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DIETARY INTAKE PATTERNS AND ADEQUACY OF HIV-INFECTED ADULTS SEEKING CLINICAL CARE IN ACCRA, GHANA

BY

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DECRARATION

I Akasoe Bismark Abingyoure declare that this thesis "Dietary intake patterns and adequacy of HIV-infected adults seeking clinical care in Accra, Ghana" was done by me under the supervision of Dr. Aryeetey Richmond Nii Okai. This dissertation, either in whole or in part has not been presented elsewhere for another degree. All references cited in this work have, however, been fully acknowledged.

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DEDICATION

I dedicate this work to my wife Mrs Akasoe Agnes Atubobire, to my children Akasoe Clifford Atariguriba and Akasoe Blessing Asumah and Dr. Awekeya Philip Nsor for your prayers and support. May the Almighty God richly bless all of you.

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ABSTRACT

Although access to highly active antiretroviral therapy has expanded rapidly and led to effective reduction in HIV/AIDS related morbidities and mortalities, inadequate dietary intake and food insecurity are barriers to the success of the therapy. Few studies have reported on the association between dietary intake coupled with food security and HIV in Ghana. This study describes dietary practices of HIV-infected adults on ART in Ghana. The study collected data on demographic characteristics and 24-hour dietary recall. The Statistical Package for the Social Science Sciences (SPSS) was used to summarize socio-demographic characteristics and dietary intake patterns of respondents into frequencies and proportions. The Food and Nutrition Technical Assistance (FANTA) Household Dietary Diversity Score version 2 was used as basis for describing dietary diversity of respondents, while the quality of diet based on the nutritive values of food consumed by respondents was determined by using ESHA FPRO version 10.0.1. In the case of the adequacy of nutrient intake, Recommended Dietary Allowance (RDA) values were employed as reference in the analysis. The findings indicated that lunch was commonly skipped, about 20% of the respondents ate less than 3 meals per day and 16% had low diverse diets. Total daily mean nutrient intakes among the respondents were: calories (2190.1±969.67), carbohydrates (315.34±166.42), proteins (79.18±39.16), fats (69.80±45.94), vitamin A (707.46±1735.90), vitamin C (88.21±123.45), iron (19.93±14.75), folate (130.55±135.37), iodine (19.59±27.94) and zinc (1.86±1.67). Mean nutrients intakes were compared with the RDA to determine their levels of intake. The mean intake of calories, carbohydrates, proteins, vitamin A, vitamin C and iron were adequate whiles that of fats, folate, iodine and zinc were low. Except for proteins (26%) and iron (41%), the majority of the respondents had high inadequate intake of calories (62%), carbohydrates (61%), fats (63%), vitamin A (85%), folate (96%), vitamin C (61%), iodine (99.6%), and zinc (99%). There is unmet need of multiple nutrient intakes among PLHV, the study therefore recommends multiples approaches that include: counseling to PLHV by the staff of ART, fevers units and clinics in the country and food security strategies for the PLHV, by supporting local organizations such as Ghana Health Service, Christian Health Association of Ghana, Ghana AIDS Commission, non-governmental organizations and the government of Ghana.

TABLE OF CONTENTS

Title **PAGE**

CHAPTER FOUR

CHAPTER FIVE

CHAPTER SIX

LIST OF TABLES

LIST ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ANOVA	Analysis of Variance
ART	Anti-retroviral Therapy
ARV	Anti-retroviral Treatment
CD4	Cluster of differentiation 4
ESHA Fpro	ESHA Food Processor
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
HDDS	Household Dietary Diversity Score
HIV	Human Immunodeficiency Virus
PLHV	People Living with HIV
PLWHA	People Living With HIV/AIDS
RDA	Recommended Dietary Allowance
SPSS	Statistical Package for the Social Sciences
UL	Tolerable Upper Intake Level
USAID	United States Agency for International Development
UNAIDS	The Joint United Nations Programme on HIV and AIDS
UNICEF	United Nations Children’s Fund
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Global incidence of HIV infection has stabilized and began to decline in many countries. Ironically, the number of people receiving antiretroviral therapy continues to increase. The global efforts towards achieving universal access to HIV prevention, treatment, care and support for all HIV-infected persons have led to the decline in the disease and the increase in antiretroviral therapy (WHO,UNAIDS & UNICEF, 2011).

In Ghana, a generalized epidemic has been described, reporting the national HIV infection prevalence of 2.1% in 2011, with wide variations among regions, districts and communities (Ghana AIDS Commission, 2012). The incidence of the disease infection in Ghana is declining, while the number of people receiving antiretroviral therapy is rising. Currently, the percentage of both adults and children receiving ART in the country is 52%(Ghana AIDS Commission, 2012). An important aspect of care and support for persons living with HIV is the assurance of adequate nutritional status. Adequate nutrition is a known predictor of optimal treatment outcomes in HIV/AIDS (Onyango, Walingo, Mbagaya, & Kakai, 2012).

A complex biological interaction has been described between HIV-infection, immune function, antiretroviral drugs and nutritional status (Onyango *et al.,* 2012;Koethe, Chi, Megazzini, Heimburger, & Stringer, 2009). HIV-infected persons often cite food as one of their greatest needs (USAID Bureau for Democracy *et al.,* 2007).The ability of HIV-infected persons to physically acquire food is daunting because they suffer loss of livelihood as a result of stigma and loss of capacity in severe illness. The spread of HIV throughout the Sub-Sahara African region is complicated by underlying insufficient food resources, exposure to other infections which precipitate malnutrition and inadequate access to antiretroviral therapy(Koethe *et al.,* 2009). It has been demonstrated that adequate dietary intake of People Living With Human Immunodeficiency Virus (PLHIV) increases ART acceptability and adherence, culminating into the success of the ART programs (Weiser *et al.,* 2010). Moreover, adequate dietary intake is known to improve nutritional status of PLHIV by potentiating their immune systems and thus their quality of life (Colecraft, 2008;Houtzager, 2009).

HIV-infection and related infections synergistically lead to increased nutritional needs. Studies have shown that low energy intake combined with increased energy demands due to HIV infection and related infections are the major causes of HIV-related weight loss and wasting (Hsu, Pencharz, Macallan, & Tomkins, 2005;Koethe *et al.,* 2009). It is recommended that dietary energy intake of HIV-infected adults, be raised by 10% over recommended dietary consumption levels for people without HIV-infection in order to maintain optimal body weight (WHO, 2003).

Adequate dietary intake is, however difficult to achieve by many HIV-infected persons who suffer loss of livelihood as a result of stigma and loss of capacity in severe illness. As a result, HIV is often associated with inadequate intake of many essential nutrients including dietary energy, iron, folate, and vitamin A (A. C. Onyango *et al.,* 2012). Adequate food intake and dietary diversity of PLHIV are affected by household food insecurity situation in Ghana (Akrofi, Brouwer, Price, & Struik, 2010).

1.2 Problem statement

Although the need to ensure adequate food security and nutrition support for HIV-infected persons has been recognized and highlighted by previous studies, there is insufficient information on dietary intake patterns and diet adequacy in Ghana among people with HIV. Addo *et al.,* (2010) reported that among a small sample of HIV seropositive and seronegative lactating women, although, protein, iron, zinc, and vitamin A intakes were adequate, energy, thiamin, and riboflavin were limiting in their diets. Moreover, Wiig and Smith, (2007) reported that, in a sample of 50 HIV seropositive adults seeking care from Korle-Bu Hospital, there was low intake of vegetables and fruits (less than three servings per day). There is need therefore to, further explore the gaps in knowledge regarding dietary intake adequacy and also the patterns, for more understanding, as these can influence nutritional status and health of PLHIV(WHO, 2003).

1.3 Justification

This study will provide evidence to support recommendations for dietary support and nutritional management of HIV-infected adults on ART in Ghana. Knowledge about dietary intake patterns and nutritional adequacy of diets of PLHIV in Ghana will be useful for determining risk of malnutrition among PLHIV and on ART.

1.4 OBJECTIVES

1.4.1 General objective

To determine dietary intake patterns and adequacy among HIV-infected adults seeking clinical care in Accra.

1.4.2 Specific objectives

1. To describe dietary intake patterns among HIV-infected adults seeking clinical care in Accra.
2. To estimate the mean intake of calories, carbohydrates, proteins, fats, vitamin A, folate, vitamin C, iodine, iron and zinc among HIV-infected adults seeking clinical care in Accra.
3. To determine the adequacy of calories, carbohydrates, proteins, fats, vitamin A, folate, vitamin C, iodine, iron and zinc among HIV-infected adults seeking clinical care in Accra.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The HIV epidemiology

Since its recognition in 1981, the HIV/AIDS epidemic has remained one of the major public health challenges globally. Presently, it is estimated that 34 million people are living with HIV worldwide(De Cock, Jaffe, & Curran, 2012). The occurrence of the HIV epidemic varies among countries, regions and sub-regions. The global prevalence has stabilized at 0.8%. Currently, 34 million people live with HIV/AIDS and 2.7 million new infections occurred in 2011(WHO, UNAIDS and UNICEF, 2011;UNAIDS, 2012).

Due to global efforts towards achieving universal access to HIV prevention, treatment, care and support for all PLHIV by the end of 2010, there was worldwide increased uptake of HIV testing and counseling which is crucial for appropriate referral and treatment. Coverage of counseling and testing among 87 reporting countries increased from 64 million in 2009 to 72 million by the end of 2010(WHO, UNAIDS and UNICEF, 2011). The major worldwide key indicator of expanding health system capacity to deliver treatment to HIV infected persons is the health care facilities providing antiretroviral therapy. The number of health facilities providing antiretroviral therapy has expanded from 7,700 in 2007 to 22,400 at the end of 2010(WHO, UNAIDS and UNICEF, 2011). The expansion of the antiretroviral therapy facilities has led to increase access to antiretroviral treatment. Coverage in low and middle-income countries has increased from 400,000 in 2003 to 6.65 million at the end of 2010(WHO, UNAIDS and UNICEF, 2011). The introduction and expansion of antiretroviral therapy have averted majority of deaths due to AIDS-related causes. Globally, the annual number of people dying from AIDS-related causes is steadily decreasing from a peak of 2.2 million in 2005 to 1.8 million in 2010(WHO, UNAIDS and UNICEF, 2011). In low-and middle-income countries the introduction of antiretroviral therapy since 1995 has averted 2.5 million deaths(WHO, UNAIDS and UNICEF, 2011). The number of people dying as a result of AIDS-related causes began to decline in the mid-2000s because of scaled-up antiretroviral therapy and in 2011, this decline continued, with evidence that the drop in the number of people dying from AIDS-related causes is accelerating in several countries. In 2011, 1.7 million people died from AIDS-related causes worldwide. This represented a 24% decline in AIDS-related mortality compared with 2.3 million deaths in 2005(UNAIDS, 2012).

The scaling up of antiretroviral therapy in low and middle-income countries has transformed national AIDS responses and generated broad-based health gains. Since 1995, antiretroviral therapy has saved 14 million life-years in low and middle-income countries, including 9 million in sub-Saharan Africa. As the programmatic scale-up continued, health gains have accelerated, with the number of life-years saved by antiretroviral therapy in sub-Saharan Africa quadrupling(UNAIDS, 2012). The experience also illustrates the macroeconomic and household livelihood benefits of expanded treatment access, with employment prospects and quality of life sharply increasing among individuals receiving antiretroviral therapy(UNAIDS, 2012).

In the Africa region, Sub-Saharan Africa remains most severely affected with an estimated 4.9% of adults living with HIV and contributing 69% to the world's population of PLHIV(WHO, UNAIDS and UNICEF, 2011). Between 2001 and 2009, the incidence of HIV infection has however, declined in Sub-Saharan Africa with new infections estimated to be 1.9 million by the end of 2010. This was 16% lower than the estimated newly HIV infected people at the end of 2001 which was 2.2 million and also was 26% lower than the peak new infections in 1997(WHO, UNAIDS and UNICEF, 2011). New infection in Sub-Saharan Africa by the end of 2011 was estimated to be 1.8 million people with adults and children accounting for 71% of these newly infected cases, thus, underscoring the importance of continuing and strengthening HIV prevention efforts in the region(UNAIDS, 2012).

Many adults (about 1 million) die annually in Sub-Saharan Africa as a result of HIV/AIDS related causes. The highest number of people dying in Sub-Saharan Africa due to AIDS-related causes was 1.7 million in 2005. However, the introduction of free of charge antiretroviral therapy in the region has averted about 1.8 million HIV/AIDS related deaths with the number of people dying from AIDS-related causes began to decline in 2005-2006 and has continued subsequently(WHO, UNAIDS and UNICEF, 2011). The trends of decline in HIV/AIDS related deaths in Sub-Saharan African have been reported similarly in other areas.

Although the region still accounted for 70% of all the people dying from AIDS by the end of 2011, the introduction of antiretroviral therapy and the global efforts towards achieving universal access to HIV prevention, treatment, care and support for all HIV-infected persons have made great progress in averting deaths due to HIV/AIDS related causes (UNAIDS, 2012). An estimated 3 million HIV infected people in low-and middle-income countries were receiving antiretroviral therapy at the end of 2007 with Sub-Saharan Africa accounting for about 2 million people. And at the end of 2008 there was an estimated increased of 38% HIV infected people receiving antiretroviral therapy in the region(Souteyrand *et al.,* 2009).

The HIV epidemic in Ghana is considered as a generalized epidemic with national prevalence at 2.1% by the end of 2011(Ghana AIDS Commission, 2012). Although the estimated adult national HIV prevalence in the country is declining, it is still high. In 2007, the estimated adult HIV prevalence in Ghana was 1.9% and declined to 1.5 by the end of 2011(Ghana AIDS Commission, 2012). The absolute figures of new infections declined significantly from 23,236 by the end of 2009 to 12,077 by the end of 2011(Ghana AIDS Commission, 2012).

As the HIV prevalence in the country decrease, the number of deaths due to HIV/AIDS related causes also decline. The estimated HIV/AIDS related deaths by the end of 2008 were 180,899. However, there was significant reduction in the number by the end of 2011 which was 15,263(Ghana AIDS Commission, 2012).

Comparatively, the epidemiological trends indicate that HIV infection prevalence in Ghana is considerably lower than other Africa countries. However, as HIV infection prevalence in the country decreases the number of people receiving antiretroviral treatment among other priority interventions continuous to increase(WHO, UNAIDS and UNICEF, 2011). Studies have also shown that HIV new infections and deaths due HIV/AIDS related causes will decrease considerably by the year 2015 because of national response to the HIV/AIDS epidemic in Ghana which focuses on expanding access to antiretroviral therapy and HIV general services throughout the country(Ghana AIDS Commission, 2012). The national response to the HIV epidemic in the country has made available among other priority interventions, antiretroviral treatment and this has reduced HIV/AIDS related morbidity and mortality(National HIV/AIDS/ STI Control Programme, Ministry of Health / Ghana Health Service, 2008).

Currently, there is increased accessibility and adherence to antiretroviral therapy and general HIV services in the country with antiretroviral coverage for adults increasing from 35.3% in 2008 to 58.2% in 2011. The increased accessibility and adherence to antiretroviral therapy coupled with elevated uptake of counseling and testing are good opportunities for appropriate referral and treatment thus ensuring more effective and efficient response to the spread of the HIV epidemic in the country(Ghana AIDS Commission, 2012). The national response to the HIV epidemic in the country however, lags behind comprehensive care for HIV-infected persons receiving antiretroviral therapy because of inadequate investment in ensuring adequate dietary intake and nourishment of HIV infected individuals(WHO, 2004).

2.2 Nutrition situation of PLHIV globally and Ghana

Despite success at global level in achieving universal access to HIV prevention, treatment, care and support in both developed and developing countries, undernutrition among PLHIV remains unacceptably high(Ivers *et al.,* 2009). Over 800 million people remain chronically undernourished worldwide. Out of this number, HIV/AIDS-related malnutrition is accounting for 33 million people thus posing a major challenge to global efforts' response to the HIV epidemic(Ivers *et al.,* 2009). Wasting is a major problem associated with HIV-infected adults worldwide. As BMI decreases below 18.5 among HIV-infected adults, there is progressive risk of HIV disease progression and mortality(World Health Organization, 2007). The prevalence of HIV-related wasting was estimated to be significantly high (38%) among HIV-infected adult cohort in Boston in 2006(Mangili, Murman, Zampini, Wanke, & Mayer, 2006). Thus, suggesting the need for dietary intake assessment among HIV-infected adults in order to know the quality of their diets and their dietary intake patterns.

HIV-infection related morbidities and mortalities remain high in Africa where larger proportion of the population lack adequate and quality diet and have poor nutritional status(FAO, 2008;Olalekan A Uthman, 2008). Meta-analysis of demographic and health survey data of women of reproductive age from 11 Sub-Saharan African countries including Ghana yielded HIV/AIDS-related malnutrition(BMI<18.5) prevalence of 10%(Olalekan A Uthman, 2008). The prevalence of HIV/AIDS-related malnutrition decreased with increasing wealth index and educational status(Olalekan A Uthman, 2008). This indicates that there is a complex relationship among HIV/AIDS, nutritional status, wealth index and educational status. It shows that HIV-infected people who have low economic and educational status are more likely to become malnourished as compared to their counterparts of high economic and educational status. Although similar data are not available for men, the prevalence of undernutrition among women provides useful estimate of general risk of malnutrition among HIV-infected adult population in the sub-region(Olalekan A Uthman, 2008).

The nutrition situation among HIV-infected adults in Ghana needs further studies for better understanding. A study conducted by Christina *et al.* (2012) in Koforidua Central Hospital in the Eastern Region of Ghana among 110 HIV-infected adults indicated that 30.9% of them were underweight, 50% of them had poor diets, low in energy and folate. Majority of 50 HIV-seropositive adults attending Korle-Bu Teaching Hospital in Accra, Ghana, cited cost as a barrier in accessing adequate amounts of food — inadequate dietary intake(Wiig & Smith, 2007). HIV-infection, malnutrition and food insecurity have an evolving relationship that needs adequate understanding to enhance comprehensive care especially in a resource limited setting like Ghana. However, there has not been much publication on it to provide adequate information to enhance understanding.

2.3 Effect of HIV infection on nutrition

HIV infection causes a complex interaction between immune system function and nutritional status, with a dominant effect on nutritional status(Colecraft, 2008;Ivers *et al.,* 2009;(A. C. Onyango, Walingo, Mbagaya, & Kakai, 2012). Suboptimal nutritional status is associated with immunological malfunctioning(Colecraft, 2008;Ivers *et al.,* 2009;Onyango *et al.,* 2012). During HIV infection, there is increased metabolism and energy expenditure. HIV infection also lead to low dietary intake as a result of loss of appetite, mouth ulcers and food insecurity due to disability, which all result in weight loss that tends to be in the form of depreciation of lean muscle mass. Malnutrition among HIV-infected persons strongly predicts illness or death independent of their CD4 (cluster of differentiation) T-lymphocyte counts(De Pee & Semba, 2010;Onyango *et al.,* 2012).

Nutrient deficiencies lead to poor nutritional status which in turn results into immune suppression. Poor nutritional status also causes loss of immune cell function and increased susceptibility to infections with subsequent intrusion by several diverse infectious agents. The major outcome of this is acquisition of opportunistic infections as a result of the body losing its ability to fight infections and diseases. Thus, the relationship between opportunistic infection, sub-optimal nutrition and immunological malfunctioning is bi-directional(Onyango *et al.,* 2012).

Nutrients that play a major role in building up immune system to be able to fight against infections include dietary energy, folate, iron, vitamin A, zinc and other vitamins and minerals(Henrik Friis, 2005). Reduction in dietary intake in HIV-infected adults leads to reduction in the intake of these nutrients which subsequently results into wasting and immunological malfunctioning and hastens HIV infection progression to complicated disease stage(Hsu, Pencharz, Macallan, & Tomkins, 2005;Henrik Friis, 2005;Donovan & Massingue, 2007;Family Health International, 2007).

2.3.1 HIV infection and energy requirement

HIV infection increases resting energy expenditure, reductions in food intake due to loss of appetite, nutrient malabsorption and loss. Other challenges associated with the HIV disease include complex metabolic alterations that result in weight loss and wasting which are common in advance stage of HIV(Piwoz E *et al.,* 2004). Low energy intake combined with increased energy demands due to HIV infection and related infections are the major driving forces behind HIV-related weight loss and wasting. Based on increased resting energy expenditure as observed in studies of HIV-infected adults, it is recommended that energy be increased by 10% in asymptomatic HIV-infected adults and approximately 20% to 30% in symptomatic HIV/AIDS adults above accepted levels for uninfected individuals in order to maintain optimal body weight and physical activities(WHO, 2003).

As in the general population, people living with HIV need a good diet that provides essential nutrients to help maintain the immune system function, boost energy levels and preserve optimal body weight. In asymptomatic HIV-positive adults, there is a 10% increase in energy needs. Energy requirements for adults suffering from more advanced HIV are increased by 20 to 30% in order to meet basic needs and to maintain optimal body weight(WHO, 2007). Although muscle wasting is a common sign of AIDS and may be due to protein metabolism because of the HIV infection, evidence indicates that muscle wasting is more related to the amount of food that a person with HIV is able to eat, than the need to increase dietary protein intake. However, there is no evidence that indicate food and dietary improvements alone can stop HIV infection from progressing to AIDS. But a comprehensive care for people living with HIV and AIDS should include both good nutrition and anti-retroviral therapy(WHO, 2007).

2.3.2 HIV infection and micronutrient status

The role of micronutrients in immune function and HIV infection is well established. And micronutrient deficiencies are common in areas where HIV is prevalent. PLHVs often suffer from micronutrient deficiencies, which potentially compromise their immune function and subsequently affect their ability to fight infection (Swindale, Anne, and Paula Bilinsky, 2006).

Although observational studies have methodological limitations for definitive conclusions about the relationship between micronutrient intake and blood levels, and HIV infection, they indicate that low blood levels and inadequate dietary intakes of some micronutrients are associated with increased HIV disease progression and mortality, and increased risk of HIV transmission(WHO, 2003). Some of the determinants of susceptibility to HIV infection, transmission and progression, increased risk of opportunistic infections and non-HIV outcomes are micronutrient deficiencies and interventions to ensure adequate intake of micronutrients(Henrik Friis, 2005).

Micronutrients intake may reduce when HIV infected persons are put on ARV resulting micronutrient deficiencies and may affect absorption and efficacy of drug(Henrik Friis, 2005).

However, the specific role of individual and multiple micronutrients in the prevention, care and treatment of HIV infection and related conditions needs further investigation (WHO, 2003). Vitamins and minerals that are important for keeping healthy body, immune system function and ensuring protection against opportunistic infections include: vitamins A, C, E, and B-complex and minerals such as selenium, zinc and iron(WHO and FAO, 2002). Deficiencies of vitamins and minerals such as vitamins A, B-complex, C and E and selenium ,zinc and iron are common in HIV infected individuals and often lead to faster immune cell death and increased HIV replication(Piwoz E *et al.,* 2004). To ensure micronutrient intakes at daily recommended levels, HIV-positive adults are encouraged to consume adequate healthy and diverse diets(WHO, 2003). The nutritional quality of an individual diet is obtained by estimating the dietary diversity score. High diversity score is directly associated with increased mean micronutrient density adequacy of foods(Swindale, Anne, and Paula Bilinsky, 2006).

Several studies indicate micronutrient supplementation as an important nutritional intervention to HIV-infected persons receiving antiretroviral treatment because supplements enhance immune function, protection against opportunistic infections and reduce mortality(Kaiser *et al.,* 2006). Micronutrient supplementation is associated with reduced morbidity and mortality in HIV-infected adults by delaying HIV from progressing to more advance HIV. It is therefore recommended that HIV-infected adults should be given micronutrient supplementation to boost their immune function and prevent opportunistic infections(Cantrell *et al.,* 2008;Shan Jiang *et al.,* 2011). Micronutrient supplements such as iron, folate, vitamin A and the vitamin B-complex perform significant functions in maintaining cellular integrity, high haemoglobin levels, functioning of enzymes and immune system. Deficiencies of these micronutrients compromise nutritional status and increased susceptibility to infections, increased severity of illness and mortality(Grace Ndeezi *et al.,* 2010;WHO, 2012)

2.4 Dietary intake patterns and adequacy among PLHIV

WHO has recommended that adequate dietary intake by PLHIV is necessary in order for them to meet their daily energy needs. WHO has estimated that the energy requirements of asymptomatic HIV-infected adults be increased by 10% and symptomatic HIV-infected adults be increased by 20-30%; part of which protein intake should provide 10-15% of daily energy intake, about 17% of daily energy intake from fat and largely, 70% of daily energy intake from carbohydrates(WHO, 2007). HIV infection affects dietary intake patterns and adequacy through reduction in food intake as a result of loss of appetite and food insecurity.

Sub-Saharan African where chronic undernutrition and food insecurity are endemic and accounting for nearly half (48.6%) of the global total undernutrition mortality, remains severely affected by the HIV epidemic(Piwoz E *et al.,* 2004). Protein-energy malnutrition is common among HIV-infected adults in Sub-Saharan African because of inadequate nutrient intake, high opportunistic infections and malabsorption(John R Koethe and Douglas C Heimburger, 2010). The underlining causes of malnutrition in PLHIV are poverty and lack of adequate access to food leading to inadequate food intake and poor dietary patterns and quality(L. M. Houtzager, 2009). Poor dietary intake patterns and adequacy which can easily lead to wasting in HIV-infected persons is common among PLHIV and food insecurity is a contributory factor(Bahwere, *et al.,* 2011).

In Ghana, few previous studies have shown that the diet quality of about half of the PLHIV was inadequate and this influenced their nutritional status(Christina *et al.,* 2012). Although energy and nutrient intake did not differ by HIV-infection status among Ghanaian lactating women, their dietary intake was limited by food insecurity and stress(Addo *et al.,* 2010). Majority of HIV-infected Ghanaian adults cited cost as a barrier to their access to adequate amounts of food and this contributed to their general low quality and inadequate dietary intake(Wiig & Smith, 2007). The observed general poor dietary intake patterns and adequacy of PLHIV in Ghana as a result of food insecurity problems have called for highly encouraged innovative efforts of PLHIV to help improve their dietary quality. A study conducted among rural Ghanaian households in Eastern Region indicated that home gardens cultivation contributed significantly to high dietary diversity score among HIV-positive households(Akrofi, Brouwer, Price, & Struik, 2010).

2.5 Antiretroviral treatment and nutrition

Achieving basic nutritional recommendations is an important issue when treating people living with HIV/AIDS (PLWHA) at all stages of the disease(Duran, Almeida, Segurado, & Jaime, 2008). Access to antiretroviral therapy (ART) for human immunodeficiency virus (HIV) infection has expanded rapidly throughout sub-Saharan Africa in the Africa region, but malnutrition due to inadequate dietary intake and food insecurity have emerged as major barriers to the success of ART programs(Koethe *et al.,*2009;Swaminathan *et al.,* 2010). HIV treatment which is an essential component of care for PLWHA should include improved nutrition intervention as an integral part of treatment programmes to enhance ART acceptability, adherence and effectiveness(WHO, 2003). Malnutrition hastens HIV disease progression, and inadequate dietary intake and food insecurity are major barriers to medication adherence. Studies have identified low body mass index among PLHIV after the start of ART as an independent predictor of early mortality(Koethe *et al.,*,2009;L. Houtzager, Barnes, & Matters, 2010). Unless food is available and there is adequate dietary intake to ensure optimal nutritional status and enhance adherence to treatment, the benefits of ARVs cannot be achieved(Hsu, Pencharz, Macallan, & Tomkins, 2005;Cantrell *et al.,* 2008).

2.6 Dietary management of HIV

For a comprehensive care and management of the HIV-infection, nutritional and food support are essential components in ensuring treatment acceptance, adherence, management of side effects, improved treatment success and nutritional recovery(WFP, 2010). WHO has recommended that the global efforts of ensuring universal access to HIV treatment and care should consider nutrition as integral intervention to improve treatment efficacy, reduce wasting, disease progression and mortality in HIV-infected persons. The success of global efforts of scaling up antiretroviral therapy and care cannot be achieved without appropriate support for nutrition as an integral intervention and the benefits of antiretroviral therapy cannot be achieved without adequate nutritional support which enhances adherence to treatment(WHO, 2007). The fact that body mass index is a strong predictor of death and treatment response among PLHIV indicates that dietary management is a key component in a comprehensive care for HIV-infected people. Although food alone cannot treat HIV, there is evidence that antiretroviral therapy with adequate dietary intake, care and support can prolong the life expectancy of PLHIV as long as 65-70 years(WHO, 2007).

CHAPTER THREE

3.0 METHODS

3.1 Study design

This study was part of a larger study entitled “Sustainable Food Security and Nutrition in HIV management in Ghana”. The proposed study utilized data from the main study and did not collect separate data. The main study was designed to collect descriptive data cross-sectionally. The descriptive cross-sectional survey collected data on demographic characteristics, household food security, 24-hour diet recall, dietary intake patterns, of HIV-infected adults attending ART clinics in Accra-Ghana.

3.2 Study location

The descriptive cross-sectional survey was implemented in two hospitals (Korle-Bu Teaching Hospital and Police Hospital) in Accra, the capital city of Ghana. Accra is located in the Greater Accra Region. Accra has a total land area of about 3,245 square kilometers with the highest population of 4,010,054 (16.3% of the total country’s population)(Ghana Statistical Service, 2012). The prevalence of HIV in the Greater Accra region is about 3.2%(Ghana AIDS Commission, 2012). The two hospital sites currently run ART clinics with weekly attendance of about 50 to 100 PLHIV which include both residents and non-residents of Accra.

3.3 Study variables

3.3.1 Independent variables

The independent variables of the study include: dietary intake patterns, intake of, calories, carbohydrates, proteins, fats, vitamin A, folate, vitamin C, iodine, iron and zinc.

3.3.2 Dependent variable

The dependent variables of the study include: dietary intake patterns adequacy, the adequacy of the intake of calories, carbohydrates, proteins, fats, vitamin A, folate, vitamin C, iodine, iron and zinc.

3.4 Sampling of respondents

The study was clinic-based and respondents were recruited from the Fevers Unit of the Korle-Bu Teaching Hospital and the ART unit of Police Hospitals in Accra. Respondents were recruited from these study areas because previous studies have found that clients who utilize these facilities include both residents and non-residents of Accra and thus likely to provide adequate representation of PLHIVs in Ghana. However, in recruiting respondents the attendees were not grouped into residents and non-residents but were recruited all together since recruitment was by self selection. The cross-sectional study recruited 281 HIV-infected adults aged 20 years and above accessing ART services from the above-mentioned hospitals. The survey targeted all HIV-infected adults aged 20 years and above attending ART clinics at Korle-Bu Teaching Hospital, or Police Hospital in Accra – Ghana who have agreed to participate in the survey.

The ART clinic staff introduced the study to HIV-infected adults on each clinic day and those who agreed to participate were recruited by signing a consent form until the number of respondents for each clinic was attained. Through this procedure a sample of 191 HIV-infected adults was recruited from the Fevers Unit of Korle-Bu Teaching Hospital because of the highest (100) ART clinic attendants on each clinic day at this ART unit. A sample size of 90 HIV-infected adults was also recruited through the same procedure from the ART unit of Police Hospitals in Accra. This approach was chosen in order to be in conformity with successful previous studies approach and to also ensure confidentially of study respondents.

To be eligible, respondents were supposed to be on ART for at least three months before the date of interview. Pregnant women were excluded in the survey. The sample size of 300 respondents was determine by using Epi Info version 3.4.1 (2007) based on sample sizes of previous studies, the population of PLHIV in Accra and the attendants of PLHIV at the ART clinics at a 95% confidential interval.

3.5 Data Collection

A 24-hour dietary recall tool was used to measure dietary intake. The 24-hour dietary recall tool was used to collect data on the study objectives 1, 2 and 3. This tool was administered to each respondent to describe and quantify all foods or dietary fluids consumed by respondents in the last 24 hours preceding the interview. Food models and household measures were used as memory aids to respondents to enable them describe quantities of foods consumed. The 24-hour dietary recall tool is effective in providing detail information about individual dietary intake with little time hence it is appropriate for this study with considerable large sample size.

A questionnaire developed for the main study was used to collect data on demographic characteristics such as (age, sex, educational level, occupation and marital status) of respondents. All the data were collected through face-to-face interviews.

3.6 Quality Control

Data collected were cleaned to correct omissions and double recording errors after which the 24-hour dietary recall data were coded using a database to match food codes with food items reported in the recall before data processing.

3.7 Data analysis

Analysis for the study utilized data from 281 respondents of the main study. Out of the 281 respondents, CD4 count data was available for 239 respondents and analysis relating to CD4 count was limited to the 239 respondents. Statistical Package for the Social Sciences (SPSS) version 16.0 was used to describe socio-demographic characteristics and dietary intake patterns of respondents into frequencies and proportions. Dietary diversity of respondents was described by using FANTA Household Dietary Diversity Score (HDDS) version 2(Swindale, Anne, and Paula Bilinsky, 2006) as basis. The HDDS contains 12 food groups comprising; cereals, root and tubers, vegetables, fruits, meat, poultry and offal, eggs, fish and seafood, pulses/legumes/nuts, milk and milk products, oil/fats, sugar/honey and miscellaneous. Dietary diversity of respondents was described into tertiles and proportions based on consumption of these food groups excluding miscellaneous. Calculation of nutrients (calories, carbohydrates, proteins, fats, vitamin A, folate, vitamin C, iodine, iron and zinc) values of foods consumed within the last 24 hours was conducted using Ghana food composition tables incorporated into ESHA FPRO version 10.0.1. Adequacy of nutrients consumed by respondents was determined by comparing nutrients values of foods consumed by respondents within the 24-hour dietary recall with the Recommended Dietary Allowance (RDA). Each participant nutrient intake was described as adequate if a particular nutrient value at least met the RDA and was within the RDA and Tolerable Upper Intake Level (UL) as shown in table 3.1 below.

Table 3.1: RDA and Tolerable Upper Intake Level of nutrients

Nutrient	RDA*	Tolerable Upper Intake Level[#]
Calories (kcal)[a]	2000-2200	-
Carbohydrates (g)[a]	130	-
Protein (g)[a]	50-82.5	-
Fat (g)[a]	75-165	-
Iron (mg)[c]	15-18	45
Zinc (mg)[c]	8-11	40
Vitamin A (RE)[b]	500	7500
Vitamin C (mg)[b]	40-45	1000
Folate (mcg)[b]	400	1000
Iodine (mcg)[b]	150	1000

*The RDA is the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individuals of a specified age range and gender. #Tolerable Upper Intake Level (UL) is the highest daily dietary intake that is likely to pose no risk of adverse health effects to almost all individuals of a specific age range. **Tolerable Upper Intake Levels were not available for calories, carbohydrates, protein and fat; all were set within the RDA.**
Source: [a] Dietary Recommendations in the Report of a Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases (WHO Technical Report Series 916, 2003).
Source: [b] Joint FAO/WHO Expert Consultation on Human Vitamin and Mineral Requirements (1998: Bangkok, Thailand. 2nd edition: 2004).
Source: [c] Office of dietary supplements, National institute of health: dietary supplement fact sheet: Institute of medicine, food and nutrition board. Washington, DC: National Academy of Press, 2001.

One way ANOVA was used to compare mean nutrient intake and proportions were compared by using crosstabs. Differences between mean nutrient intake and proportions were tested by using Chi-square.

3.8 Ethical consideration

Regarding ethical approval, the main study obtained ethical approval from Tufts Health Sciences Campus Institutional Review Board, Washington and also the Noguchi Memorial Institute for medical research. There were no any foreseeable risks to respondents participating in this study. Regarding benefits; information obtain from the study would provide understanding of dietary patterns of PLHIV which may form the basis of designing appropriate intervention programmes for the benefit of PLHIV in Ghana. Information obtained from subjects was stored in a data file protected by a password. Hard copy of the research was submitted to the School of Public Health which was stored in a locked file cabinet and only people who were mandated by the study were allowed to access the information. There was no any conflict of interest with regards to this study.

3.8.1 Pretest/pilot study

The 24-hour dietary recall tool and the questionnaire of the main study were pretested with a sample of HIV-infected adults seeking clinical care in Accra.

3.9 Limitations

The 24 hours dietary recall mainly relied on the respondents' memory and ability to estimate portion sizes. This could have introduced errors in the data.

Because of time constraint a single day's dietary recall was taken; this was not enough to capture day-to-day variability in dietary intake of the respondents. Several days recall could have been used if time was enough.

During the data analysis, foods that were not in the ESHA food processor were replaced by similar foods and this could have led to changes in the nutrients content of foods consumed by respondents.

CHAPTER FOUR

4.0 RESULTS AND FINDINGS

4.1 Background characteristics

The background characteristics of the HIV-positive Ghanaian adults studied are presented in Table 1. The mean age of the respondents was 43 ± 11 years with the highest proportion (48%) age group being 20-40 years. Overwhelming majority (76%) of the respondents were females. In the case of marital status, about 41% of the respondents were married and living with spouse. A considerable number (39%) of the subjects of the study were unemployed and (42% of the respondents) attained Junior High School/Middle School education. Trading was reported to be the dominant occupation (38%) among the respondents. A considerable proportion (34%) of the respondents was reported to be diagnosed HIV-positive 6 years ago and above and the mean CD4 count of the respondents was reported to be 421.94 ± 255.29 cells/mm^3.

Table 1: Socio-demographic characteristics and health history of HIV-infected Ghanaian adults (N=281)

Respondents characteristics	n (%)
Age (years)[mean ± standard deviation)	43±11
20-40	134 (47.7)
41-60	125 (44.5)
>60	22 (7.8)
Sex	
Male	66 (23.5)
Female	215 (76.5)
Marital status	
Married	129 (45.9)
Divorced	42 (14.9)
Not married	44 (15.7)
Widowed	66 (23.5)
Occupation	
None	110 (39.2)
Trader	106 (37.7)
Artisan	27 (9.6)
Salaried worker	38 (12.5)
Educational level	
Primary	58 (20.6)
JHS/middle school	118 (42.0)
Senior secondary and higher	73 (25.9)
No formal education	32 (11.4)
[1]CD4 count (cells/mm^3) [mean ± standard deviation]	421.94 ± 255.29
<350	111 (46.4)
≥350	128(53.6)
Duration of HIV infection diagnoses	
Less than one year	41 (14.6)
1-3 years	78 (27.8)
4-6 years	68 (24.2)
≥6 years	94 (33.5)

[1]CD4 (cluster of differentiation 4) count (n=239)

4.2 Dietary intake patterns of respondents

Meal frequency, pattern and dietary diversity of respondents by their sex are presented in Table 2. It was observed that 81% of the respondents ate three times or more per day. Among those who ate less than three times per day, lunch was frequently skipped (by 16% of the respondents) unlike breakfast and supper. Skipping breakfast was significantly different ($p<0.05$) among age groupings. Respondents who aged 20-40 years were 7% higher compared to respondents who aged 41-60 years and >60 years as far as skipping breakfast was concerned. The study also found that 84% of the respondents were reported having dietary diversity score in the middle and upper tertiles. However, in the findings, there was no significant difference in meal frequency and patterns and dietary diversity among respondents in terms of their CD4 count categories, duration of diagnosis and occupational status.

Table 2: Meal Frequency and pattern, and dietary diversity of HIV-infected Ghanaian adults (N=281)

Variable	Males (n=66) n (%)	Females (n=215) n (%)	Total (n=281) n (%)	p-value
Frequency of eating				
Twice or less/day	12 (18.2)	41 (19.1)	53 (18.9)	0.61
Thrice/day	31 (47.0)	87 (40.5)	118 (42.0)	
Four times or more/day	23 (34.8)	87 (40.5)	110 (39.1)	
Breakfast				
Skipped	3 (4.5)	7 (3.3)	10 (3.6)	0.70
Did not skip	63 (95.5)	208 (96.7)	271 (96.4)	
Lunch				
Skipped	10 (15.2)	26 (12.1)	46 (16.4)	0.85
Did not skip	56 (84.8)	179 (87.9)	235 (83.6)	
Supper				
Skipped	1 (1.5)	12 (5.6)	13 (4.6)	0.20
Did not skip	65 (98.5)	203 (94.4)	268 (95.4)	
Dietary diversity score				
Lower tertile	5 (7.6)	39 (18.1)	44 (15.7)	0.07
Middle tertile	50 (75.8)	132 (61.4)	182 (65.0)	
Upper tertile	11 (16.6)	43 (20.5)	54 (19.3)	

4.3 Mean nutrient intake among respondents

Table 3 is a presentation of mean daily nutrient intake of respondents by their age grouping. It was observed that the total mean intake of calories (2190.10±969.67), carbohydrates (315.34±166.42), proteins (79.18±39.16), vitamin A (707.46±1735.90), vitamin C (88.21±123.45) and iron (19.93±14.75) at least met the RDA whiles the total mean intake of fats (69.80±45.94), folate (130.55±135.37), iodine (19.59±27.94) and zinc (1.86±1.67) did not meet the RDA. There was significant difference ($p<0.05$) between the mean fats intake (76.64±48.62) of age group 20-40 years and (47.46±28.57) of age group >60 years.

The mean daily nutrient intake of respondents by their sex and CD4 count as presented in Table 4 indicated that there was significant difference ($p<0.05$) observed between the mean proteins intake of males (89.94±41.91) and females (75.88±37.76). There was no significant difference observed between the mean nutrient intake of respondents with CD4 count <350 cells/mm^3 and respondents with CD4 count ≥350 cells/mm^3. The results also showed that the mean intake of calories, carbohydrates, proteins, iron and vitamin C of both sex and CD4 count groupings at least met the RDA whiles the mean intake of fats, folate, iodine and zinc did not meet the RDA. The mean intake of vitamin A of males did not meet the RDA whiles that of females and respondents with both CD4 count grouping met the RDA. There was no significant difference in mean nutrient intake of respondents observed among the groupings of duration of diagnosis as presented in Table 5. However, the respondents mean intake of calories, carbohydrates, proteins, vitamin C, and iron were at least met the RDA for all groupings of duration of diagnosis except for fats, vitamin A, folate, iodine and zinc.

Table 6 is a presentation of mean nutrient intake of respondents by their occupational status. It was observed that the respondents mean intake of calories, carbohydrates, proteins, vitamin C and iron at least met the RDA for all occupational status except for the mean intake of fats, vitamin A, folate, iodine and zinc. There was no significant difference ($p>0.05$) in mean nutrient intake by respondents' occupational status.

As shown in Tables 3, 4, 5 and 6, the mean scores of vitamin A intakes are less than the standard deviations (SDs) for age grouping, sex, CD4 count, duration of diagnosis and occupational status of the respondents. This indicates that among the respondents, some of them had very low vitamin A in their diet causing the huge deviation from the mean.

Table 3: Mean daily nutrient intake of HIV-infected Ghanaian adults (N=281) by their age grouping

Nutrients	Age categories			Total (N=281) Mean ± SD	p-value
	20-40 (n=134) Mean ± SD	41-60 (n=125) Mean ± SD	>60 (n=22) Mean ± SD		
Macronutrient					
Calories (kcal)	2237.70 ± 896.36	2147.90 ± 981.11	2190.10 ± 1317.87	2190.10 ± 969.67	0.74
Carbohydrates (g)	315.86 ± 148.70	308.28 ± 162.42	352.26 ± 267.90	315.34 ± 166.42	0.52
Proteins (g)	81.18 ± 36.92	78.98 ± 42.20	68.12 ± 33.76	79.18 ± 39.16	0.35
Fats (g)	76.64 ± 48.62[a]	66.39 ± 44.05[a,b]	47.46 ± 28.57[b]	69.80 ± 45.94	0.01*
Micronutrient					
Vitamin A (IU)	765.28 ± 1839.11	690.84 ± 1697.46	449.69 ± 1284.50	707.46 ± 1735.90	0.73
Folate (µg)	116.74 ± 137.27	144.33 ± 127.28	136.38 ± 164.24	130.55 ± 135.37	0.26
Vitamin C (mg)	85.86 ± 111.93	94.80 ± 142.32	65.03 ± 58.10	88.21 ± 123.45	0.56
Iodine (µg)	20.66 ± 30.39	18.46 ± 23.93	19.51 ± 34.07	19.59 ± 27.94	0.82
Iron (mg)	20.43 ± 15.20	19.58 ± 14.18	18.85 ± 15.76	19.93 ± 14.75	0.84
Zinc (µg)	1.83 ± 1.78	1.95 ± 1.59	1.51 ± 1.38	1.86 ± 1.67	0.52

*significant at $p<0.05$; a-b within a row with the same superscript means that there are no significant differences but those with different superscript show significant differences

Table 4: Mean daily nutrient intake of HIV-infected Ghanaian adults (N=281) by their sex and (N=239) by their CD4 count (cells/mm^3)

Nutrient	Sex		p-value	CD4 count (cells/mm^3)		p-value
	Male (n=66) Mean ± SD	Female (n=215) Mean ± SD		<350 (n=111) Mean ± SD	≥350 (n=128) Mean ± SD	
Macronutrient						
Calories (kcal)	2353.60 ± 1006.29	2139.90 ± 954.94	0.12	2.232.40 ± 981.46	2193.20 ± 965.51	0.76
Carbohydrates (g)	342.54 ± 195.25	306.99 ± 156.08	0.13	3062.10 ± 155.21	3221.30 ± 177.56	0.46
Proteins (g)	89.94 ± 41.91	75.88 ± 37.76	0.01*	83.07 ± 42.99	77.38 ± 35.23	0.26
Fats (g)	66.99 ± 35.51	70.66 ± 48.74	0.57	75.15 ± 47.62	71.41 ± 48.03	0.55
Micronutrient						
Vitamin A (IU)	431.13 ± 1368.31	792.28 ± 1828.45	0.14	535.61 ± 1482.26	927.50 ± 2023.06	0.09
Folate (µg)	148.95 ± 143.66	124.90 ± 132.56	0.21	131.18 ± 148.15	132.60 ± 130.57	0.94
Vitamin C (mg)	73.71 ± 79.45	92.66 ± 133.92	0.28	71.95 ± 67.41	94.33 ± 122.42	0.09
Iodine (µg)	22.70 ± 30.13	18.63 ± 27.23	0.30	18.72 ± 30.16	20.67 ± 26.23	0.59
Iron (mg)	20.81 ± 15.22	19.65 ± 14.63	0.58	19.36 ± 13.60	21.07 ± 16.55	0.39
Zinc (µg)	2.00 ± 1.71	1.81 ± 1.65	0.42	1.81 ± 1.83	1.97 ± 1.61	0.46

*significant at p<0.05

Table 5: Mean daily nutrient intake of HIV-infected Ghanaian adults (N=281) by their duration of diagnosis (years)

Nutrients	Duration of diagnosis (years)				p-value
	<1 year (n=41) Mean ± SD	1-3 (n=78) Mean ± SD	4-6 (n=68) Mean ± SD	>6 (N=94) Mean ± SD	
Macronutrient					
Calories (kcal)	2175.50 ± 943.72	2127.00 ± 1023.37	2220.50 ± 1006.48	2226.90 ± 919.48	0.91
Carbohydrates (g)	307.94 ± 148.43	298.98 ± 166.72	305.56 ± 157.15	339.22 ± 179.48	0.39
Proteins (g)	82.31 ± 45.36	75.33 ± 42.86	81.80 ± 42.30	79.12 ± 30.00	0.73
Fats (g)	69.06 ± 48.40	70.57 ± 45.39	75.05 ± 54.12	65.68 ± 38.63	0.64
Micronutrient					
Vitamin A (IU)	655.53 ± 1412.68	466.67 ± 1441.91	598.49 ± 1728.56	100.87 ± 2046.89	0.20
Folate (µg)	133.95 ± 117.42	191.11 ± 106.28	138.08 ± 139.24	133.12 ± 160.51	0.84
Vitamin C (mg)	90.34 ± 135.16	81.23 ± 135.60	84.80 ± 81.13	95.52 ± 134.00	0.89
Iodine (µg)	25.14 ± 35.19	17.39 ± 27.07	16.40 ± 21.23	21.30 ± 29.93	0.34
Iron (mg)	19.11 ± 14.39	18.36 ± 13.56	18.82 ± 11.75	22.37 ± 17.47	0.27
Zinc (µg)	2.07 ± 1.91	1.57 ± 1.23	1.82 ± 1.42	2.04 ± 1.99	0.25

Table 6: Mean daily nutrient intake of HIV-infected Ghanaian adults (N=281) by their occupational status

Nutrients	Occupation				p-value
	Artisan (n=27) Mean ± SD	Salaried worker (n=38) Mean ± SD	Trader (n=106) Mean ± SD	None (n=110) Mean ± SD	
Macronutrient					
Calories (kcal)	2134.80 ± 792.76	2168.50 ± 798.42	2237.60 ± 998.62	2165.40 ± 1041.47	0.93
Carbohydrates (g)	319.32 ± 142.29	286.45 ± 121.71	327.59 ± 168.87	312.53 ± 182.68	0.62
Proteins (g)	77.78 ± 33.92	89.96 ± 41.50	78.27 ± 38.84	76.68 ± 38.84	0.33
Fats (g)	63.51 ± 42.02	68.24 ± 36.92	70.92 ± 47.95	70.80 ± 48.06	0.88
Micronutrient					
Vitamin A (IU)	412.80 ± 1157.61	436.05 ± 1210.24	997.90 ± 2085.74	593.66 ± 1609.62	0.16
Folate (µg)	103.28 ± 106.93	124.59 ± 120.23	138.01 ± 127.90	132.12 ± 153.07	0.68
Vitamin C (mg)	66.94 ± 52.05	57.89 ± 61.56	96.92 ± 157.26	95.51 ± 113.27	0.26
Iodine (µg)	13.56 ± 18.70	24.07 ± 36.88	18.07 ± 23.81	20.98 ± 29.89	0.42
Iron (mg)	19.14 ± 10.55	17.07 ± 9.17	20.24 ± 12.47	20.80 ± 18.72	0.59
Zinc (µg)	1.68 ± 1.26	1.93 ± 1.41	1.80 ± 1.40	1.93 ± 2.05	0.87

4.4 Adequacy of nutrient intake among respondents

Adequacy of nutrient intake among respondents are presented in Tables 7, 8, 9 and 10 below, by their age groupings, sex and CD4 count, duration of diagnosis and occupational status respectively. Generally, small proportions of respondents' nutrient intake were adequate with the exception of proteins and iron. As indicated in Table 7, the proportion of respondents whose calories intake met the RDA was 38% while that of carbohydrates was 39%, proteins was 74% and fats was 37%. The proportion of respondents who had adequate intake of vitamin A was reported to be 15%, and those of folate, vitamin C, iodine, iron and zinc were 4%, 39%, 0.4%, 59% and 1% respectively. Across all the characteristics categorized in the study, about 70% of the respondents had adequate proteins intake. However, no respondent's intake was adequate for iodine and zinc for age grouping 41-60 years and >60 years as indicated in Table 7 below. The adequate intake of iodine and zinc were also reported zero for males and zero adequate intake of zinc was reported for respondents with CD4 count ≥350 cell/mm^3 as indicated in Table 8 below. By duration of diagnosis as presented in Table 9 below, the adequate intake of iodine was zero for 1-3 years, 4-6 years and >6 years. And the adequate intake of zinc was zero for <1 year, 1-3 years and 4-6 years groupings of diagnosis. According to occupational status as presented in Table 10 below, the adequate intake of iodine was zero for respondents who were artisans, traders and none workers. The adequate intake of zinc was also reported zero for respondents who were artisans, salaried workers and traders. There were significant differences observed between the adequate intake of vitamin C (p<0.05) and iron (p<0.001) for males and females as depicted in Table 8 below.

Table 7: Adequacy of nutrient intake among HIV-infected Ghanaian adults (N=281) by their age grouping

Nutrients	Age categories			Total (N=281) n (%)	p-value
	20-40 (n=134) n (%)	41-60 (n=125) n (%)	>60 (n=22) n (%)		
Macronutrient					
Calories (kcal)					
Did not meet RDA	83 (61.9)	79 (63.2)	12 (54.5)	174 (61.9)	0.75
Met RDA	51 (38.1)	46 (36.8)	10 (45.5)	107 (38.1)	
Carbohydrates (g)					
Did not meet RDA	82 (61.2)	77 (61.6)	13 (59.1)	172 (61.2)	1.00
Met RDA	52 (38.8)	48 (38.4)	9 (40.9)	109 (38.8)	
Proteins (g)					
Did not meet RDA	33 (24.6)	33 (26.4)	6 (27.3)	72 (25.6)	0.94
Met RDA	101 (75.4)	92 (73.6)	16 (72.7)	209 (74.4)	
Fats (g)					
Did not meet RDA	78 (58.2)	83 (66.4)	15 (68.2)	176 (62.6)	0.36
Met RDA	56 (41.8)	42 (33.6)	7 (31.8)	105 (37.4)	
Micronutrient					
Vitamin A (IU)					
Did not meet RDA	113 (84.3)	107 (85.6)	20 (90.9)	240 (85.4)	0.81
Met RDA	21 (15.7)	18 (14.4)	2 (9.1)	41 (14.6)	
Folate (μg)					
Did not meet RDA	129 (96.3)	121 (96.8)	20 (90.9)	270 (96.1)	0.38
Met RDA	5 (3.7)	4 (3.2)	2 (9.1)	11 (3.9)	
Vitamin C (mg)					
Did not meet RDA	77 (57.5)	79 (63.2)	16 (72.7)	172 (61.2)	0.33
Met RDA	57 (42.5)	46 (36.8)	6 (27.3)	109 (38.8)	
Iodine (μg)					
Did not meet RDA	133 (99.3)	125 (100.0)	22 (100.0)	280 (99.6)	1.00
Met RDA	1 (0.7)	0 (0.0)	0 (0.0)	1 (0.4)	
Iron (mg)					
Did not meet RDA	62 (46.3)	48 (38.4)	4 (18.2)	114 (40.6)	0.35
Met RDA	72 (53.7)	48 (61.6)	18 (81.8)	167 (59.4)	
Zinc (μg)					
Did not meet RDA	132 (98.5)	125 (100.0)	22 (100.0)	279 (99.3)	0.57
Met RDA	2 (1.5)	0 (0.0)	0 (0.0)	2 (0.7)	

Table 8: Adequacy of nutrient intake among HIV-infected Ghanaian adults (N=281) by their sex and (N=239) by their CD4 count (cells/mm^3)

Nutrients	Sex		p-value	CD4 count (cells/mm^3)		p-value
	Male (n=66) n (%)	Female (215) n (%)		<350 (n=111) n (%)	≥350 (n=128) n (%)	
Macronutrient						
Calories (kcal)						
Did not meet RDA	42 (63.6)	132 (61.4)	0.77	67 (60.4)	79 (61.7)	0.89
Met RDA	24 (36.4)	83 (38.6)		44 (39.6)	49 (38.3)	
Carbohydrates (g)						
Did not meet RDA	43 (65.2)	129 (60.0)	0.47	70 (63.1)	76 (59.4)	0.60
Met RDA	23 (34.8)	86 (40.0)		41 (36.9)	52 (40.6)	
Proteins (g)						
Did not meet RDA	12 (18.2)	60 (27.9)	0.15	23 (20.7)	35 (27.3)	0.29
Met RDA	54 (81.8)	155 (72.1)		88 (79.3)	93 (72.7)	
Fats (g)						
Did not meet RDA	44 (66.7)	132 (61.4)	0.47	62 (55.9)	78 (60.9)	0.43
Met RDA	22 (33.3)	83 (38.6)		49 (44.1)	50 (39.1)	
Micronutrient						
Vitamin A (IU)						
Did not meet RDA	60 (90.9)	180 (83.7)	0.17	98 (88.3)	104 (81.3)	0.15
Met RDA	6 (9.1)	35 (16.3)		13 (11.7)	24 (18.8)	
Folate (µg)						
Did not meet RDA	62 (93.9)	208 (96.7)	0.29	107 (96.4)	122 (95.3)	0.76
Met RDA	4 (6.1)	7 (3.3)		4 (3.6)	6 (4.7)	
Vitamin C (mg)						
Did not meet RDA	48 (72.7)	124 (57.7)	0.03*	72 (64.9)	74 (57.8)	0.29
Met RDA	18 (27.3)	91 (42.3)		39 (35.1)	54 (42.2)	
Iodine (µg)						
Did not meet RDA	66 (100.0)	214 (99.5)	1.00	110 (99.1)	128 (100.0)	0.46
Met RDA	0 (0.0)	1 (0.5)		1 (0.9)	0 (0.0)	
Iron (mg)						
Did not meet RDA	12 (18.2)	102 (47.4)	<0.001*	46 (41.4)	47 (36.7)	0.51
Met RDA	54 (81.8)	113 (52.6)		65 (58.6)	81 (63.3)	
Zinc (µg)						
Did not meet RDA	66 (100.0)	213 (99.1)	1.00	110 (99.1)	127 (99.2)	1.00
Met RDA	0 (0.0)	2 (0.9)		1 (0.9)	1 (0.8)	

*significant at p<0.05

Table 9: Adequacy of nutrient intake among HIV-infected Ghanaian adults (N=281) by their duration of diagnosis (years)

Nutrients	Duration of diagnosis (years)				p-value
	<1 year (n=41) n (%)	1-3 (n=78) n (%)	4-6 (n=68) n (%)	>6 (N=94) n (%)	
Macronutrient					
Calories (kcal)					
Did not meet RDA	25 (61.0)	49 (62.8)	46 (67.6)	54 (57.4)	0.62
Met RDA	16 (39.0)	29 (37.2)	22 (32.4)	40 (42.6)	
Carbohydrates (g)					
Did not meet RDA	25 (61.0)	56 (71.8)	41 (60.3)	50 (53.2)	0.10
Met RDA	16 (39.0)	22 (28.2)	27 (39.7)	44 (46.8)	
Proteins (g)					
Did not meet RDA	11 (26.8)	25 (32.1)	16 (23.5)	20 (21.3)	
Met RDA	30 (73.2)	53 (67.9)	52 (76.5)	74 (78.7)	0.42
Fats (g)					
Did not meet RDA	26 (63.4)	45 (57.7)	40 (58.8)	65 (69.1)	0.39
Met RDA	15 (35.6)	33 (42.3)	28 (41.2)	29 (30.9)	
Micronutrient					
Vitamin A (IU)					
Did not meet RDA	34 (82.9)	70 (89.7)	60 (88.2)	76 (80.9)	0.34
Met RDA	7 (17.1)	8 (10.3)	8 (11.8)	18 (19.1)	
Folate (µg)					
Did not meet RDA	40 (97.6)	77 (98.7)	65 (95.6)	88 (93.6)	0.34
Met RDA	1 (2.4)	1 (1.3)	3 (4.4)	6 (6.4)	
Vitamin C (mg)					
Did not meet RDA	27 (65.9)	52 (66.7)	38 (55.9)	55 (58.5)	0.48
Met RDA	14 (34.4)	26 (33.3)	30 (44.1)	39 (41.5)	
Iodine (µg)					
Did not meet RDA	40 (97.)	78 (100.0)	68 (100.0)	94 (100.0)	0.15
Met RDA	1 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	
Iron (mg)					
Did not meet RDA	16 (39.0)	40 (51.3)	29 (42.6)	29 (30.9)	0.06
Met RDA	25 (61.0)	38 (48.7)	39 (57.4)	65 (69.1)	
Zinc (µg)					
Did not meet RDA	41 (100.0)	78 (100.0)	68 (100.0)	92 (97.9)	0.52
Met RDA	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.1)	

Table 10: Adequacy of nutrient intake among HIV-infected Ghanaian adults (N=281) by their occupational status

Nutrients	Occupation				p-value
	Artisan (n=27) n (%)	Salaried worker (n=38) n (%)	Trader (n=106) n (%)	None (n=110) n (%)	
Macronutrient					
Calories (kcal)					
Did not meet RDA	17 (63.0)	28 (73.7)	67 (63.2)	62 (56.4)	0.29
Met RDA	10 (37.0)	10 (26.3)	39 (36.8)	48 (43.6)	
Carbohydrates (g)					
Did not meet RDA	16 (59.3)	28 (73.7)	62 (58.5)	66 (60.0)	0.40
Met RDA	11 (40.7)	10 (26.3)	44 (41.5)	44 (40.0)	
Proteins (g)					
Did not meet RDA	4 (14.8)	7 (18.4)	27 (25.5)	34 (30.0)	0.23
Met RDA	23 (85.2)	31 (81.6)	79 (74.5)	76 (69.1)	
Fats (g)					
Did not meet RDA	19 (70.4)	23 (60.5)	63 (59.4)	71 (64.5)	0.71
Met RDA	8 (29.6)	15 (39.5)	43 (40.6)	39 (35.5)	
Micronutrient					
Vitamin A (IU)					
Did not meet RDA	24 (88.9)	34 (89.5)	84 (79.2)	98 (89.1)	0.16
Met RDA	3 (11.1)	4 (10.5)	22 (20.8)	12 (10.9)	
Folate (µg)					
Did not meet RDA	26 (96.3)	37 (97.4)	103 (97.2)	104 (94.5)	0.82
Met RDA	1 (3.7)	1 (2.6)	3 (2.8)	6 (5.5)	
Vitamin C (mg)					
Did not meet RDA	15 (55.6)	27 (71.1)	64 (60.4)	66 (60.0)	0.58
Met RDA	12 (44.4)	11 (28.9)	42 (39.6)	44 (40.0)	
Iodine (µg)					
Did not meet RDA	27 (100.0)	37 (97.4)	106 (100.0)	110 (100.0)	0.23
Met RDA	0 (0.0)	1 (2.6)	0 (0.0)	0 (0.0)	
Iron (mg)					
Did not meet RDA	13 (48.1)	16 (42.1)	48 (45.3)	37 (33.6)	0.28
Met RDA	14 (51.9)	22 (57.9)	58 (54.7)	73 (66.4)	
Zinc (µg)					
Did not meet RDA	27 (100.0)	38 (100.0)	106 (100.0)	108 (98.2)	0.70
Met RDA	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.8)	

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Background characteristics

The mean age of respondents reported to be 43 years was an indication that majority of the respondents were in the middle age group and have accepted their status and availed themselves to the ART clinics for ART treatment as compared to the younger age persons. The results also indicated that majority of the respondents were females (about 41%). This confirms the fact that women have better health services seeking and utilization behaviors than men(Ddamulira, Rutebemberwa, Tumushabe, & Nuwaha, 2009;Lawson, 2004). The fact that a high proportion (42%) of the respondents attained Junior High School/Middle School education, which was closer to the percentage (39%) of the respondents who were unemployed showed a clear relationship between school dropout and inability to seek employment. The implication of this relationship is the high risk of HIV infection and the inability to access sufficient food for adequate dietary intake.

5.2 Dietary intake patterns of respondents

This study found that greater proportion (81%) of the study participants met the normal three square meals or more per day which is in conformity with the findings of Christina *et al.,* (2012). Eating three times per day is a health living practice that ensures adequate food intake especially for HIV-infected persons on ART. One of the WHO, (2007) recommendations for HIV-infected persons on ART is adequate dietary intake to enhance effective adherence to ART therapy.

However, among those respondents who ate less than three times per day, lunch was frequently skipped unlike breakfast and supper and skipping breakfast was significantly different among age groupings. The respondents who aged 20-40 years were 7% higher ($p<0.05$) of skipping breakfast as compared to the respondents who aged 41-60 years and >60 years. This results contrast with the findings of Christina et al. (2012), which reported all PLHV of eating breakfast. The skipping of meals especially breakfast by HIV-infected persons on ART treatment could lead to non adherence to therapy and reduce dietary energy intake and work performance(World Health Organization, 2007).

This study also found that greater proportion of the respondents ate foods from at least 5 food groups as reported in similar studies conducted by Akrofi *et al.,* (2010) and Christina *et al.,* (2012). Food consumption with high dietary diversity score is an indication of adequate food intake that leads to optimal nutritional status(Swindale, Anne, and Paula Bilinsky, 2006) which is appropriate for HIV-infected persons on ART. Similarly, Onyango *et al.,* (2012) reported that majority of HIV-infected adults in Uganda consumed 3 or more meals per day and a diet diversity of 5 or more food groups. Consuming diverse diets has been associated with high income level and high socioeconomic status(Swindale, Anne, and Paula Bilinsky, 2006). In contrast, this study found no significant association between diet diversity and occupational status which is a determinant of income levels and socioeconomic status. This study also reported no significant association between diet diversity and CD4 count and duration of diagnosis similar to a study conducted by Kiefer *et al.* (2011) among Rwanda HIV-women that found no nutritional variable associated with change in CD4 count. However, a diverse diet improves nutritional quality and nutritional status thereby contributing to resistance to opportunistic infections in HIV-infected persons(Tony Castleman, Eleonore Seumo-Fosso, & and Bruce Cogill, 2004). The high dietary diversity reported among the respondents could be translated into improve nutritional quality and resistance against opportunistic infection.

5.3 Mean nutrient intake among respondents

Generally, respondents mean intake of calories, carbohydrates, proteins, vitamin C and iron met at least the RDA. But, the mean intake of vitamin C exceeded the RDA in almost all characteristics groupings reported in this study. This is in conformity with the findings reported by Christina *et al.* (2012) that both males and females exceeded their vitamin C requirement. The important function of vitamin C is maintenance and repair of connective tissues thereby ensuring optimal health status. Therefore the respondents mean intake of vitamin C that exceeded the RDA but within the Tolerable Upper Intake Level is good for their health. The report of mean proteins intake between males and females however contrasts the report on proteins by Christina *et al.* (2012) since this study reported significant difference ($p<0.05$) in mean proteins intake between males (89.94±41.91) and females (75.88±37.76). With regards to proteins intake there was no significant difference observed between males and females (Christina *et al.,* 2012). However, the mean proteins intake by respondents at least met the RDA which is similar to what was reported by Christina *et al.* (2012) among HIV-infected persons in Ghana and Addo *et al.* (2010) among lactating Ghanaian women.

The present study found the mean intake of calories, carbohydrates and iron of the respondents presented according to their sex, age categories, CD4 count, duration of diagnosis and occupational status to have at least met the RDA. The is in contrast with some of the findings on HIV seropositive patients attending Chulaimbo Hospital in Kenya by Onyango, *et al.*(2012). Onyango *et al.* (2012) found that the mean intake of energy was 1556 for males and 1596 for females and the mean intake of iron was 10.30 for males and 10.35 for females which were all below the RDA. WHO, 2003 recommended about 10%-30% increase energy intake among HIV-infected persons above the normal intake; however, the mean calories and carbohydrates intake reported in this study barely met the RDA but not enough to meet WHO recommendation.

The mean intake of fats by the younger age group was significantly different ($p<0.05$) from that of the older age group. This could be due to the fact that the younger age group consumes a lot of fats and oil rich foods than their older counterparts. Mean vitamin A intake of males was lower than the RDA but that of females' exceeded the RDA. The findings for males' mean vitamin A intake is in contrast with the findings of Christina *et al.* (2012) that reported mean vitamin A intake of both males and females to far exceed the RNI. The study results also indicated that the mean intake of zinc, folate and iodine were far below the RDA. This could mean that the respondents' dietary intake was not sufficient or diverse enough to meet the requirement of these nutrients. These micronutrients are very important in performing immune function, maintaining and repairing connective tissues as well as forming certain glands. Because of this WHO, 2003 recommended adequate intake of healthy diets by HIV-infected persons in order for them to meet their increasing needs of micronutrients.

5.4 Adequacy of nutrient intake among respondents

Although about half of the nutrients (calories, carbohydrates, proteins, vitamin C and iron) mean intakes of the respondents at least met the RDA for sex, all age groups, CD4 count categories, durations of diagnosis and occupational status, the proportion of respondents whose nutrients mean intake that at least met the RDA, were very low or even zero for some nutrients except proteins. The proportions of respondents whose proteins mean intake that at least met the RDA were about 70% across all characteristics categorized and presented by this study. The adequacy of proteins intake reported by this study is similar to what was reported by Onyango *et al.* (2012) among HIV seropositive patients attending Chulaimbo Hospital in Kenya. Onyango *et al.* (2012) reported adequate protein intake to be 72.1% for males and 88.7% for females. The adequacy of iron intake by respondents was averagely 50% across sex, age groups, CD4 count categories, duration of diagnosis and occupational status. This slightly differs from what was reported by Onyango *et al.* (2012). Adequacy of iron intake was reported to be 58.3% for females and 128.8% for males by Onyango *et al.* (2012). The adequacy of calories, carbohydrates, fats, vitamin A, folate, vitamin C, iodine and zinc intake by the respondents were below 50% and in some situations 0% for iodine and zinc. This study found the adequacy of vitamin A intake to be similar to what was reported by Onyango *et al.* (2012); 22.8% for males and 26.7% for females which are all below 50%. However, the findings of vitamin C adequate intake in this study contrast with the findings of Onyango *et al.* (2012) that reported the adequacy of vitamin C intake to be 55.0% for males and 62.7% for females, all higher than what was reported by this study.

The reported majority of the respondents that ate at least three meals per day and at least 5 groups did not translate into their adequate nutrient intake. HIV-persons can consume diets to ensure adequate nutrients intake but this may not be sufficient to correct nutritional deficiencies (WHO, 2003).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

About a quarter of HIV infected adults have inadequate dietary intake; they therefore cope by skipping lunch, about 20% of the respondents ate less than 3 meals per day and 16% had low diverse diets.

Total daily mean nutrient intakes among the respondents were: calories (2190.1±969.67), carbohydrates (315.34±166.42), proteins (79.18±39.16), fats (69.80±45.94), vitamin A (707.46±1735.90), vitamin C (88.21±123.45), iron (19.93±14.75), folate (130.55±135.37), iodine (19.59±27.94) and zinc (1.86±1.67). Mean nutrients intakes were compared with the RDA to determine their levels of intake. The mean intake of calories, carbohydrates, proteins, vitamin A, vitamin C and iron were adequate whiles that of fats, folate, iodine and zinc were low.

Except for proteins (26%) and iron (41%), the majority of the respondents had high inadequate intake of calories (62%), carbohydrates (61%), fats (63%), vitamin A (85%), folate (96%), vitamin C (61%), iodine (99.6%), and zinc (99%).

6.2 Recommendations

There is unmet need of multiple nutrient intakes among PLHV, the study therefore recommends multiples approaches that include:

- Counseling to PLHV by the staff of ART, fevers units and clinics in the country and
- food security strategies for the PLHV, by supporting local organizations such as Ghana Health Service, Christian Health Association of Ghana, Ghana AIDS Commission, non-governmental organizations and the government of Ghana

References

Addo, A. A., Marquis, G. S., Lartey, A. A., Pérez-Escamilla, R., Mazur, R. E., & Harding, K. B. (2010). Food insecurity and perceived stress but not HIV infection are independently associated with lower energy intakes among lactating Ghanaian women. *Maternal & child nutrition*, *7*(1), 80–91.

Akrofi, S., Brouwer, I. D., Price, L. L., & Struik, P. C. (2010). Home gardens contribute significantly to dietary diversity in HIV/AIDS afflicted households in rural Ghana. *Journal of Human Ecology*, *31*(2), 125–134.

Cantrell, R. A., Sinkala, M., Megazinni, K., Lawson-Marriott, S., Washington, S., Chi, B. H., Tambatamba-Chi…,B., Levy, J., Stringer, E. M., & Mulenga, L. (2008). A pilot study of food supplementation to improve adherence to antiretroviral therapy among food-insecure adults in Lusaka, Zambia. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *49*(2), 190–195.

Christina A. Nti , Jane Hayford , Clara Opare-Obisaw Department of Family and Consumer Sciences, University of Ghana, Legon, Ghana Correspondence to: Christina A. Nti , Department of Family and Consumer Sciences, University of Ghana, Legon, Ghana. (2012). Nutrition Knowledge, Diet Quality and Nutritional Status of People Living with HIV (PLHIV) in Ghana. *Copyright © 2012 Scientific & Academic Publishing.*

Colecraft, E. (2008). HIV/AIDS: nutritional implications and impact on human development. *Proceedings of the Nutrition Society*, *67*(01), 109–113.

Ddamulira, J. B. M., Rutebemberwa, E., Tumushabe, E., & Nuwaha, F. (2009). Factors associated with delayed diagnosis of HIV infection in Mukono District, Uganda. *East African medical journal*, *86*(9), 411–416.

De Cock, K. M., Jaffe, H. W., & Curran, J. W. (2012). The evolving epidemiology of HIV/AIDS. *AIDS*, *26*(10), 1205–1213.

De Pee, S., & Semba, R. D. (2010). Role of nutrition in HIV infection: Review of evidence for more effective programming in resource-limited settings. *Food & Nutrition Bulletin*, *31*(Supplement 4), 313S–344S.

Donovan, C., & Massingue, J. (2007). Illness, death, and macronutrients: adequacy of rural Mozambican household production of macronutrients in the face of HIV/AIDS. *Food & Nutrition Bulletin*, *28*(Supplement 2), 331S–338S.

Duerr, A., Altice, F. L., Harries, A. D., & Sohn, A. H. (2012). Antiretroviral Treatment in Resource-Limited Settings 2012. *AIDS Research and Treatment*, *2012*. http://www.hindawi.com/journals/art/aip/346708/

Duran, A., Almeida, L. B., Segurado, A. A. C., & Jaime, P. C. (2008). Diet quality of persons living with HIV/AIDS on highly active antiretroviral therapy. *Journal of Human Nutrition and Dietetics*, *21*(4), 346–350.

Family Health International. (2007). HIV, Nutrition, and Food A Practical Guide for Technical Staff and Clinicians.

FAO. (2008). The State of Food Insecurity in the World. *Web site: www.fao.org/icatalog/ inter-e.htm.*

GHANA AIDS COMMISSION. (2012). GHANA COUNTRY AIDS PROGRESS REPORT; REPORTING PERIOD JANUARY 2010 – DECEMBER 2011. *www.unaids.org/.../countryprogressreports/2012countries/ce_GH_Na...*

GHANA STATISTICAL SERVICE. (2012). 2010 POPULATION AND HOUSING CENSUS FINAL RESULTS. *www.statsghana.gov.gh/.../2010phc/2010_POPULATION_AND_HO..*

Grace Ndeezi et al. (2010). Effect of multiple micronutrient supplementation on survival of HIV-infected children in Uganda: a randomized, controlled trial. *Ndeezi et al. Journal of the International AIDS Society 2010, 13:18 http://www.jiasociety.org/content/13/1/18.*

Henrik Friis. (2005). Micronutrients and HIV infection: a review of current evidence. *World Health Organization Department of Nutrition for Health and Development.*

Houtzager, L., Barnes, T., & Matters, K. (2010). 18 The Nutritional Management of Patients Living with Tuberculosis and HIV Co-Infection. *Nutrition and HIV*, 385.

Houtzager, L. M. (2009). Nutrition in HIV: A review. *Benin Journal of Postgraduate Medicine*, *11*(1). http://www.ajol.info/index.php/bjpm/article/view/48829

Hsu, J. W. C., Pencharz, P. B., Macallan, D., & Tomkins, A. (2005). Macronutrients and HIV/AIDS: a review of current evidence. *World Health Organization, Durban*, 10–13.

Ivers, L. C., Cullen, K. A., Freedberg, K. A., Block, S., Coates, J., Webb, P., & Mayer, K. H. (2009). HIV/AIDS, undernutrition, and food insecurity. *Clinical infectious diseases*, *49*(7), 1096–1102.

John R Koethe and Douglas C Heimburger. (2010). Nutritional aspects of HIV-associated wasting in sub-Saharan Africa. *American Journal of Clinical Nutrition*.

Kaiser, J. D., Campa, A. M., Ondercin, J. P., Leoung, G. S., Pless, R. F., & Baum, M. K. (2006). Micronutrient supplementation increases CD4 count in HIV-infected individuals on highly active antiretroviral therapy: a prospective, double-blinded, placebo-controlled trial. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *42*(5), 523.

Koethe, J. R., Chi, B. H., Megazzini, K. M., Heimburger, D. C., & Stringer, J. S. A. (2009). Macronutrient supplementation for malnourished HIV-infected adults: a review of the evidence in resource-adequate and resource-constrained settings. *Clinical infectious diseases*, *49*(5), 787–798.

Lawson, D. (2004). *Determinants of Health Seeking Behaviour in Uganda - Is It Just Income and User Fees That Are Important?* (Development Economics and Public Policy Working Paper No. 30553). University of Manchester, Institute for Development Policy and Management (IDPM). http://econpapers.repec.org/paper/agsidpmde/30553.htm

Mangili, A., Murman, D. H., Zampini, A. M., Wanke, C. A., & Mayer, K. H. (2006). Nutrition and HIV Infection: Review of Weight Loss and Wasting in the Era of Highly Active Antiretroviral Therapy from the Nutrition for Healthy Living Cohort. *Clinical Infectious Diseases*, *42*(6), 836–842. doi:10.1086/500398

National HIV/AIDS/ STI Control Programme Ministry of Health / Ghana Health Service. (2008). GUIDELINES FOR ANTIRETROVIRAL THERAPY IN GHANA.

Olalekan A Uthman. (2008). Prevalence and pattern of HIV-related malnutrition among women in sub-Saharan Africa: a meta-analysis of demographic health surveys. *http://www.biomedcentral.com/1471-2458/8/226*.

Onyango, A. C., Walingo, M. K., Mbagaya, G., & Kakai, R. (2012). Assessing Nutrient Intake and Nutrient Status of HIV Seropositive Patients Attending Clinic at Chulaimbo Sub-District Hospital, Kenya. *Journal of Nutrition and Metabolism*, *2012*. http://www.hindawi.com/journals/jnume/2012/306530/abs/

Paluku Bahwere, Hedwig Deconinck, Theresa Banda, Angella Mtimuni, Steve Collins, Valid International, Oxford, United Kingdom; Center of Research in Epidemiology, Biostatistics, and Clinical Research, School of Public Health, Free University of Brussels, Brussels, Belgium; Save the Children, Westport, CT, US A. (2011). Impact of household food insecurity on the nutritional status and the response to therapeutic feeding of people living with human immunodeficiency virus. *Patient Preference and Adherence*.

Piwoz E et al. (2004). NUTRITION AND HIV/AIDS: Evidence, Gaps, and Priority Actions. *United Nations System Standing Committee on Nutrition*.

Shan Jiang et al. (2011). The Effect of multiple Micronutrient Supplementation on Mortality and Morbidity of HIV-infected Adults: A Meta-Analysis of Randomized Control Trials. *Journal of Nutritional Science and Vitaminology: The Vitamin Society of Japan, Japanese Society of Nutrition and Food Science*, *Vol. 58 (2012) No. 2 p. 105-112*.

Souteyrand, Y., Akwara, P., Warner Smith, M., Beusenberg, M., Jashi, M., Hayashi, C., Lou, C. (2009). Scaling up access to antiretroviral therapy in low-and middle-income countries: global and regional progress in 2008. In *5th IAS Conference on*

HIV Pathogenesis, Treatment and Prevention. http://cdrwww.who.int/entity/hiv/mediacentre/ias_2009.

Swaminathan, S., Padmapriyadarsini, C., Yoojin, L., Sukumar, B., Iliayas, S., Karthipriya, J., Sakthivel, R., Gomathy, P., Thomas, B. E., Mathew, M. (2010). Nutritional supplementation in HIV-infected individuals in South India: a prospective interventional study. *Clinical infectious diseases*, *51*(1), 51–57.

Swindale, Anne, and Paula Bilinsky. (2006). Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicato r Guide (v.2). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development, 2006. *www.fantaproject.org*.

Tony Castleman, Eleonore Seumo-Fosso,, & and Bruce Cogill. (2004). Food and Nutrition Implications of Antiretroviral Therapy in Resource Limited Settings.

UNAIDS. (2012). UNAIDS Report on the global AIDS epidemic. *WHO Library Cataloguing-in-Publication Data Global report: UNAIDS report on the global AIDS epidemic 2012 "UNAIDS / JC2417E" 1.HIV infections – therapy. 2.HIV infections – diagnosis. 3.HIV infections – epidemiology. 4.Acquired immunodeficiency syndrome – prevention and control. 5.International cooperation. I.UNAIDS. ISBN 978-92-9173-996-7 (Printed version) (NLM classification: WC 503.6) ISBN 978-92-9173-592-1 (Digital version).*

USAID Bureau for Democracy, Conflict & Humanitarian Assistance, Office of Food for Peace and the U.S. President's Emergency Plan for AIDS Relief. (2007, September). USAID P.L. 480 TITLE II FOOD AID PROGRAMS AND THE PRESIDENT'S EMERGENCY PLAN FOR AIDS RELIEF: HIV AND FOOD SECURITY CONCEPTUAL FRAMEWORK.

W. H. O. (2003). Nutrient requirements for people living with HIV/AIDS. *World Health Organization technical report series*, (894). http://libdoc.who.int/trs/WHO_TRS_894.

Weiser, S. D., Tuller, D. M., Frongillo, E. A., Senkungu, J., Mukiibi, N., & Bangsberg, D. R. (2010). Food insecurity as a barrier to sustained antiretroviral therapy adherence in Uganda. *PLoS One*, *5*(4), e10340.

WFP. (2010). WFP HIV AND AIDS POLICY.

WHO. (2012). Guideline: Intermittent iron and folic acid supplementation in non-anaemic pregnant women. *(www.who.int) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: bookorders@who.int).*

WHO and FAO. (2002). *Living well with HIV/AIDS A manual on nutritional care and support for people living with HIV/AIDS*. Rome.

WHO,UNAIDS & Unicef. (2011). Global HIV/AIDS response: epidemic update and health sector progress towards universal access: progress report 2011. Geneva: World Health Organization; 2011. Available from: h ttp. *whqlibdoc. who. int/publications/2011/9789241502986_eng. pdf.(Accessed 2012 July 3).*

Wiig, K., & Smith, C. (2007). An Exploratory Investigation of Dietary Intake and Weight in Human Immunodeficiency Virus–Seropositive Individuals in Accra, Ghana. *Journal of the American Dietetic Association*, *107*(6), 1008–1013.

World Health Organization. (2003). Nutrient requirements for people living with HIV/AIDS.

World Health Organization. (2004). The World Health Report.

World Health Organization. (2007). Regional Consultation on Nutrition and HIV/AIDS: Evidence, lessons and recommendations for action in South-East Asia. *www.who.int/nutrition*.

World Health Organization, UNAIDS and Unicef. (2011). GLOBAL HIV/AIDS RESPONSE Epidemic update and health sector progress towards Universal Access ; Progress Repport. *Publications of the World Health Organization are available on the WHO web site (www.who.int) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: bookorders@who.int).*