HIV/AIDS, congenital heart failure, malnutrition. Nearly 25% of children infected with HIV have a rapid course of manifestation of AIDS within one year. The rate of the disease reflects in part the level of care, nutrition and concurrent infections. Primary infection with HIV or secondary opportunistic infections changes the body's metabolic pathways. Abnormal patterns of protein and lipid metabolism result, with nutrients transferred from lean to adipose (fat) tissue. Some inflammatory cytokines (intercellular immune regulators), such as tumor necrosis factor (TNF) and interleukin-1, have been associated with metabolic dysregulation and wasting (Keithley and Swanson, 1998). Their chronic release during HIV infection seems to play a major role in HIV-related wasting.

Alterations in the function of the gastrointestinal tract and the ability to use food in an efficient way increase the use of body fat stores, recurrent fevers and infections causing a rise in metabolic rates and depletion of vitamin and mineral stores. Metabolic problems such as glucose dysregulation and lipid abnormalities may originate from immune dysfunction, medication side effects, opportunistic infections, hormonal alterations, or the direct effects of HIV itself (Ayoob, 2000). In these children, early growth failure is an important predictor of a poor prognosis. It is obvious that HIV infection causes a disruption in protein metabolism that leads to reduced protein deposition in infants and young children, but not in adults.

Children with HIV/AIDS are dying may be because of a lack of access to ARV treatment or lack of good nutrition. Lack of cheap feasible diagnostic tests for children under 18 months, lack of trained health personnel and the affordable child-friendly ARV drugs exacerbate the problem in children (WHO, 2006). Ongoing supply of ARVS in Tanzania has assisted to some extent to prolong life of individual's adults but few children are receiving ARV and yet for those receiving ARV is not clearly known if the ARV is improving their growth pattern to normal. This study was aimed at providing information on the contribution of ARV to the nutritional status and growth pattern of HIV positive children.

1.3 Objectives

1.3.1 Overall objective

To assess the nutritional status and growth patterns of HIV positive children receiving and not receiving antiretroviral treatment aged 5 to 10 years in Dar es salaam for six months.

1.3.2 Specific objectives

(a) To determine the nutritional status of HIV positive children aged 5 to 10 years

(b) To determine the differences in growth patterns of children receiving and those not receiving anti retroviral treatment in Dar es salaam

(c) To assess dietary intake of children living with HIV/AIDS in Dar es salaam

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Global Situation of HIV and AIDS

Since the identification of acquired immune deficiency syndrome (AIDS) 20 years ago, more than 20 million people have died and 40 million people live with HIV or AIDS in the world. The pandemic is still spreading worldwide and in year 2000, three million people including 500 000 children died of AIDS and another 5.3 million people including 600 000 children were newly infected with HIV (USAID, 2002). Among those affected, 95% live in developing countries and Africa alone accounts for two thirds of current HIV and AIDS cases. The increase in adult mortality has left and will continue to leave many children without parents who are the principal caregivers and breadwinners in the households. This is a very big challenge to the resource poor households in Africa who cannot meet even the basic needs.

2.2 The Problem of HIV and AIDS in Tanzania

Since 1983 when the first cases of AIDS were reported in Tanzania, HIV and AIDS epidemic has spread both in rural and urban areas. Most infections are mainly sexually transmitted through homosexual and heterosexual intercourse and therefore young men and women being the sexual active groups are the population groups most affected. Worse still, the HIV and AIDS pandemic has interacted with other underlying public health problems, most notably tuberculosis (TB). Tanzania, HIV/AIDS and TB were reported to be the leading cause of death in adults in the surveyed areas and TB remains the principle cause of death in people living with HIV and AIDS. Up to 50% of TB patients in Tanzania are co-infected with HIV and AIDS whereas in other countries, this accounts for up to 70% (MOH, 2002). According to UNAIDS (2002), 50% of beds at Muhimbili hospital were occupied by those with AIDS related illnesses.

2.3 Nutritional Requirement of Young Children

Nutrition during early childhood has a great bearing on health and quality of life throughout the individual's lifetime. Clinical signs of nutritional deficiencies normally appear sooner in early childhood than in other age groups. According to Lathan (1997) and King and Burgess (1993) children's nutrient requirements are great due to: rapid growth, especially between 0 - 5 months when the body grows faster than any other time in lifetime beyond intrauterine life. For instance, full-term breast fed infant grows at a rate of approximately 30 g/day. They have greater surface area in relation to their weight resulting in greater heat loss. Rapid psychomotor development and acculturation (primitive organs become modified to become advanced), increased physical activity especially after age of four months.

2.3 Nutritional Status

Nutritional status can be defined as the interpretation of information obtained from the methods of nutritional status assessment. The information obtained is used to determine the health status of individuals or population groups as influenced by their intake and utilization of nutrients (Gibson, 1990). The common categories of nutritional status assessment are dietary, biochemical, antropometric and clinical. The raw measurements derived from each of the methods of nutritional status assessment systems are often combined to form indices. Indices are used to interpret and group the measurements. Nutritional assessment indices can be evaluated by comparison with distribution of reference values, reference limits drawn from reference distribution and predetermined cut-off points (Gibson, 1990). In this study antropometric method was used to assess nutritional status.

2.4 Factors Influencing Nutritional Status

The causes of malnutrition are complex and have multifactorial causes, in the sense that there are various ways in which nutritional status can be affected. Commonly food is one of the most important factors which affect nutrition followed by diseases. Insufficient food intake is related to insufficient food production, low income, and difficult access to markets. Women workload is another contributing factor in child nutritional status. Most African women are the ones responsible for all farm activities, together with other domestic activities. This has resulted to most of the women to have no enough time for preparing meals for their children (TFNC, 1997). Adequate care and feeding practices require time, attention and support, this is essential to meet the physical, mental and social need (Lathan, 1997). Therefore children need to be fed frequently, since an increment in food intake is always an indicative of increase of nutrient intake.

2.4.1 Malnutrition

Child malnutrition is one of the most severe and lasting consequence of parental death. AIDS orphans are prone to malnutrition and infection and less likely to receive healthcare than other children the very young children are at more risk especially if the grandparents look after them. This is reinforced by the belief that, the child whose mother has died of AIDS or AIDS related illness is also doomed to die of the same cause. These children are likely to die unnecessarily of malnutrition and common childhood illness such as diarrhea and respiratory infections (Mukoyo and William, 1991). Malnutrition may be classified using the following indicators:

(a) Weight –for-age (Underweight)

Underweight reflects body relative to chronological age and is influenced by both weight and height of the child and therefore its composite nature makes its interpretation complex as it fails to distinguish short child of adequate body weight and tall but thin child. Weight-for-age Z-score and data on underweight are of limited use because of failing to distinguish between stunting and wasting. However, like stunting it reflects long-term health and nutritional experience of individual or population (NBS, 2000). In Tanzania almost 30% of under 5 years are moderate or severe underweight for their age and reports indicate that there has been little change in the 1990s in the rate of malnutrition on the Mainland while Zanzibar the rate of moderate malnutrition has fallen while that of severe malnutrition on the bases of Weight-for-age has risen slightly (UNICEF, 2002)

(b) Height-for-age (Stunting)

Stunting reflects the process of failure to reach linear growth potential as a result of sub optimal health or nutrition condition, which is frequently associated with poor overall economic conditions and or exposure to adverse conditions such as illness and inappropriate feeding practice. Improvement in level of stunting is an indication of improvement in overall social economic. Stunting usually starts to rise at the age of 3 years and for children aged below 3 years stunting reflects a continuous process of failing to gain weight or being stunted (NBS, 2000). In Tanzania 48% of under 5 years children are stunted (low height-for-their age) a reflection of chronic malnutrition that sets in as children are weaned (UNICEF, 2002).

(c) Weight –for-height (Wasting)

Wasting indicate deficit in tissue and fatty mass compared with the amount expected in the child of the same height or length. It represents a failure to receive adequate nutrition in the period immediately preceding the survey and also as a result of inadequate food intake or recent episodes of illness causing loss of weight and onset of malnutrition. Severe wasting is closely linked to an elevated risk of mortality and wasting prevalence varies considerably with season. Provided there is no food shortage, the prevalence of wasting is usually below 5% even in poor countries (UNICEF, 2002). A prevalence exceeding 5% is alarming gives a parallel increase in mortality and prevalence between 10 and 14 % are regarded as serious and that above or equal to 15% are regarded as critical (NBS, 2000). Inadequate delayed 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 good indicators to assess growth as well as nutritional status.

2.5 Metabolic Changes in HIV/AIDS

Changes in metabolism in HIV-infected people occur as a result of the immune system's response to HIV infection. When the body mounts its acute phase response to infection, it releases pro-oxidant cytokines and other oxygen-reactive species. These cytokines produce several results, including anorexia (causing lower intake of food) and fever (increasing energy requirements).

If the infection is prolonged, muscle wasting occurs because muscle tissue is broken down to provide the amino acids with the immune protein and enzymes they need. These processes increase energy requirements of people living with HIV/AIDS during the asymptomatic phase by 10 percent over the level of energy intake recommended for healthy, non-HIV-infected people of the same age, sex, and physical activity level (USAID, 2003).

2.6 Treatment for HIV Disease in Children

HIV treatment for children is especially important because their immune systems are not as strong as adult immune systems. Treatment for children is also more complicated because children may need lots of help taking pills and other forms of drugs. Children who have a low T-cell count or any HIV disease symptom should get anti-HIV treatment. The nucleoside analog drugs used to treat HIV in children are the same as those used for adults: AZT, 3TC, ddI, d4T, ddC. Children can also be treated with 2 of the 4 protease inhibitor drugs now available in the market. These are ritonavir (Norvir) and nelfinavir (Viracept). Combinations of anti-HIV drugs are recommended to treat HIV. For example, ddI must be taken on an empty stomach, which may be difficult for children, and the protease inhibitors must be taken every day on a schedule. Viral load tests are not as useful for children as they are for adults. Research is being done to find out how viral load tests work in children (WHO, 2005).

Although good food and diet are important for the wellbeing of people living with HIV/AIDS, there is no evidence that food and/or dietary supplements alone will stop people who are infected with HIV from progressing to AIDS. Comprehensive care for people living with HIV and AIDS needs to include prophylaxis and treatment for opportunistic infections and antiretroviral therapy. Antiretroviral therapy has been shown in numerous studies to reduce the replication of HIV in the body, reduce the incidence of opportunistic infections and AIDS-related illness and improve quality of life (WHO, 2005).

2.7 Children and Adherence to ARVs

Adherence issues are important to consider when evaluating the effectiveness of anti-HIV therapy. Dosing schedules, dietary requirements, the amount and taste of medications and children's dependence on adults may influence adherence and present obstacles to effective viral suppression. It is important to concentrate on getting used to the treatment. If the treatment instructions are not followed, it is likely that the drugs will not be absorbed properly in the body. It will allow viral load to increase, and increases the likelihood of the HIV developing drug resistance (AVERT, 2006).

2.8 HIV/AIDS and Immune Status

HIV causes severe damage to the immune system and eventually destroys it. The virus accomplishes this by utilizing the DNA of CD4 cells to replicate itself, and in so doing the virus destroys the CD4 cells thus reducing their count. The immune system protects the body by recognizing antigens on invading bacteria and virus and reacting to them. When the immune system is weakened or destroyed by a virus such as HIV, the body itself becomes vulnerable to opportunistic infections (AVERT, 2004)

2.9 CD4 and Lymphocytes in Children

Infected children with HIV often have severe diseases when first diagnosed, or may develop AIDS overtime, much like adults infected with HIV. Infants and young children normally have higher CD4 counts than do adults. The normal CD4 counts in children vary with age, but it is equal to the adult value by the time the child is six years old. Immunologic and clinical categories are used to evaluate HIV disease status in children and to make treatment decision. The Immunological categories of classifying HIV children are indicated in the Tables 1 and 2.

2.9.1 CD4/CD8 ratio

Immunological changes in HIV-1 infection include a decrease in CD4+ cells, a transient increase in CD8+ cells, total lymphocytes and inversion of the CD4/CD8 ratio. As HIV infection progresses, the CD4+ cells decline, while the CD8+ cells which may remain at high levels for long periods, eventually decrease but not to baseline levels. Since in healthy children the CD4+ and CD8+ cells account for 60% and 30% of the T-lymphocytes, a normal CD4/CD8 ratio should always be >1.0. Thus, in HIV-1 infection where there is a decrease in CD4+ cells and an increase in CD8+ cells, the reversal of the CD4/CD8 to < 1.0 should in theory be useful for diagnosis of HIV-1 infection (Zijenah *et al.*, 2005).

Table 1: Immunological categories of children HIV classification system

Category	CD4 count suppression	Age of child		
		< 12 months	**1- 5 years**	**6 – 12 years**
1	Normal	>1500/mm³	>1000/mm³	>500 /mm³
2	Moderate	750 -1499/mm³	500- 999 /mm³	200 - 499 /mm³
3	Severe	< 750 /mm³	< 500 /mm³	< 200 /mm³

Source: Centre for Disease Control Prevention (1994).

Table 2: The relationship between CD4 count and immune status

CD4 cell count	Immune status condition
500 – 1400	Healthy HIV - individuals
< 500	Immune system damaged
< 350	Immune system damage is moderately severe
< 200	Immune system damage is severe and the patient is officially diagnosed as having AIDS
< 50	Disease is advanced and damage may be irrepairable

Source: Centre for Disease Control Prevention (1994)

2.10 The Impact of HIV on Children Growth

Children's growth is affected by many factors, including general nutrition, overall health, endocrine abnormalities and caretaker nurturing. A child is said to be failing to thrive when his or her height and weight are less than the 5th percentile for age or he or she is crossing percentiles downward on standardized growth curves. Failure to thrive is a diagnosis that has multiple etiologies, one of which is HIV infection. According to the

European Collaborative Study, at 10-year follow-up, infected children were on average 7 kg lighter and 7.5 cm shorter than uninfected children. The onset of growth failure in children infected with HIV+ has been variable. Some studies have reported growth deceleration as early as the first few months of life. Other studies have shown children with normal growth into and beyond their second year of life (Lowenthal et al; 2000). Studies have shown that children with HIV infection grow more slowly than uninfected children, a difference that becomes more significant with age. Asymptomatic infected children have similar growth patterns as mildly or moderately symptomatic children. However, children with severe illness tend to have poorer growth. Increased levels of postnatal viremia have been clearly associated with decreased linear growth (Lowenthal *et al*., 2000).

HIV-infected children are at particular risk for problems related to growth and development. HIV and opportunistic infections often negatively influence the growth and development of young children. The lives of many HIV-infected children are complicated by a lack of nutritious food necessary for normal growth and development. When a child's caretakers are ill or are suffering emotionally from the loss of friends and family members, they may be less available to provide appropriate developmental stimulation. Health care providers who treat children should understand how to assess whether a child's growth and development are appropriate for the age of the child. By evaluating growth and development at every medical visit, we can learn much about the child's health.

2.10.1 Growth as a predictor of prognosis

Children infected with HIV have been classified in three clinical groups with regard to the timing of their disease progression. Infants who develop symptoms of AIDS or who die within the first year of life are classified as “rapid progressors.” Children who suffer from an AIDS-defining illness or who die within one to five years of infection are classified as “intermediate progressors.” Those children who do not develop symptoms and who survive past 5 years of age are classified as “slow progressors.” Growth failure in children has been clearly associated with accelerated progression from asymptomatic HIV infection to AIDS. Those children who qualify for classification as “rapid progressors” have the highest incidence of growth failure (Lowenthal *et al*., 2000).

Perinatally acquired HIV infection is sometimes associated with early and progressive decrements in weight and length. Height growth velocity (rate of growth) has been shown to predict survival independently of age, viral load, and CD4 cell count. Studies in Thailand, Rwanda, and the U.S. have evaluated growth as a predictor of prognosis. The consensus in these studies was that growth failure is highly suggestive of rapid disease progression. Patients, who failed to gain 2 kg by 4 months of age, as well as those with low CD4 counts (maternal and infant) at time of birth and high viral loads at 2 months of age, were most likely to have rapid disease progression. In resource-limited environments, where obtaining laboratory data is sometimes not possible, growth monitoring may be the best available tool for assessing risk of disease progression.

2.10.2 Nutrition growth and HIV infection

Even in patients without HIV infection, nutrition plays an important role in childhood growth. The effects of nutrition on patients with HIV have been studied with respect to CD4 counts and growth parameters. An observational study of nutritional interventions among children with AIDS (giving adequate calories, protein, fat, and micronutrients) determined that attention to these nutritional factors may help restore intestinal absorption and improve CD4 counts. The researchers reported that, providing adequate nutrition was most beneficial if started prior to the development of an AIDS-defining illness. Early nutritional interventions play an important role in helping to decrease morbidity and mortality among HIV-infected children, particularly in developing countries without access to antiretroviral therapy.

2.10.3 Effects of antiretroviral drugs on growth of children

Antiretroviral drugs are medications for the treatment of infection by retroviruses, primarily HIV. Different classes of antiretroviral drugs act at different stages of the HIV life cycle. Combination of several (typically three or four) antiretroviral drugs is known as Highly Active Anti-Retroviral Therapy (HAART). Early studies demonstrated that mono or dual antiretroviral therapies containing zidovudine, didanosine, or zalcitabine led to a temporary increase in weight and linear growth rate. The transitory nature of the benefits seen with mono and dual therapy are related to the frequent occurrence of treatment failure due to drug resistance. Because HAART is less likely to lead to resistance and treatment failure, more sustainable clinical growth responses are seen among children on HAART. HAART clearly has a positive effect on height and weight in children with HIV-1 infection. According to a study performed in the Netherlands, this effect is sustained for at least 96 weeks (study duration) in patients who respond virologically to HAART.

Successful application of HAART was defined as a long-term reduction in viral load of at least 1.5 log copies/ml, or viral load suppression to less than 500 copies/ml, and increased CD4+ counts. The children in this study were divided into virologic responders and virologic non-responders. Virologic responders demonstrated a significant increase in height and weight, whereas virologic non-responders did not. The body mass index (BMI) has been used as a tool to evaluate nutritional status in both adults and children (Lowenthal *et al*., 2000).

Children with worse clinical stages at the beginning of therapy had a more significant increase in BMI than children starting at better clinical stages. Catch-up growth typically affects weight before affecting height. HAART's beneficial effects on a patient's growth likewise are first seen as increases in weight (usually by 48 weeks of therapy) and later as height improvements (usually by 96 weeks of therapy). A group from the Duke Clinical Research Institute is looking at the prediction of treatment failure using height velocity as a marker for treatment response. If validated internationally, this type of prediction could provide an excellent low-cost method for evaluating treatment response in resource-limited settings (Lowenthal *et al*., 2000).

2.11 ARV and Nutrition

Interactions between antiretroviral therapy (ART) and food and nutrition can affect medication efficacy, nutritional status, and adherence to drug regimens. Drug-food interactions consist of the effects of food on medication efficacy, the effects of medication on nutrient utilization, the effects of medication side effects on food consumption, and unhealthy side effects caused by medication and certain foods. As ART interventions scale up in resource limited settings, addressing food and nutrition implications becomes a critical component of care and support programs and services. ARVs can interact with food and nutrition in a variety of ways, resulting in both positive and negative outcomes. The four main types of interactions that can occur between drugs and food and nutrition. Because different ARVs interact with food and nutrition differently, it is critical to understand the specific nutritional interactions and implications of the particular drugs being taken. This understanding enables effective management of these interactions to maintain nutritional status and to improve drug efficacy, tolerance, safety, and adherence (Castleman *et al.*, 2004).

2.12 ARV and Food Intake

Food can affect medication absorption, metabolism, distribution and excretion. Certain foods affect the efficacy of certain ARVs by affecting their absorption, metabolism, distribution, or excretion. Food enhances the efficacy of some ARVs and inhibits the efficacy of others. For example, a high energy, high fat, high protein meal decreases absorption of the retanovir. A high fat meal increases the bioavailability of the NRTI tenofovir. Medication side effects can negatively affect food consumption and nutrient absorption. The side effects of some medications can lead to reduced food intake or reduced nutrient absorption that exacerbates the weight loss and nutritional problems experienced by PLWHA. ARV side effects, such as nausea, taste changes, and loss of appetite may reduce food consumption, while side effects such as diarrhea and vomiting may increase nutrient losses. For example, the NRTI zidovudine can cause anorexia, nausea, and vomiting, and side effects of the NRTI didanosine include diarrhea and vomiting, loss of appetite, and dryness of the mouth. Appropriate dietary changes can help PLWHA to manage certain ARV side effects and to reduce the impact these side effects have on their nutritional status. A simple example is that if zidovudine causes nausea, then taking it with a light meal, eating dry, salty foods, and drinking fluids between meals may help to prevent nausea. If consumption of didanosine causes diarrhea, drinking plenty of fluids and eating foods rich in energy and other nutrients – as is recommended for diarrhea generally – will help to reduce the impact of diarrhea on health and nutritional status (Castleman *et al.,* 2004).

ARVs can also have unhealthy side effects that are not related to food consumption or nutrient absorption but call for food and nutritional responses. For example, some studies have shown that certain ARVs increase the risk of osteopenia and osteoporosis, though further research is continuing on the subject. These conditions lead to poor bone health. Ensuring adequate vitamin D and calcium intake is a recommended nutritional response for patients with osteoporosis. While the majority of people who take ARVs experience some side effects during the treatment period, the prevalence, frequency, and severity of side effects vary among ARVs, among individuals, and among different side effects. Combination of medication and certain foods can produce unhealthy side effects. Some ARVs can create dangerous side effects when combined with certain foods. For example, consuming drinks that contain alcohol while taking didanosine can cause pancreatitis, an inflammation of the pancreas that can be serious and even fatal. Service providers need to make PLWHA aware of the foods contraindicated with the drugs they are taking so these foods can be avoided (Castleman *et al*., 2004).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

Kinondoni Municipal is within Dares Salaam Region. Kinondoni Municipal Council is one of the three administrative municipalities constituting the Dar es Salaam City.Other municipalities include Ilala and Temeke. Kinondoni Municipality is bordered by the Indian ocean to the North East, Ilala Municipal Council to the South, Bagamoyo District to the North, Kibaha District to the West and Kisarawe District to the South West. The Dar es Salaam city is estimated to cover an area of 1393 km^2 and is the biggest urban agglomeration in the country. It is the most dynamic socially, economically, culturally and geographically. The city lies 10 metres above sea level and is located around latitude 7˚ 0'S and 39 ˚0'E. Based on the 2002 Tanzania Populations and Housing Census (URT, 2003), Dares Salaam has a population of 2.5 million people and an average household size of 4.2. The census showed that female population was 1.23 million, while male population was 1.26 million.

The original occupants of Kinondoni Municipality are Zaramo and Ndengereko but due to urbanization many people of different ethnic groups have migrated into the municipality (URT, 2003). The distribution of public health facilities in kinondoni, is as follows: one District Hospital (Mwananyamala Hospital), two Health Centres located in Sinza and Magomeni (Sinza and Magomeni Health Centres) and 20 dispensaries. Average patients per doctor are 80 patients per day.

3.2 Study Design

This study was longitudinal in design. It was conducted for six months between September 2006 and March 2007.

3.2.1 Sampling frame

The sampling frame comprised all HIV positive boys and girls aged 5 to 10 years, receiving medical care and/or home based care at Mwananyamala Hospital in Dares Salaam and enrolled in the multivitamin supplementation programme.

3.2.1.1 Exclusion criteria population

All HIV negative children and HIV positive children above the age of ten years. Also children who were very ill and mentally deteriorated were excluded from the study.

3.2.2 Sampling technique

Subjects were randomly selected from the pool of children enrolled in the multivitamin supplementation programme and assigned into two study groups of those receiving and not receiving ARV. To avoid imbalances the subjects were categorized based on age and gender between those receiving and not receiving ARV treatment. Criteria for receiving ARV was CD4+ count $< 200\ mm^3$.

3.2.3 Sample size

Using statistical power analysis (Fisher *et al*., 1991) a sample of 174 children was randomly selected from the pool of children participating in the multivitamin supplementation programme.

The representative sample size was determined by using the following formula;

$n = Z^2pq / d^2$

Where n= sample size, Z=1.96 for a confidence limit of 95%, p=expected prevalence of HIV

d= relative precision.

Calculation

Relative precision (d) = 50%

Prevalence (P) = 13%

Confidence limit (z) = 1.96

i.e. $n = 1.96^2 . (1- 0.13) / 0.05^{2/3}$

n=174

Therefore, sample size was 174. Out of the 174 subjects, 124 were receiving ARV while 50 others were not receiving ARV. The distribution by gender was boys on ARV (62), boys not on ARV (26); girls on ARV (62) and girls not on ARV (24).

3.2.4 Interventions

All children enrolled into the study were given doses of multivitamin doses once every week. The multivitamins were obtained from Tanzania with brand name of Megavit. The HIV+ children were also divided into two groups. Group I received the ARV while group II did not receive any ARV. The children continued to receive the ARV for a maximum of 6 months. ARVs were administered to the children according to body weight. Likewise multivitamins were given based on RDA and the body weight**.**

3.3 Data Collection

3.3.1 Construction of Questionnaires

Two questionnaires were constructed. Questionnaire No. I solicited section information about the nutritional status and growth pattern of HIV+ children receiving and not receiving ARV, while Questionnaire No. 2 solicited information about parents/guardian characteristics.

3.3.2 Pre-testing of the questionnaires

The questionnaires were pre-tested into 10 asking questions face to face interview to the respondents at the Hospital. The questionnaire was pre-tested to 10 children in Morogoro Hospital. Unclear and ambiguous questions were corrected accordingly.

3.3.3 Administration of the questionnaire

The questionnaires were administered by the main researcher on a face – to – face interviews during visits to the respective hospitals. Questionnaires were administered during the morning hours.

3.3.4 Measurements taken

3.3.4.1 Weight and Height

Height was measured using a stadiometer and recorded to the nearest 0.1cm while weight was measured using digital scale and recorded at the nearest 0.1 kg. These measurements were taken from the children without their shoes on and with minimal clothing. A scale was zeroed before each measurement and was two times calibrated. Weight-for-height, weight-for-age and height for age z-scores were calculated to determine the extent of wasting, underweight and stunting, respectively. The children were classified according to the WHO (1983) reference charts.

Immune status of children was obtained by measuring the CD4 and CD8 cell counts. These measurements were taken once every three months. The type of ARV regimes admistered to the children was the first line comprising stavudine, nevirapine and lamivudine syrups. These were given to children who were HIV positive and had CD4 < 200 mm^3.

Table 3: Z-score classification

WA, HA, WH Z -Score Cut-off points	Classification
<-3 SD	Severe underweight, stunting, wasting
Between –3 SD and <-2 SD	Moderate underweight, stunting, wasting
≥ -2 SD	Normal

Source: WHO (1983)

The second line drugs comprised abacavir, ritonavir and didanosine which were given to children who had drug resistance to the first line drugs and/or did not show increase in CD4 cell counts when on the first line drugs.

3.3.4.2 Determination of CD4+ and CD8+ cell counts

The CD4 and CD8 were determined by Fluorescence Activated Cell Sorting (FACS) method of using whole blood in sample processing (Hulsta et al., 1994). Whole Blood was drawn from the vein. The blood sample was added to a pair of test tubes containing having reagent. The 50 cc of whole blood was Pipetted after gently mixing into each tube, then vortexed and incubated for 60 to 120 minutes at room temperature in the dark. Then 50cc of fixative solution was pipetted into each tube and vortexed. The fluorochrome label antibodies were binded specifically to antigens on the surface of the lymphocytes – CD3, CD4/CD8. The FACS count instrument detected two colours and relative cell size was measured. The CD3 cells fluoresced red and the CD4 and CD8 fluoresced yellow, Reference beads functioned as – fluorescence quantitation standard for calculating the absolute counts for CD3, CD4 and CD8 T- lymphocytes. Fixative was added to preserve the integrity of the antibody binding. No lysis of cells was necessary (Hulsta *et al*., 1994).

3.4 Food Intake

The 24-hour dietary recall method was used because it leads to detailed and accurate information where it was collected on two weekdays and one day weekend. Food consumption of children was obtained by recalling foods (including snacks) and beverages consumed in the previous 24 hours. Food consumption was recorded in three days and one weekend day. The average daily consumption of calories, nutrients was determined by using food composition tables. Consumption levels were compared with the Recommended Dietary Intakes (WHO, 1985). The energy and protein contents of the diets were calculated using food composition table for use in Africa (FAO, 1998).

3.5 Statistical Analysis

The collected data were summarized and analyzed using Statistical Package for Social Sciences (SPSS) version 11.5 computer programme. Anthropometric indices (WAZ, WHZ and HAZ) were calculated using the EPIINFO Package 2002 and compared with WHO (1993) reference population. Differences in baseline measurements between the two groups (those receiving and not receiving antretroviral drugs were determined.

3.6 Confidentiality

All subjects were identified and assigned identity numbers. Those numbers were used to identify the subjects during data collection. There was no use of names in the data entry, analysis or writing of the report.

3.7 Ethical Clearance

Permission to use human subjects for this study was obtained from the Ethics Committee of the National Institute for Medical Research, Dar es Salaam. Parents, guardians or care providers signed a consent form to affirm their willingness to let their children or children under their jurisdiction to participate in the study.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic and Demographic Characteristics of the Caregivers

4.1.1 Age of caregivers

Table 4.1 data show the socioeconomic and demographic characteristics of the guardians/parents. The age of the guardians/parents ranged between 15 and 55 years. About 1.1% (n = 174) of the guardians were 15 to 19 years, 17.8% (n = 174) were 20 to 35 years, 29.3% (n = 174) were 36 to 40 years, 37.9% (n = 174) were 41 to 50 years while 13.8% (n = 174) were above 51 years. Majority of the guardians/parents 81% (n = 174) were adults above 36 years.

4.1.2 Marital status

Table 4.1 data show the marital status of the caregivers. Majority of the guardians were married 39.1% (n = 174), 24.7% (n = 174) were widowed, 13.8% (n = 174) were divorced and 9.8% (n = 174) were single, while 12.6% (n = 174) were polygamous. Results indicated that children were coming from the widowed families.

4.1.3 Education level

Table 4 shows the level of education attained by the care providers. About 44.8% (n = 174) attended secondary education (is from form one to form six), 25.9% (n = 174) attained primary education (is from standard one to standard seven), 19% (n = 174) attained university education, 6.3% (n = 174) attended adult education while 4% (n = 174) did not attend formal school. This indicated that most of the caregivers attained formal education and were literate. According to Kavishe (1993) women who have acquired even minimal education are able to improve the nutritional situation of their families.

4.1.4 Occupation of caregivers

Table 4.0 shows the occupation of the caregivers. It was found that 32.7% (n = 174) were employed in public sector, 21.8% (n = 174) were unemployed, 24% (n = 174) were doing business, 12.8% (n = 174) were barmaids while 10.2% (n = 174) were farmers.

4.1.5 Earnings per month of the caregivers

Table 4 shows the earnings per month of the caregivers. About 48.9% (n = 174) of the caregivers earned between 20 000 and 30 000 Tshs per month, 25.9% (n = 174) earned above 50 000 Tshs per month, 21.3% (n = 174) earned between 40 000 to 50 000 Tshs per month while 4% (n = 174) earned were between 10 000 and 20 000 Tsh per month. This showed, majority of the caregivers earned low earnings which might not be enough for caring and providing nutritious food for the HIV positive children.

4.2 Immune Status of the Studied Children

Table 5 shows the mean CD4+ cell count (mm^3) of boys (776.32 mm^3) and girls (954.31 mm^3) receiving ARV at baseline. For boys and girls not receiving ARV, the CD4+ counts were 869.45 and 909 mm^3 respectively. After supplementation with multivitamin for four months, the CD4+ count for boys on ARV was 691.47 mm^3 while for those not on ARV was 574.08 mm^3. Likewise the change in the CD4+ counts for girls on and not on ARV treatment were 869.45 and 800.48 mm^3, respectively. The CD4+ counts revealed a general decline in the immunity with time. The decrease in CD4+ count was higher for the boys than for the girls.

A number of opportunistic infections were recorded during supplementation period. These included pneumonia, infective diarrhoea, urinary tract infections, oral thrush, malaria and bacteraemia. A CD4+ cell count is a measure of immune integrity and is used in HIV/AIDS to determine the immune status and the level to initiate ARV treatment (WHO, 2005). Also the CD4+ and CD8+ ratio improves for children receiving ARV than for children not taking ARV. The CD4+/ CD8+ ratios was 0.58 for boys and 0.64 for girls at the baseline while for those not on ARV the CD4+/CD8+ ratio were 0.51(boys) and 0.44 (girls). A decrease in CD4+ cells, a transient increase in CD8+ cells, total lymphocytes and inversion of the CD4+/CD8+ ratio implies that a progression of HIV infection. As HIV infection progresses, the CD4+ cells decline, while the CD8+ cells which may remain at high levels for long periods, eventually decrease but not to baseline levels (Zijenah *et al.,* 2005).

From the studied children the CD4+ count was increasing for children on ARV and decreasing for children not receiving ARV treatment. However all of the children were having CD4+ count above 500 cells/ mm^3, meaning that they were all having the CD4+ count above AIDS classification level. A study in Guinea Bissau, reported that Guinean children under the age of 2 years had lower CD4+ counts and CD4+/CD8+ ratios and higher CD8+ count when compared to their counterparts from developing countries

Table 4: Socio economic characteristics of the guardians/ parents

Characteristics	**N = 174**	**Percent**
Age category		

15 - 19 years	2	1.1
20 - 35 years	31	17.8
36 - 40 years	51	29.3
41 - 50 years	66	37.9
Above 51 years	24	13.8
Marital status		
Unmarried	17	9.8
Married- monogamous	68	39.1
Married – polygamous	22	12.6
Widowed	43	24.7
Divorced	24	13.8
Education		
Did not go to school	7	4
Adult Education	11	6.3
Primary Education	45	25.9
Secondary Education	78	44.8
University Education	33	19
Occupation of the guardian		
Farmer	19	10.2
Employed in public sector	67	32.7
Unemployed	38	21.8
Business	49	24.0
Barmaid	22	12.8
Earnings per month		
Tshs 10 000 – 20 000	7	4
Tshs 20 000 – 30 000	45	25.9
Tshs 40 000 – 50 000	85	48.9
Tshs > 50 000	37	21.3

Table 5: CD4+ count (mm³) of children receiving and not receiving ARV treatment

GENDER	**ON ARV**				**NOT ON ARV**			
	Boys		**Girls**		**Boys**		**Girls**	
	Baseline	**Final**	**Baseline**	**Final**	**Baseline**	**Final**	**Baseline**	**Final**
CD4(mm³)	776.3	691.5	954.3	869.5	806.6	574.1	909.9	800.5
CD8(mm³)	1799.2	1575.	1664.4	1406.	2559.3	1951.	1691.3	1602.
		2		9		2		4
CD4/CD8	0.6	0.5	0.6	0.7	0.5	0.4	0.4	0.4

(Zijenah *et al.,* 2005). Interestingly, girls had higher CD4+/CD8+ ratios and lower CD8+ count than boys. In this study, there were no significant differences ($p > 0.05$) CD4+/CD8+ ratio between boys and girls. The CD4+/CD8+ ratio is useful in identifying infected children while CD4+ counts helps to identify children who may benefit from cotrimoxazole prophylaxis or need initiation of ARVs (Zijenah *et al.,* 2005).

4.3 Anthropometric Measurements and Nutritional Status of Boys and Girls

Nutritional anthropometry is the measure of variation of physical dimension and gross composition of the human body at different levels and degree of nutrition (Gibson, 1990). In children, nutritional anthropometrics serve as proxy indicators for their wellbeing because they reflect the burden of disease as well as caring practices. In this study heights and weights and age of each child were used to derive three key nutritional indicators namely: weight for age, height for age and weight for height Z-scores for children aged 5 to 10 years. This measurement was taken monthly for six months and the first measurement was assumed to be a baseline measurement.

4.3.1 Distribution of WAZ for boys and girls receiving ARV and not receiving ARV during the six month study

Table 6 summarizes the WAZ- scores for the studied children at baseline. It can be noted that at baseline 12.9% (n = 62) of boys taking ARV were severely underweight while 15.4 % (n = 24) of their counterparts not taking ARV were severely underweight. For girls who were taking ARVs only 9.7% (n = 62) were severe underweight while 8.3 % (n = 24) of girls not using ARVs were severely underweight. There were no significant differences in the body weights for boys (p = 0.095) and girls (p = 0.811) receiving and not receiving ARVs at baseline. The data showed that after the first month of multivitamin supplementation, prevalence of severe underweight was 8.1% (n = 62) for boys on ARVs, 11.5% (n = 26) for boys not taking ARVs, 3.2% (n = 62) for girls on ARVs and 8.3% (n = 24) for girls not receving ARVs. There were no significant differences in weights of boys (p = 0.097) and girls (p = 0.661) receiving and not receiving ARVs after the first month of multivitamin supplementation.

After the second month of multivitamin supplementation, the proportions of moderately and severely underweight boys receiving the ARV were 7 and 5%, respectively while those not receiving ARV were 2 and 3%, respectively. There were no significant differences (p = 0.106) in the body weights of boys and girls receiving and not receiving ARV during the second month of multivitamin supplementation. The proportions of girls classified as moderately or severely underweight were 2 and 4% (receiving ARV) and 2% (not receiving ARV) respectively, during the third month data show that 1.6% (n = 62) of boys on ARV were severely underweight while 7.7% (n = 26) of their counterparts who were not receiving ARV were severely underweight. For the girls receiving ARV, only 3.2% (n = 62) were severely underweight while for girls not receiving ARV, no girl was severely underweight (0%, n = 24). There were no significant differences in the body weight for boys (p = 0.109) and girls (p = 0.401) who were receiving ARV and not receiving ARV during the third month. During the fourth month none of the boys receiving ARV was severely underweight (0%, n = 62), while only 3.8% of their peers not taking ARV were severely underweight (Table 6). For girls on ARV only 1% (n = 62) were severely under weight, while 4.2% (n = 24) of their counterparts not receiving ARV were severely underweight. There were no significant differences in the body weights of boys (p = 0.139) and girls (p = 0.216) in the two groups during the fourth month of the study. During the fifth month of treatment 0 % (n = 62) of boys and3.2% (n = 62) of girls receiving ARV were severely underweight while 2% (n = 26) boys and 0% (n = 24) of girls not receiving ARV were severely underweight. There were no significant differences in the body weights for boys (p = 0.210) and girls (p = 0.143) who were receiving ARV and not receiving ARV during the fifth month of intervention. Multivitamin supplementation improved the nutritional status of the children receiving ARVs. Prevalence of under nutrition decreased from 12.9 to 8.1% among boys and from 9.7 to 3.2% among girls receiving ARVs. For children not taking ARVs, there was only a slight improvement among boys (prevalence rate from 15.4 to 11.5%) but no such improvement was noted among girls (prevalence remained at 8.3%). For boys and girls receiving ARV, there was an improvement in WAZ from baseline with prevalence of severe underweight decreasing from 12.9 to 8% among boys and from 9 to 6.5% among girls. Study on multimicronutrient supplementation to Tanzanian children 6–10 y of age resulted in significantly greater weight and height gains after 6 month and improved weight-for-height *z* scores after 8 wk in children 5–11 y of age from Botswana. Among younger children, multimicronutrient supplementation had varying effects on growth (Fawzi *et al.*, 2005).

4.3.2 Distribution of HAZ for boys and girls receiving ARV and not receiving ARV during the six month study

Table 7 data showed that, only 8.1% (n = 62) of boys taking ARV were severely stunted (HAZ< -3SD) while 19.2% (n = 26) of their peers not receiving ARVs were severely stunted. For girls taking ARVs 25.8 % (n = 62) were severely stunted while about 16.7% (n = 24) of those not on ARVs were severely stunted. There was no significant difference in the body heights for boys (p = 0.45) and girls (p = 0.65) who were receiving and not receing ARVs at baseline. During the first month of supplementation prevalences of severe stunting were 8.1% (n = 62) and 19.2% (n = 26) for boys receiving and not receiving ARVs, respectively and 24.2% (n = 62) and 16.7% (n = 24) for girls receiving and not receiving ARVs respectively. The heights of boys (p = 0.24) and girls (p = 0.646) receiving and not receiving ARVs were not significantly different. In the second month of treatment there were no children receiving ARV who were severely stunted and only few boys (3.2%, n = 62) and girls (4.8%, n= 62) were classified as moderately stunted. During the third month about 8.1% (n = 62) of boys taking ARV were severely stunted while 19.2% of boys not taking ARV were severely stunted. For girls taking ARV 17.7% (n = 62) were severely stunted while those not on ARV, 16.7% (n = 24) were

Table 6: Distribution of weight for age z-scores (WAZ) for children receiving and not receiving ARVs[1]

Duration/status	ON ARV						NOT ON ARV					
	Boys		Girls		Total		Boys		Girls		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Baseline												
Normal	30	48.4	27	43.5	57	45.0	13	50.0	6	25.0	19	38
Mild	18	29.0	25	40.3	43	34.0	7	26.9	11	45.8	18	36
Moderate	6	9.7	4	6.5	10	8.0	2	7.7	5	20.8	7	14
Severe	8	12.9	6	9.7	14	11.2	4	15.4	2	8.3	6	12
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
1st Month												
Normal	31	50.0	28	45.2	59	47.5	13	50.0	6	25.0	19	38
Mild	18	29.0	25	40.3	43	34.6	8	30.8	11	45.8	19	38
Moderate	8	12.9	7	11.3	15	12.1	2	7.7	5	20.8	7	14
Severe	5	8.1	2	3.2	7	5.6	3	11.5	2	8.3	3	10
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
2nd Month												
Normal	35	56.5	32	51.6	67	54.0	12	46.2	8	33.3	20	40
Mild	15	24.2	24	38.7	39	31.0	9	34.6	12	50.0	21	42
Moderate	7	11.3	2	32	9	72.0	2	7.7	2	8.3	4	8
Severe	5	8.1	4	6.5	9	72.0	3	11.5	2	8.3	5	10
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
3rd Month												
Normal	40	64.5	33	53.2	73	58.0	13	50.0	8	33.3	21	42
Mild	10	16.1	23	37.1	33	26.0	8	30.8	12	50.0	20	40
Moderate	11	17.7	4	6.5	15	12.0	3	11.5	4	16.7	7	14
Severe	1	1.6	2	3.2	3	2.4	2	7.7	0	0	2	4
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
4th Month												
Normal	42	67.7	29	46.8	71	14.2	13	50.0	8	33.3	21	42
Mild	10	16.1	28	45.2	38	30.6	9	34.4	12	50.0	21	42
Moderate	10	16.1	4	6.5	14	11.2	3	11.5	3	12.5	6	12
Severe	0	0	1	1.6	1	0.8	1	3.8	1	4.2	2	4
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
5th Month												
Normal	44	71.0	38	61.3	82	66.0	14	53.8	10	41.7	24	48
Mild	10	16.1	21	33.9	31	0.3	7	26.9	12	50.0	19	38
Moderate	8	12.9	1	1.6	9	7.2	3	11.5	2	8.3	5	10
Severe	0	0	2	3.2	2	1.6	2	7.7	0	0	2	4
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100

[1] Normal weight for age = SD > - 1; Mild underweight = SD -1 – -1.9; Moderate underweight = SD -2 - -2.9; Severe underweight = SD < - 3.

severely stunted (Table 7). During the third month, the heights of boys receiving ARVs were significantly higher (p = 0.025) than that of their counterparts not receiving ARVs, but insignificant among girls (p = 0.733). During the fourth month of the study about 8.1% (n = 62) of the boys on ARV were severely stunted compared to 19.2% (n = 26) of their peers who were not receiving ARV. There was no significant difference in the body heights of boys (p = 0.028) who were receiving ARV and not receiving ARV. During the fifth month only 8.1% (n = 62) of boys and 12.9% (n = 62) of girls receiving ARV were severely stunted, while 19.2% (n = 26) of boys and 16.7% (n = 24) of girls not receiving ARV were severely stunted. The body heights of boys receiving and not receiving ARV were significantly different (p = 0.030). Boys who were receiving ARV were significantly ($p < 0.05$) better than their peers who were not receiving ARVs. The same trend of improvement in HAZ was observed among the girls. Based on this observation, ARV medication helped to improve growth not only in weight but also in longitudinal height.

4.3.3 Distribution of HAZ for boys and girls receiving ARV and not receiving ARV during the six month study

Table 6 data showed that at baseline 6.5% (n = 62) of girls taking ARV were severely wasted compared to those not taking ARV (8.3%, n = 24). Likewise wasting was more prevalent among boys not taking ARVs (3.8%, n = 26) than those receiving the treatment (3.2%, n = 62). Prevalence of severe wasting was 3.8% (n = 26) and 0% (n = 62) for boys

Table 7: Distribution of height for age z-scores (HAZ) for children receiving and not receiving ARVs[1]

Duration/status	ON ARV						NOT ON ARV					
	Boys		Girls		Total		Boys		Girls		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Baseline												
Normal	25	40.3	19	30.6	44	35.5	11	42.3	7	29.2	18	36
Mild	14	22.6	14	22.6	28	22.6	2	7.7	5	20.8	7	14
Moderate	18	29.0	13	21.0	31	0.3	8	30.8	8	33.3	16	32
Severe	5	8.1	16	25.8	21	17.9	5	19.2	4	16.7	9	18
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
1st Month												
Normal	24	38.7	21	33.9	45	36.2	11	42.3	7	29.2	18	36
Mild	15	24.2	12	19.7	27	21.7	4	15.4	5	20.8	9	18
Moderate	18	29.0	14	22.6	32	25.8	6	23.1	8	33.3	14	28
Severe	5	8.1	15	24.2	20	16.1	5	19.2	4	16.7	9	18
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
2nd Month												
Normal	29	46.8	23	37.1	52	41.9	11	42.3	7	29.2	18	36
Mild	10	16.1	10	16.1	20	16.1	4	15.4	6	25.0	10	20
Moderate	18	29.0	18	29.0	36	29.0	6	23.1	7	29.2	13	26
Severe	5	8.1	11	17.7	16	12.9	5	19.2	4	16.7	9	18
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
3rd Month												
Normal	29	46.8	23	37.1	52	41.9	11	42.3	6	25.0	17	34
Mild	10	16.1	10	16.1	20	16.1	4	15.4	7	29.2	11	22
Moderate	18	29.0	18	29.0	3	2.9	6	23.1	7	29.2	19	26
Severe	5	8.1	11	17.7	16	12.9	5	19.2	4	16.7	9	18
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
4th Month												
Normal	29	46.8	24	38.7	53	42.7	11	42.3	7	29.2	18	36
Mild	14	22.6	9	14.5	23	18.5	5	19.2	6	25.0	11	22
Moderate	14	22.6	19	30.6	33	26.6	5	10	7	14.0	12	24
Severe	5	8.1	10	16.1	15	12.1	5	19.2	4	16.7	9	18
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
5th Month												
Normal	31	50.0	24	38.7	55	44.0	11	42.3	7	29.2	18	36
Mild	13	21.0	10	16.1	23	18.5	5	19.2	6	25.0	11	22
Moderate	13	21.0	20	32.3	33	26.6	5	19.2	8	33.3	13	26
Severe	5	8.1	8	12.9	13	10.5	5	19.2	3	6.0	8	16
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100

[1] Normal height for age = SD > - 1; Mild stunting = SD -1 – -1.9; Moderate stunting = SD -2 - -2.9; Severe stunting = SD < - 3.

not receiving and receiving ARVs and 1.6% (n = 62) and 0% (n = 24) for girls receiving and not receiving ARVs. Wasting was more prevalent among boys not taking ARVs (3.8%, n = 26) than those receiving the treatment (3.2%, n = 62). Similar trends showing higher prevalence of wasting (WHZ) and stunting (HAZ) among children not receiving ARV than those receiving ARV was observed (Table 8). There were no children receiving ARV who were severely wasted and only few boys (3.2%, n = 62) and girls (4.8%, n= 62) were classified as moderately wasted. A similar low prevalence of wasting was observed among boys and girls not receiving ARV. In the third month less boys receiving ARV were moderately wasted (0%, n = 62) compared to their peers not receiving ARV (3.8%, n = 26). None of the boys in either group was severely wasted. For the girls on ARV, 3.2% (n = 62) were moderately wasted while 4.2% (n = 24) of the girls not receiving ARV were moderately wasted. Regarding wasting in the fourth month 1.6% (n = 62) of boys and 6.5% (n = 62) of girls receiving ARV were moderately wasted while 3.8% (n = 26) of boys and 8.3% (n = 24) of girls not receiving ARV were moderately wasted. Neither boys nor girls receiving or not receiving ARV were severely wasted. In the fifth month, none of the children receiving and not receiving ARV was severely wasted. However, 1.6% (n = 62) of boys and 3.2% (n = 62) of girls receiving ARV and 3.8% (n = 26) of boys and 0% (n = 24) of girls not receiving ARV were moderately wasted. Study on ARV treatment found that there was an improved child immunity through micronutrient supplementation decrease the incidence and severity of HIV infection that adversely affected growth. Treatment with ARV regimens significantly affected weight and weight-for-height ratio and had a marginal effect on height (Fawzi *et al*., 2005).

Table 8: Distribution of weight for height z-scores (WHZ) for children receiving and not receiving ARVs[1]

Duration/status	ON ARV						NOT ON ARV					
	Boys		Girls		Total		Boys		Girls		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Baseline												
Normal	55	88.7	54	87.1	109	87.9	19	73.1	18	75.0	37	74
Mild	5	8.1	4	6.5	9	7.2	6	23.1	9	16.7	10	20
Moderate	0	0	0	0	0	0	0	0	0	0	0	0
Severe	2	3.2	4	6.5	6	4.8	1	3.8	2	8.3	3	6
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
1st Month												
Normal	55	88.7	53	85.5	108	87.1	19	73.1	17	70.8	36	72
Mild	5	8.1	6	9.7	11	8.8	6	23.1	6	25.0	12	24
Moderate	2	3.2	2	3.2	4	3.2	0	0	1	4.2	1	2
Severe	0	0	1	1.6	1	0.8	1	3.8	0	0	1	2
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
2nd Month												
Normal	56	90.3	53	85.5	109	87.9	23	88.5	19	79.2	42	84
Mild	4	6.5	6	9.7	10	8.1	2	7.7	4	16.7	6	12
Moderate	2	3.2	3	4.8	5	4.0	0	0	1	4.2	1	2
Severe	0	0	0	0	0	0	1	3.8	0	0	1	2
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
3rd Month												
Normal	61	98.4	54	87.1	115	92.7	20	76.9	20	83.3	40	80
Mild	1	1.6	6	9.7	7	5.6	5	19.2	3	12.5	8	16
Moderate	0	0	2	3.2	2	1.6	1	3.8	1	4.2	2	4
Severe	0	0	0	0	0	0	0	0	0	0	0	0
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
4th Month												
Normal	60	96.8	56	90.3	116	93.5	21	80.8	18	75.0	39	78
Mild	1	1.6	2	3.2	3	2.4	4	15.4	4	16.7	8	16
Moderate	1	1.6	4	6.5	5	4.0	1	3.8	2	8.3	3	6
Severe	0	0	0	0	0	0	0	0	0	0	0	0
Overall	62	100.0	62	100.0	124	100.0	26	100.0	24	100.0	50	100
5th Month												
Normal	60	96.8	60	96.8	120	91.0	24	92.3	22	91.7	46	92
Mild	1	1.6	0	0	1	0.8	1	3.8	2	8.3	3	6
Moderate	1	1.6	2	3.2	3	2.4	1	3.8	0	0	1	2
Severe	0	0	0	0	0	0	0	0	0	0	0	0
Overall	62	100.	62	100.	124	100.	26	100.	24	100.	50	10

	0	0	0	0	0	0

[1] Normal weight for height = SD > - 1; Mild wasting = SD -1 – -1.9; Moderate wasting = SD -2 - -2.9; Severe wasting = SD < - 3.

4.3.4 Summary of percent prevalence of WAZ, HAZ and WHZ among HIV+ boys and girls receiving and not receiving ARV from baseline to 5th month

In Table 9a, prevalence of moderate underweight for boys on ARV increased from 9.7 to 12.9% at the end of the study period, while their counterparts not receiving ARVs, prevalence of underweight increased from 7.7% at baseline to 11.5% at the end of the study. For girls receiving ARVs, prevalence of moderate underweight remained almost stable from baseline (6.5%) to the end of the study (6.1%), while their peers not receiving ARV, prevalence of moderate under nutrition decreased dramatically from 20.8% at baseline to 8.3% at the end of the study. For the severe underweight, boys receiving ARVs were better than their peers not receiving ARVs. For boys receiving ARVs prevalence of severe underweight decreased from 12.9% at baseline to 0% at the end of the study, while for their counterparts not receiving ARVs, the prevalence of severe underweight decreased from 15.4% (baseline) to 7.7% (end of study). The trends in the prevalence of moderate and severe underweight cases was echoed by the proportion of the children who changed to normal nutritional status. For boys receiving ARVs, the proportion of children classified as normal, increased from 48.4% (baseline) to 71.0% (end of study) while for their peers not receiving ARVs, the proportion increased from 50.0% at baseline to 53.8% at the end of study. For girls receiving the ARVs the proportion of children classified as normal increased from 43.5% at baseline to 61.3% at the end of the study, while their counterpart girls not receiving ARVs, the proportion increased from 25.0% (baseline) to 41.7% (end of the study). Although both groups of children receiving and not receiving ARVs showed improvement of weight for age over the study period, those receiving ARVs were slightly superior, though not significantly. Table 9b summarizes the percent prevalence of wasting among the HIV + boys and girls receiving and not receiving ARVs. Prevalence of wasting was generally low for both groups and there was only a small change over the 5 months study period. For boys receiving ARVs moderate wasting increased slightly from 0.0% at baseline to 1.6% at the end of the study. A similar trend was observed for boys not receiving ARVs whereby prevalence of moderate wasting increased from 0.0% at baseline to 3.8% at the end of the study. A similar trend of prevalence of moderate wasting was observed among girls.

Table 9 (a): Summary of percent prevalence of underweight (WAZ), among HIV positive boys and girls receiving and not receiving ARV from baseline to 5th month of the study

Time period	Moderate SD= -2 – 2.9				Severe SD = < -3				Normal SD = >-1			
	On ARV		No ARV		On ARV		No ARV		On ARV		No ARV	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Baseline	9.7	6.5	7.7	20.8	12.9	9.7	15.4	8.3	48.4	43.5	50.0	25.0
1st Month	12.9	11.3	7.7	20.8	8.1	3.2	11.5	8.3	50.0	45.2	50.0	25.0
2nd Month	11.3	3.2	7.7	8.3	8.1	6.5	11.5	8.3	56.5	51.6	46.2	33.3
3rd Month	17.7	6.5	11.5	16.7	1.6	3.2	7.7	0.0	64.5	53.2	50.0	33.3
4th Month	16.1	6.5	11.5	12.5	0.0	1.6	3.8	4.2	67.7	46.8	50.0	33.3
5th Month	12.9	6.1	11.5	8.3	0.0	3.2	7.7	0.0	71.0	61.3	53.8	41.7

Regarding severe wasting, both boys and girls receiving and not receiving ARVs showed a similar trend and none of the children in either group were severely wasted at the end of the study. Likewise the proportion of boys and girls classified as not wasted (normal) increased in the same rate for those receiving and not receiving ARVs. Overall, use of

ARVs did not appear to influence the prevalence of moderate or severe wasting among the HIV+ boys and girls receiving and not receiving the ARVs (Table 9b). Regarding the prevalence of stunting among the HIV+ boys and girls, Table 9c showed that, prevalence of moderate stunting among boys receiving ARVs decreased from 29.0% at baseline to 21.0% at the end of the study; while their counterparts not receiving ARVs prevalence of moderate stunting decreased from 30.8% (baseline) to 19.2% (end of study). Conversely, prevalence of moderate stunting for girls receiving ARVs increased from 21.0% (baseline) to 32.3% (end of study) while their peers not receiving ARVs had prevalence of moderate stunting remained almost constant at 33.3% from baseline to the end of the study. Regarding prevalence of severe stunting, boys receiving and not receiving ARVs had constant prevalence of stunting from baseline to the end of study.

Table 9(b): Summary of percent prevalence of wasting (WHZ), among HIV positive boys and girls receiving and not receiving ARV from baseline to 5th month of the study

Time period	% Moderate wasting SD= -2 – 2.9				% Severe wasting SD = < -3				% Normal SD = >-1			
	On ARV		No ARV		On ARV		No ARV		On ARV		No ARV	
	Boys N=62	Girl n=62	Boys n=26	Girl n=24	Boys n=62	Girl n=62	Boys n=26	Girl n=24	Boys n=62	Girls n=62	Boys n=26	Girls n=24
Baseline	0.0	0.0	0.0	0.0	3.2	6.5	3.8	8.3	88.7	87.1	73.1	75.0
1st Month	3.2	3.2	0.0	4.2	0.0	1.6	3.8	0.0	88.7	85.5	73.1	70.8
2nd Month	3.2	4.8	0.0	4.2	0.0	0.0	3.8	0.0	90.3	85.5	88.5	79.2
3rd Month	0.0	3.2	3.8	4.2	0.0	0.0	0.0	0.0	98.4	87.1	76.9	83.3
4th Month	1.6	6.5	3.8	8.3	0.0	0.0	0.0	0.0	96.8	90.3	80.8	75.0
5th Month	1.6	3.2	3.8	0.0	0.0	0.0	0.0	0.0	96.8	96.8	92.3	91.7

For girls on ARVs, prevalence of severe stunting decreased from 25.8% at baseline to 12.9% at the end of study, however, their counterparts who were not receiving ARVs had a constant prevalence rate (16.7%) from the baseline to the end of the study. Overall, the prevalence of boys and girls who were classified as not stunted (normal) increased from 40.3 – 50.0% (boys on ARV) and from 30.6 – 38.7% (girls on ARV) while the boys and girls not receiving ARVs, the prevalence of normal children remained constant at 42.3% for boys and 29.2% for girls. ARVs therefore appeared to have a beneficial effect on the height gain of the children.

Table 9(c): Summary of percent prevalence of stunting (HAZ), among HIV + boys and girls receiving and not receiving ARV from baseline to 5th month of the study

Time period	% Moderate stunting SD= -2 – 2.9				% Severe stunting SD = < -3				% Normal SD = >-1			
	On ARV		No ARV		On ARV		No ARV		On ARV		No ARV	
	Boys n=62	Girls n=62	Boys n=26	Girls n=24	Boys n=62	Girls n=62	Boys n=26	Girls n=24	Boys n=62	Girls n=62	Boys n=26	Girls n=24
Baseline	29.0	21.0	30.8	33.3	8.1	25.8	19.2	16.7	40.3	30.6	42.3	29.2
1st Month	29.0	22.6	23.1	33.3	8.1	24.2	19.2	16.7	38.7	33.9	42.3	29.2
2nd Month	29.0	29.0	23.1	29.2	8.1	17.7	19.2	16.7	46.8	37.1	42.3	29.2
3rd Month	29.0	29.0	23.1	29.2	8.1	17.7	19.2	16.7	46.8	37.1	42.3	25.0
4th Month	22.6	30.6	10.0	14.0	8.1	16.1	19.2	16.7	46.8	38.7	42.3	29.2
5th Month	21.0	32.3	19.2	33.3	8.1	12.9	19.2	16.7	50.0	38.7	42.3	29.2

4.3.5 Growth patterns of boys and girls receiving and not receiving ARVs

Figure 1 indicates the growth pattern in height of HIV+ boys and girls receiving and not receiving ARVs. Figure 1 shows that boys receiving ARV had an average height growth rate of 0.79 m per month while their peers not receiving ARV treatment had average height growth of 0.3 m per month. A height growth spike was noted between the baseline and the 2nd month of treatment for both boys receiving and not receiving ARVs. This could be attributed to the multivitamin supplement. Studies of intervention programmes with high nutrient dense foods have shown a similar ‘’spike’’ effect in weight and height gain

(Mosha and Bennink, 2003). For girls receiving ARV, the height growth rate was 0.30 m per month while those not receiving ARVs had height growth rate of 0.23 cm per month. For the girls, there was no significant difference in height growth rate among girls receiving and not receiving ARVs. Also the initial spike in height gain observed among the boys was not depicted among the girls.

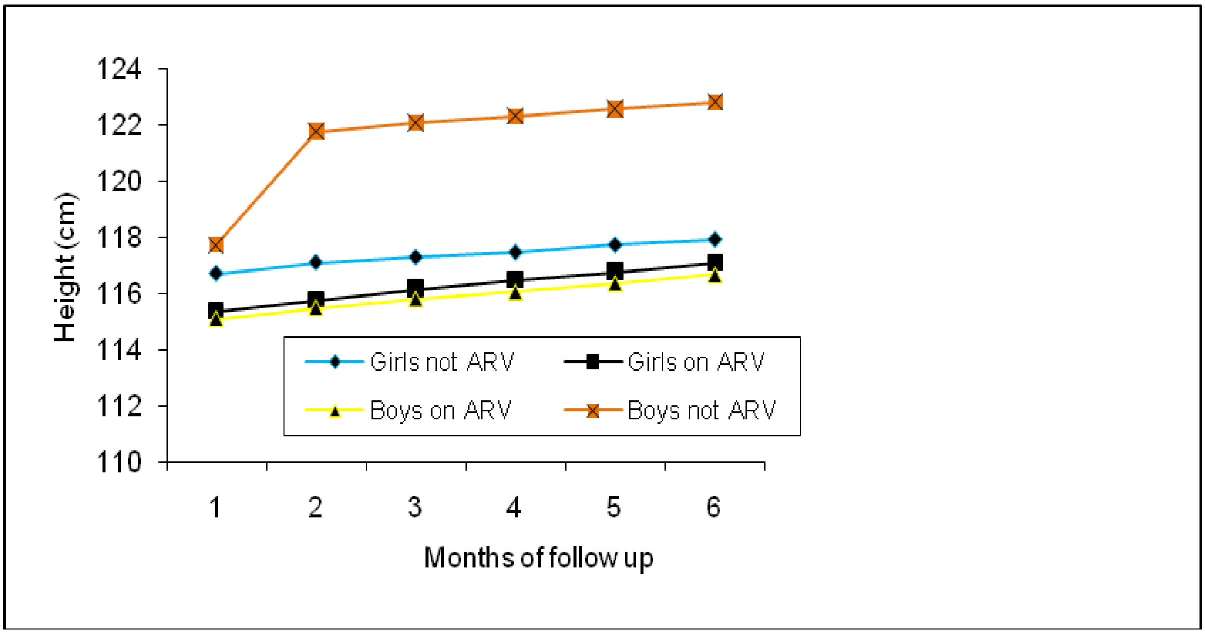

Figure 1: Growth trend in height of boys and girls receiving and not receiving ARV

Figure 2 indicates the growth pattern in weight of HIV+ boys and girls receiving and not receiving ARVs. In Figure 2, the HIV+ boys receiving ARV had an average weight gain rate of 0.35 kg per month while those not receiving ARV had an average weight gain rate of 0.28 kg per month. The weight gain per month was therefore not significantly different ($p > 0.05$) for boys receiving and not receiving ARVs. For the girls receiving ARVs the average weight gain rate was 0.49 kg per month while for those not receiving ARVs had an average weight gain of 0.16 kg per month. On average, girls receiving ARV had significantly ($p < 0.05$) higher rate of weight gain per month than their counterparts who were not receiving ARVs.

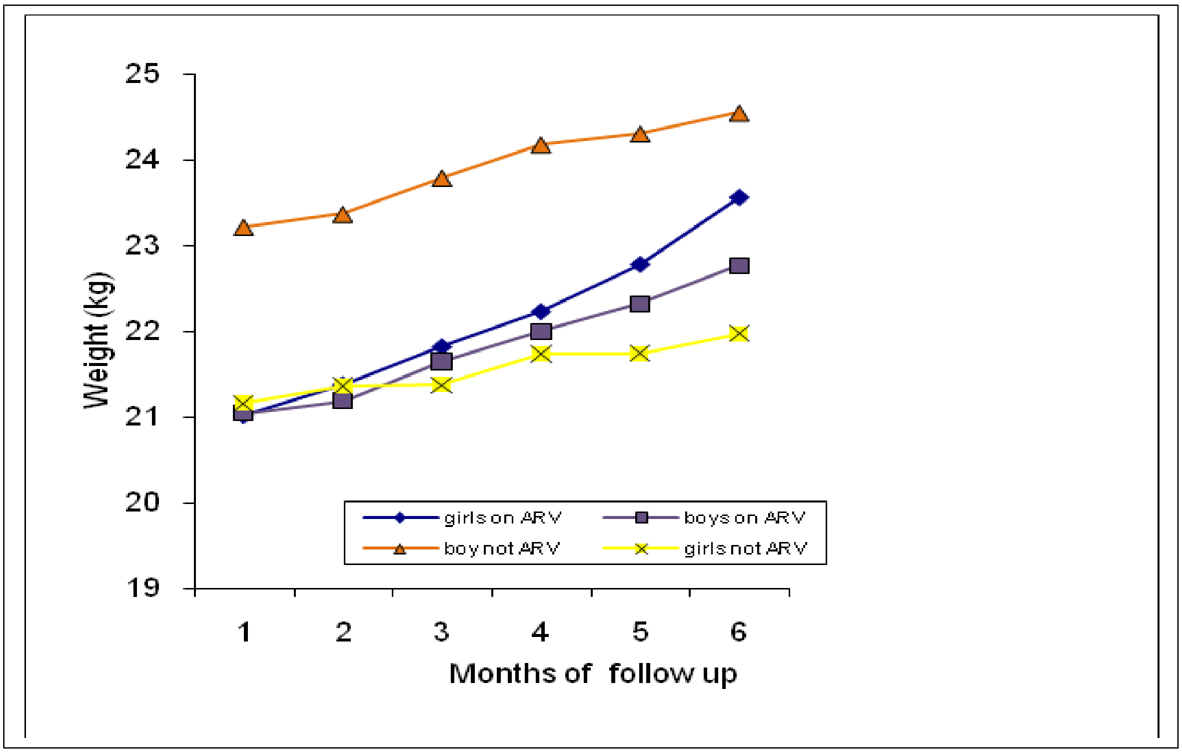

Figure 2: Growth trend in weight of boys and girls receiving and not receiving ARV

Generally, children receiving and not receiving ARV followed a similar pattern of growth. Children receiving ARV had slightly higher (not significant) height and weight z-scores compared to their peers not receiving ARVs. Derek (2006) reported a similar trend in growth in weight and height among HIV+ children from a study of HIV positive children in Kenya.

4.4 Dietary Intake

Dietary intake of energy and nutrients for children aged 5 to 10 years were 1192.8 ± 304.4 kcal which ranged from 678.0 to 2360 kcal. This indicated that, most children in the study received daily energy intake below the recommended daily intake of 1710 kcal per day for 5 year old children. The mean dietary intake of protein was 25.97 ± 7.50 g (range 10.04 to 50.40 g). The amount of protein consumed was lower than the recommended daily intake of 20 g for 5- 10 year old children and 50 g. Mean dietary intake of fat was 34.47± 10.88 which ranged from (12.46 to 55.06) which suggested that the children in the study ate less fat than recommended. The recommended daily intake of fat for 5year old child is 48g while for 10year old child is 52g. The mean intake of iron was 8.21± 2.21mg which ranged from (5.01 to 19.06 mg). The recommended daily intake of iron is 19 mg for a 5 year old child and 23 mg for a 10 year old child. Dietary iron intake was therefore below the recommended levels. The average daily intake of calcium was 7.47 ± 2.81g range from (4.33 to 26.56 mg). The recommended daily intake of calcium for 5 year old children is 0.5g and 1.3g for children aged 10 years. The dietary calcium intake was thus higher than the recommended amounts.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study showed that use of ARV in HIV positive children did not result in significant increase in growth at each month of treatment; there was slight variation in weight and height gain among study children. The ARVs intake resulted into an increase in CD4 count for children receiving the treatment. Dietary approach including supplementation with multivitamin and minerals should be emphasized in the management of HIV + children, nutritional improvement is just as good as ARV in improving the WA, WH and

HA z-scores of the HIV+ children.

5.2 Recommendations

Caregivers should try to meet balanced diets for children in order to improve their nutritional status. Also provision of ARVs for children should be done at the extreme situation, but dietary approach should be emphasized. The general public, non governmental organizations and the government should support nutritional based initiatives to care and support children infected with HIV/AIDS.

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APPENDIX

Appendix 1: Questionnaire on nutritional status and growth pattern of HIV positive children receiving and not-receiving anti retroviral treatment in Dar Es Salaam, Tanzania.

QUESTIONNAIRE 1: CHILD INFORMATION

A: General information

1. Participant ID ……………………
   Visit Code ……………………
   Date of visit ……………………

2. Gender
   1. Female
   2. Male

3. Age/Date of birth [ ] years [ ] day [ ] month [ ] year

B: GROWTH PARAMETERS AND INDICES

4. Weight (kg)

5. Height (cm)

C: ARV Medication

6. Is the subject taking any ARV Drugs?
   1. = Yes (Go to question 14)
   2. = No (If no, STOP)
7. Given ....

   Not given ....

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

D: Diet History

10. 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	Amt/Portion

11. How many time per week do you eat meals with your family?

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

13. If yes: 1. At least once/day ……………………………..
2. At least 2-3 times/week ……………………………..
3. At least once/week ……………………………..

14. Please specify the type of dietary supplements, vitamins, minerals that you take.

……………………………………. ……………………………………

……………………………………. …………………………………….

THANK YOU FOR YOUR ESTEEMED COOPERATION.

QUESTIONNAIRE II: GENERAL GUARDIAN'S INFORMATION

1. Guardians ID ……………………………
   Date visited ……………………………

2. Age of the guardian
   1. Under 14 years
   2. Between 15 – 19 years
   3. Between 20 – 35
   4. Between 36-40 years
   5. Between 41- 50 years
   6. Above 51 years.

3. Marital status
   1. Unmarried
   2. Married – monogamous
   3. Married – polygamous
   4. Widowed
   5. Divorced

4. Highest level of education attained
   1. Did not go to school
   2. Adult education
   3. Primary education
   4. Secondary education
   5. University education

5. Occupation of the guardian
   1. Farmer
   2. Employed in public sector
   3. Unemployed
   4. Business
   5. Other occupation.

6. How much do you earn per month
   1. Below 10,000
   2. Between 10,000 – 20,000
   3. Between 20,000 – 30,000
   4. Between 40,000 – 50,000
   5. Above 50,000

7. What is the major source of income for your family?
   1. Salary/wages
   2. Sales of crop produce
   3. Sales of livestock
   4. Petty business
   5. Casual labour
   6. Others (Specify).