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**Arm-span/Height Correlation in the Luo Community – a tool to Improve Admission Criteria Based on BMI for Nutrition Rehabilitation HIV Programs**

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**Research Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Science Foods, Nutrition and Dietetics in the School of Applied Human Sciences, Kenyatta University**

May 2012

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*Arm-span/Height  
correlation in the*



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**Declaration**

This Thesis is my original work and has not been presented for a degree in any other University.

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**Dedication**

I dedicate this work to my parents William and Grace for their moral and financial support.

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## List of abbreviations and acronyms

<b>AIDS</b>	Acquired immune deficiency syndrome
<b>AMPATH</b>	Academic model for prevention and treatment of HIV and AIDS
<b>AMREF</b>	Africa medical research foundation
<b>ART</b>	Antiretroviral treatment
<b>ARV</b>	Antiretroviral
<b>BMI</b>	Body mass index
<b>BMI-as</b>	Body mass index based on arm span
<b>BMI-ht</b>	Body mass index based on height
<b>CACC</b>	Constituency AIDS Control Committee
<b>FANTA</b>	Food and nutrition technical advice
<b>FAO</b>	Food and Agriculture Organization
<b>HBC</b>	Home-based care
<b>HIV</b>	Human immunodeficiency virus
<b>HR</b>	Hazard ratio
<b>ICC</b>	Interagency Coordinating Committee
<b>KAIS</b>	Kenya AIDS Indicator Survey
<b>KDHS</b>	Kenya Demographic and Health Survey
<b>MoH</b>	Ministry of Health
<b>MSF</b>	Medecins san frontiers
<b>MUAC</b>	Middle upper arm circumference
<b>NACC</b>	National AIDS Control Council
<b>NASCOP</b>	National AIDS and STD Control Program
<b>NGO</b>	Non-governmental organization
<b>NHANES</b>	National Health and Nutrition Examination Survey
<b>PEP</b>	Post-exposure prophylaxis
<b>PEPFAR</b>	President's Emergency Plan for AIDS Relief
<b>PLWHA</b>	People living with HIV and AIDS
<b>PMTCT</b>	Prevention of mother-to-child transmission
<b>STI</b>	Sexually transmitted infection
<b>SSA</b>	Sub-Sahara Africa
<b>TB</b>	Tuberculosis

<b>TSF</b>	Technical Support Facility
<b>TWG</b>	Technical working group
<b>UNAIDS</b>	United Nations Joint Program on AIDS
<b>UNGASS</b>	United Nations General Assembly Session
<b>UNODC</b>	United Nations Office on Drugs and Crime
<b>WHO</b>	World Health Organization
<b>VCT</b>	Voluntary counseling and testing

## Abstract

Body mass index (BMI) is one of the main criteria used during targeting for therapeutic feeding. For bed ridden HIV-positive people, height cannot be accurately taken because they cannot stand straight due to gross muscle weakness resulting in inaccurate BMI calculation. Arm span has been shown to correlate with height and is not affected by sickness or aging but varies with ethnicity. This study was to explore the correlation between arm span/demi span and height among the Luo community so as to come up with a correlation equation that can be used to approximate the height of bedridden HIV positive people. A cross sectional study was done and the main objective was to determine the correlation between arm span and height among the Luo community. The study location was Homabay MSF HIV clinic with the sample size of 500 Luo adults between the age 18 and 60 years. At the study site, anthropometric measurements were taken using the standard techniques. Partial correlation between arm span/demi arm span and height with control of sex was done. Stepwise forward analysis was done to enable construction of a correlation equation that best estimate height from arm span. Bland-Altman assessment of agreement was done to check the difference in the use of either predicted height from arm span or demi arm span to calculate BMI. Scatter plot diagrams were used to show the correlation between arm span/demi span and height. Tables showing anthropometric characteristics of the sample, arm span/ demi span and height correlation by sex, prediction models, partial correlation between MUAC and BMI, sex specific regression equation relating arm span/demi span and height and BMI-as cut offs equivalent to BMI-height cut offs for classifying nutritional status among adults were used to present data. The study found that there were differences in all variables between males and females from the Luo community. There was a high arm span/demi span with height correlation (0.86) in both sexes among the Luo community. Arm span alone accounted for 83.6% of the variability in height with sex and age having no impact on the variability. The prediction equations for estimating height are:  $\text{Height}=0.71(\text{arm span})+40.86$  and  $\text{Height}=1.44(\text{demi arm span})+43.28$ . Partial correlation between BMI-as/BMI-ht with MUAC (controlled by sex) showed the lowest (0.57) and the highest (0.65) correlations respectively. In conclusion, the height estimated from arm span can be used to calculate BMI as a way of improving admission criteria for therapeutic feeding programs for the HIV positive adults in the Luo community. More research is recommended to determine the trend in other communities in Kenya and other African countries where there is high HIV prevalence.

## CHAPTER ONE: INTRODUCTION

### 1.1 Background

The complex nature of HIV has shown the need for renewed approaches of tackling malnutrition. Combined with underdevelopment, this complexity has increased the risk caused by other factors leading to worsening malnutrition, both directly through infection and indirectly by increasing poverty and decreasing economic abilities (De Waal and Whiteside, 2003). Despite the major achievements in the fight against HIV infection and enhancement of financial support, HIV and AIDS related illnesses and deaths in developing countries remains high (Louise, 2009). The major contributing factor is that more than 800 million people globally are chronically malnourished and the HIV scourge largely affects people with poor diet quality and quantity (Koethe, 2009).

Access to antiretroviral treatment for HIV infection has increased all over sub-Saharan Africa, but malnutrition and food insecurity have become the major obstacles in HIV care and treatment programs (Koethe, 2009). Several countries in the region have reported clinical and programmatic successes (Bussmann, 2008, Nash, 2008) but malnutrition makes it difficult for the care to succeed in areas burdened by the combined epidemics of high HIV prevalence and food insecurity (FAO, 2009). Protein-calorie malnutrition (a common form of malnutrition in the region) escalates HIV disease progression, and food insecurity is a barrier to medication adherence.

An estimated 33.2 million people globally were HIV positive in 2007, with 2.5 million new infections and 2.1 million deaths due to AIDS. Sub-Saharan Africa (SSA) continued to be the most affected by this epidemic. Nearly 22.5 million adults and children had HIV and AIDS in 2007 (UNAIDS, 2008). Specifically, HIV prevalence in Kenya was 6.3% by 2009 (UNGASS, 2010) a decrease from 7.4% in 2007 according to a survey released by the

government (KAIS, 2007), with estimated 1.4 million adults living with HIV and AIDS. The decrease in the prevalence of HIV is likely because of increased uptake of prevention messages and access to antiretroviral therapy.

Kenya is one of the 15 countries which are trying to enhance HIV and AIDS programs with financial support from the President's Emergency Plan for AIDS Relief (PEPFAR). The HIV and AIDS infections in these countries together represent estimated 50 percent of HIV infections globally (UNGASS, 2008). In accordance with the 2009-13 Kenyan National HIV and AIDS Strategic Plan, the Government of Kenya identified good nutrition as an important component in the national program against HIV and AIDS epidemic. The key responses identified are: management of severely malnourished children (in-patient, transition phase and out-patient management), nutritional supplementation for moderately malnourished adults and children, micro-nutrient supplementation for people living with HIV (both adults and children in care), and provision of breast milk substitutes for exclusive replacement feeding for infants where the acceptable, feasible, affordable, sustainable and safe (AFASS) criterion is met. This should be done in relation to the evidence that good nutrition is necessary for the promotion of health and quality of life of all people, especially those living with HIV and AIDS (GOK, 2009).

Nyanza, where this study was done, is one of the most densely populated provinces in the country and accommodates the third largest population (5,442,711) after Rift valley (10,006,805) and Eastern provinces (5,668,123) (GOK, 2010). Despite its demographic and related political importance nationally and the economic potential that the Lake basin offers, the Southern part of Nyanza province has the highest poverty levels of up to 64% nationally (National Poverty Survey, 2007). Nyanza also bears the highest HIV prevalence rates

(15.3%) countrywide compared to 7.4%, the national prevalence rate (KAIS, 2007). Luos, who are the majority in Nyanza, have the highest HIV prevalence of up to 29.9% nationally.

However, food security in Kenya has remained precarious due to unpredictable rains and the unstable shilling (GOK, 2011). History has revealed that the vulnerable communities will soon fall back to needy situation. The current food security situation is poor for the people who bear the worst effects of HIV and AIDS scourge (ibid). The situation has affected the most vulnerable groups, including the elderly, women-headed households, and the orphans who are less likely to recover from crises and do not always use the traditional coping mechanisms. Food insecurity in the Homabay is more common in the dry and less productive divisions of Kobama and Nyarongi divisions due to low financial abilities and poor and unsustainable sources of livelihoods. The high dependency rate of 1:133 is also a barrier to the labor force to accumulate savings for investments and increased productivity, creating a vicious cycle of food insecurity (GOK, 2007). Due to inadequate food production and food access, cases of malnutrition are common. The situation is confounded by lack of affordable access to primary health care services in the district.

There is an important relationship between HIV and nutrition. HIV infection increases nutrient requirements, and at the same time impairs nutrient intake and uptake. In turn, poor nutrition increases the risk of opportunistic infections and accelerates the progression of HIV to AIDS. Malnutrition and HIV and AIDS are synergistic and create a vicious cycle that generally weakens the immune system (FANTA, 2005). Proper nutritional management of ART clients helps improve drug effectiveness, tolerance, safety and adherence and helps maintain patients' nutritional status. Maintaining adequate food consumption and nutrient intake levels to meet the nutritional needs of those living with HIV and AIDS is therefore important. Studies on patient outcomes have shown that a low body mass index, after the start

of ART as an independent predictor of early death, (Paton, 2006) but the causes of a low body mass index are multi-factorial (John et al, 2009).

Anthropometric measurements provide simple friendly method to assess the nutritional status of populations (FAO, 1996). They are important in the determination of the nutritional state of children and BMI for adults. The World Health Organization grades malnutrition according to body mass index (BMI), as mild (17.00–18.49), moderate (16.00–16.99), and severe ( $<16.00 \text{ kg/m}^2$ ) (United Nations ACC/SCN, 2000). The causes of low BMI are multi factorial and may represent a number of conditions ranging from normal anthropometric variation to wasting associated with HIV and other infections. Accurate anthropometric measurements of older adults might be difficult to obtain because of changes in body composition, posture and mobility which occur during aging process. Several studies have documented the challenge in estimating height in severely malnourished adults. In a study done at Homabay District Hospital, staff had difficulties in estimating height in the bedridden patients, which lead to inaccuracies in BMI as admission and discharge criteria (Dibari, 2008). In many older persons, the use of BMI, the conventional index that is used to determine adult's nutritional status is limited by the measurement of height which is often unreliable (Kwok and Whitelaw, 1991).

Generally all malnourished individuals, HIV positive or not, are in need of improved nutrition care through any means possible and feasible. Moderate to severe malnutrition at the time of starting ART is a significant independent predictor of death (hazard ratio [HR] 2.19, for those with BMI  $<17$  compared with those with BMI  $>18.5$ ) (Paton, 2006). In Zambia, for example, patients with a BMI  $<16.0 \text{ kg/m}^2$  had higher mortality in the first 3 months on ART, (adjusted hazard ratio [AHR]: 2.4, 95% CI: 1.8 to 3.2) when compared with those above this BMI threshold (John et al, 2009). The question of when nutrition interventions should start

emerges with the establishment of energy requirements of those living with HIV, even at asymptomatic stage (Elizabeth, et al, 2006). Widespread provision of nutrition counseling to all people living with HIV and AIDS is one measure to address these energy needs, but more intervention may be needed.

The World Food Program and the Food and Agricultural Organization of the United Nations have tailored their response to address malnutrition and HIV in many of the most affected populations in sub-Saharan Africa. Most of these programs deliver staple foods to areas of scarcity, provide agricultural trainings and assistance to improve local production in a community-level effort to avert the development or reduce the advancement of malnutrition. This food-first approach is based on the findings that the prevalence and severity of a number of diseases are higher in poorly nourished populations. However, a difference should be made between supplementary feeding and therapeutic feeding. Supplementary feeding aims at provision of food rations (either local staples or specialized foods) to vulnerable or malnourished persons to enhance the local diet and provide balanced and/or adequate daily energy intake.

Therapeutic feeding on the other hand aims at nutritional rehabilitation of severely malnourished adults with specific foods that are often high in energy and nutrients (FANTA, 2005). Whether the response represents supplementary or therapeutic feeding may depend on the target population or the aim of the program, but some products may be more suitable to the latter. For example ready-to-use therapeutic foods (RUTFs) are appropriate for the management of severe acute malnutrition because of their nutrient concentration while micronutrient supplements are suitable for management of moderate acute malnutrition.

The major cause of weight loss in HIV-infected patients is thought to be anorexia caused by raised interleukin-1, interleukin-6, and tumor necrosis factor  $\alpha$  (Macallan, 1995 and Powanda,

2003). Oral and gastrointestinal infections and manifestations of advanced HIV disease (e.g., fatigue, fever, and dyspnea), adds to progressive disability and interfere with an individual's capacity to ingest or swallow food (Bukusuba, 2007). After initiating ART, the negative effects associated with the use of certain antiretroviral drugs (e.g. nausea and insomnia) may be increased if these drugs are taken without food (Hardon, 2007, Ammassari, 2001), and poor nutrition may lead to drug toxicity (WHO, 2004).

## 1.2 Problem statement

Body Mass Index (derived by  $\text{weight(kg)/Height (M}^2\text{)}$ ) is the indicator of the nutritional status in adults during targeting in therapeutic feeding programs and is also one of the main admission criteria ( $\text{BMI}<17$ ) based on Paton et al., (2006). Measuring height in malnourished adults is often challenging due to their muscle gross weakness/pain which does not allow them to stand or lean straight against the stadiometer (Kwok and Whitelaw, 1991). Therefore the mistake in height estimation is squared during calculation, finally raising the BMI value. The consequence is that a certain number of patients are not admitted to therapeutic nutrition rehabilitation even if entitled to. This often leads to a decrease of survival (direct observation in the Kenyan MoH/MSF HIV/TB programs) (Dibari, 2008).

An alternative, simple system to estimate height is the arm-span/demi arm-span. Unfortunately the arm-span measure is accurate but ethnicity-specific (Reeves, 1996). Equations for determining height from arm-span/demi arm-span in African populations are few and based on small samples (Chilima and Ismail, 1998). This study was done to explore the possibility of estimating height using arm-span/demi arm-span. It aimed to develop a regression equation, to be used as a tool to improve height estimation and therefore accuracy of BMI for the bedridden HIV positive patients from the Luo community. In addition, the study was to determine the BMI using arm-span (BMI-as) cut off values

equivalent to conventional BMI using height (BMI-ht) cut off values then compare them. This BMI-as cut off will be useful in assessing the nutritional status of the HIV positive patients so as to decrease exclusion error during targeting.

### **1.2.1 Justification**

Several studies have documented the effectiveness of using various body parameters in calculating body height (Yun et al, 1995) and the arm-span was found to be the most reliable (Jalzem and Gledhill, 1993) and therefore was chosen as the anthropometric measure to use. In addition, it is a simple and inexpensive measurement to obtain in the field setting. Homabay district was chosen because MOH and MSF run a therapeutic feeding program which supports the HIV positive patients and are currently challenged by the problem of targeting, especially for the bed ridden as per the MSF technical briefing report released in 2008 (Dibari, 2008). Also, Nyanza Province has the highest HIV prevalence countrywide (KAIS, 2007). Nationally, Luos have the highest HIV prevalence rate of up to 29.9% and are the majority inhabitants of Nyanza province. Because of the simplicity and importance of mid upper arm circumference in nutritional screening, MUAC measurement was also taken.

## **1.3 Objectives**

### **1.3.1 Main Objective**

1. Develop a tool to be used to improve the targeting criteria based on BMI by estimating BMI from arm-span/demi arm-span for the severely malnourished bedridden HIV positive patients in the Luo community.

### **1.3.2 Specific objectives**

1. To determine the anthropometric characteristics of the study population.
2. To determine the correlation between arm-span/ demi arm-span and actual height among the Luos.
3. To investigate the use of arm-span/demi arm-span as a proxy for height in the assessment of nutritional status using body mass index (BMI) for the Luo community.
4. To formulate an ethnic specific equation for height estimation using arm-span/demi arm-span applicable to Luos.

### **1.4 Hypotheses**

Ho<sub>1</sub>- There is no correlation between arm-span/demi arm span and height among the Luo community.

Ho<sub>2</sub>- There is a correlation between arm-span/demi arm span and height among the Luo community.

Ho<sub>1</sub> -There is no relationship between the BMI-as and BMI-hgt among the Luo community.

Ho<sub>2</sub> -There is a relationship between BMI based on arm-span and BMI based on height among the Luo community.

### **1.5 Significance of the study**

The study developed an equation to adjust the arm-span/demi arm-span estimate into the height in Luo bedridden patients. This tool is useful for health workers and nutritionists during the targeting of HIV positive patients for therapeutic feeding programs so as to minimize exclusion error hence reduce the mortality rates among the Luo community.

## **1.6 Limitations**

Intermarriage between Luos and other tribes may have led to change in genetic make-up of the current generation Luo population. However, family tree was followed.

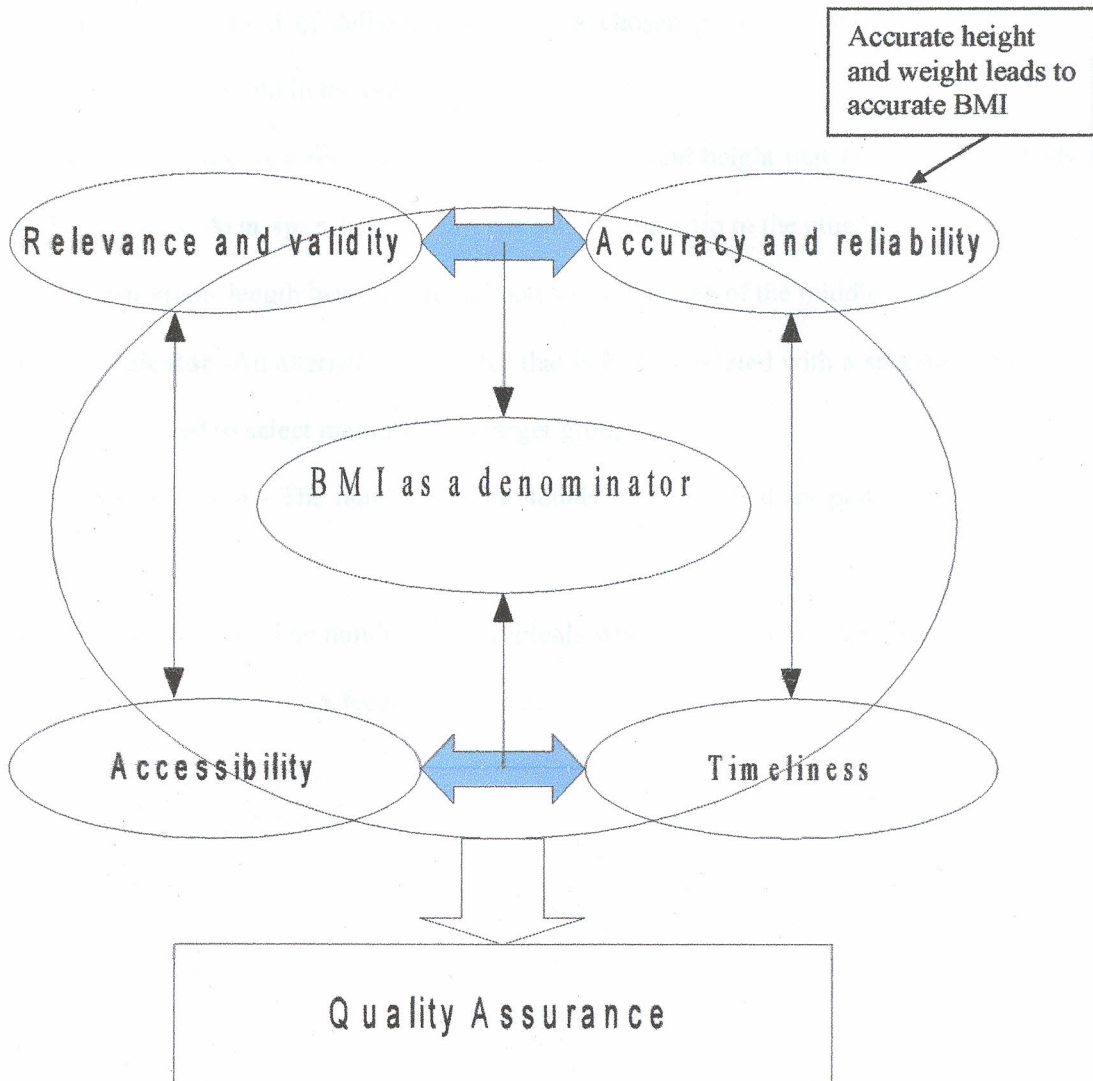
## **1.7 Delimitations**

Participants in this study included adults from the Luo community aged 18-60 years of age who were not malnourished ( $BMI > 18.5$ ) and at the first stage of HIV (asymptomatic stage).

## **1.8 Conceptual Framework**

When choosing particular targeting indicators, the aim is to maximize the usefulness and quality of the information for decision-making, while taking consideration of the costs of collecting, processing and analyzing the data. This study adopted a self-authored conceptual framework. For any targeting criterion to be effective, it must be valid and relevant, accurate and reliable, accessible and timely. All these attributes are interrelated in that one cannot be achieved without achieving the other. The study focused on improving the accuracy of height so as to improve accuracy of BMI for the HIV positive bedridden patients. By estimating height based on arm-span, the study will improve the overall accuracy of the targeting criteria and therefore making it more relevant for use in targeting for bedridden patients. Because of the accuracy, it will enable early detection of malnutrition making it timely. Targeting indicators that require time-consuming data collection, processing and analysis may delay program implementation. The criteria must also be capable of identifying vulnerabilities where the at-risk populations are and what their immediate needs are. Since it is simple to calculate, it is a more accessible method in the hospital setting. All those combined will make BMI an important targeting criterion. Generally this will contribute to quality assurance of the targeting indicator leading to better results of the program. The variables in this study

were height (independent) and arm-span/demi arm-span (dependent) while age and sex were the confounding factors.



**Figure 1 Conceptual Framework**

**Source: Author**

## 1.9 Definition of Terms

**Targeting-** A method of delivering foods to a chosen group of individuals rather than to everyone or household in the population.

**Body Mass Index-** is a relationship between weight and height that is related with body fat and health risk. **Arm-span-**length from one middle fingertip to the other middle fingertip

**Demi arm-span-** length between sternal notches to the web of the middle finger

**Proxy indicator** -An alternative indicator that is closely related with a specific indicator and can also be used to select members of a target group.

**Error of exclusion** - The number of individuals who qualified for participation but are not selected.

**Error of inclusion** - The number of individuals who did not qualify for participation but are selected to be included in a feeding program.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Introduction

Malnutrition among people living with HIV remains a big challenge to achieving the full success of response aimed at improving their quality of life, productivity and endurance. Morbidity and mortality associated with human immunodeficiency virus (HIV) infection in the developing countries remain high, despite major achievements in HIV treatment and increased donor support for care (UNAIDS, 2007). People living with HIV infection (themselves or among family members) face not just sickness but also compromised efficiency, deteriorating income, and increasingly tough choices among essential but challenging costs, such as food versus health care or education versus rent (Oldewage and Dicks, 2006).

The functional complications associated with advancement of HIV infection are confounded by the problems associated with poverty, because it translates into inadequate consumption of a diet of good quality and quantity to boost immune function and support medical therapy. Recently, several international agencies emphasized that targeted nutritional interventions should be related to antiretroviral interventions (WHO, 2005). Initially, HIV was commonly referred to as “slim disease,” emphasizing the presence of severe wasting. This term has continued to be used in local languages in Kenya, implying the common existence of nutritional degeneration (FANTA, 2009).

Fighting under-nutrition and HIV and AIDS are two of the eight United Nations Millennium Development Goals to be attained by 2015. International targets which form a blueprint for setting priorities for the world’s poor. The multifaceted nature of interaction between HIV infection and nutrition completely threatens the attainment of these goals. The HIV and AIDS

epidemic poses an unavoidable challenge to the world at large and to Africa in particular. More than 800 million people globally are chronically malnourished, and 133 million are HIV positive (UNAIDS, 2008). An immense effort is needed to mitigate the effect of the epidemic, and nutritional care and support should be the basic element of any intervention.

Reviews of service utilization data shows that 15 to 65 percent of adults attending comprehensive care centers (CCCs) in public facilities in Kenya have body mass index (BMI) below  $18.5 \text{ kg/m}^2$  (UNICEF; FBP program data cited by FANTA-2, 2009). Among orphans and vulnerable children (OVC), it is estimated that 30 percent are underweight with weight-for-age (WFA) below -2 z-score. In addition, the rates of malnutrition among people living with HIV seem to be relatively greater among patients living in areas with poorer food security. Given that nutritional disorder begin early in the disease progression, wide-ranging nutrition responses are increasingly being encouraged to be given collectively with antiretroviral treatment. The main aim of nutritional response is to avert malnutrition and re-establish good nutritional status of malnourished people living with HIV with a view to maintain their productivity and immune function abilities. These interventions also aim to improve observance to treatment and possibly extend the pre-antiretroviral stage.

An evidence-based intervention is required to reduce the overall burden of malnutrition and the severity and density of the impact that HIV and AIDS and malnutrition have on each other. A diverse, healthy diet and sufficient micronutrient intake are essential to better health for HIV infected individuals. Nutrition education and support about nutrition, mostly in nutritionally vulnerable populations is essential.

Anthropometric indicators that are used to screen people living with HIV for malnutrition and the need for specialized food products include body mass index, mid-upper arm circumference (MUAC), weight gain during pregnancy and unintentional weight loss (Cogill,

2003 ). These indicators are frequently used without any other assessment to decide on their suitability for the provision of specific food products. However, specialized food products should not be given separately. Medical examination and care, as well as nutrition assessment and counseling are recommended for people living with HIV with malnutrition. Furthermore, other clinical indicators of malnutrition such as bilateral pitting edema should also be considered when defining the need for treatment of malnutrition.

## **2.2 Trends in HIV Prevalence**

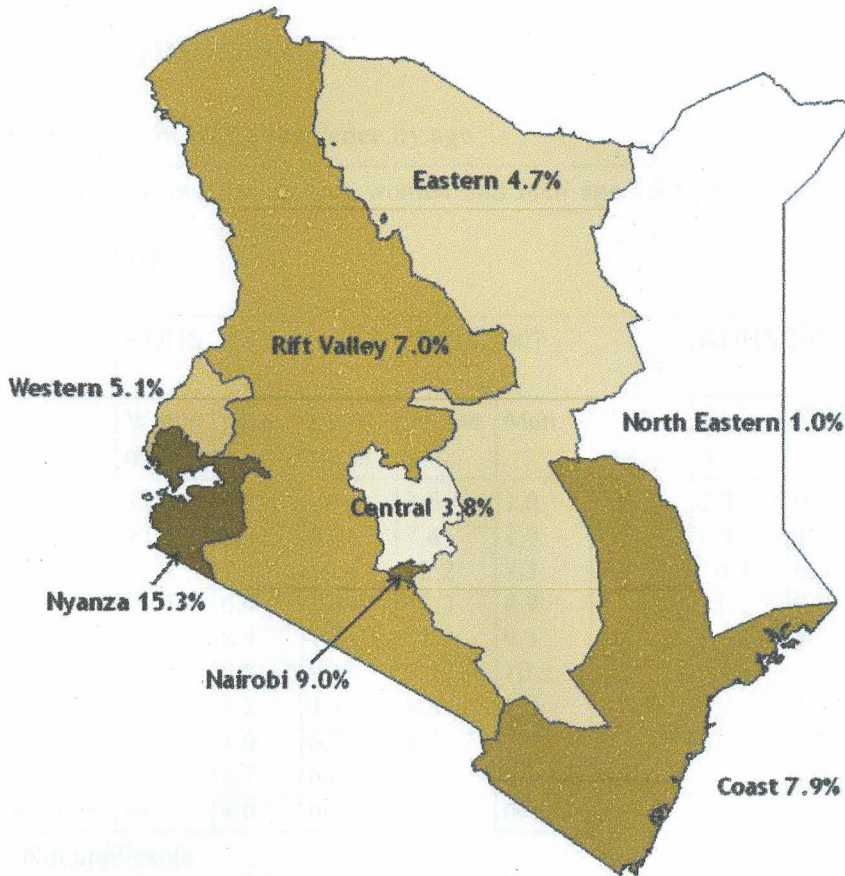
The global percentage of people living with HIV has steadied since 2000 in part as a result of success in growing access to antiretroviral drugs. However, the overall number of people living with HIV has risen as a result of the current number of new infections each year and the positive effects of more extensively available antiretroviral therapy. In 2008, the approximated number of new HIV infections was about 30% lower than at the epidemic's highest 12 years earlier (UNAIDS, 2009). Sub-Saharan Africa remains most severely affected, accounting for 67% of all people living with HIV and for 72% of AIDS related mortality in 2007.

The global epidemic is steady but at a way too high level. In 2008, estimated 2.7 million [2.4 million–3.0 million] new HIV infections documented. It is estimated that 2 million [1.7 million–2.4 million] people died due to AIDS-related illnesses globally in 2008. (UNAIDS, 2009) Sub-Saharan Africa remains the most heavily affected, accounting for 71% of all new infections in 2008. While the rate of new HIV infections in sub-Saharan Africa has gradually dropped with the rates of new infections in 2008 approximately 25% lower than at the epidemic's highest in 1995. The number of people living with HIV in sub-Saharan Africa marginally rose in 2008, relatively due to increased life span as a result of increased access to

HIV treatment. Adult (15–49 years) HIV prevalence dropped from 5.8% [5.5–6.0%] in 2001 to 5.2% [4.9–5.4%] in 2008.

Though prevalence in most countries have steadied or begun to fall, findings from Kenya showed that in 2007, HIV infections are increased (KIAS, 2007). KAIS estimates that 1.4 million adults in Kenya have HIV. Nyanza and Rift Valley provinces host more than half of the HIV positive adults in Kenya. This may be because of the cultural practices and different population sizes across provinces. Provinces hosting the highest HIV prevalence include: Nyanza (15.3%), Nairobi (9.0%), Coast (7.9%), and Rift Valley (7.0%). North-Eastern province has the lowest prevalence with less than 1% of the population infected. (The map below shows the percentage prevalence per province). HIV has a damaging effect on food security and therefore malnutrition is more likely to rise. Stage three of AIDS is characterized by patients being bedridden. The implication is that there will be more bedridden patients and therefore need for a precise means of selecting the beneficiaries for food support for those malnourished.

## Prevalence of HIV AIDS in Kenya



**Figure 2 Map showing prevalence of HIV AIDS in Kenya per Province**

Source: Kenya AIDS Indicator Survey 2007

Statistics from three nationally-representative population based surveys in Kenya show different trends in HIV among different age clusters (KDHS, 2008-2009). Overall, HIV infection levels dropped marginally among those aged 15-49 years, from 7 percent in 2003 and 2007 to 6 percent in 2008-09. Among women aged 15-49 years, HIV prevalence decreased from 9 percent in 2003 and 2007 to 8 percent in 2008-09, while among men aged 15-49 years, HIV prevalence rose from 5 percent in 2003 to 6 percent in 2007 and then

declined to 4 percent in 2008-09. The table below shows the trends in HIV prevalence from surveys from 2003 to 2009.

**Table 1 Trends in HIV prevalence by age**

Percentage HIV positive among women and men age 15-54 by age group, Kenya 2003 to 2008-09									
	KDHS 2003			KAIS 2007			KDHS 2008-09		
Age	Wome n	Men	Both sexes	Wome n	Men	Both sexes	Wome n	Men	Both sexes
15-19	3.0	0.4	1.6	3.5	1.0	2.3	2.7	0.7	1.7
20-24	9.0	2.4	6.0	7.4	1.9	5.2	6.4	1.5	4.2
25-29	12.9	7.3	10.4	10.2	7.3	9.1	10.4	6.5	8.8
30-34	11.7	6.6	9.4	13.3	8.9	11.6	11.0	6.8	9.1
35-39	11.8	8.4	10.1	11.2	9.3	10.5	8.8	10.4	9.5
40-44	9.5	8.8	9.1	9.4	10.2	9.7	14.3	5.7	10.3
45-49	3.9	5.2	4.4	8.8	5.6	7.5	6.4	4.3	5.5
Total 15-49	8.7	4.6	6.7	8.8	5.5	7.4	8.0	4.3	6.3
Age 50-54	na	5.7	na	7.5	8.3	7.8	na	9.1	na
Total 15-54	na	4.6	na	na	na	na	na	4.6	na

na = Not applicable  
Source: CBS, MOH, and ORC Macro, 2004, NASCOP, 2009.

### 2.3 Nutrition in HIV and AIDS

The relationship between nutrition and HIV and AIDS is clear: HIV negative people with poor diets are more prone to infection and have compromised immunity to HIV. HIV positive people with poor diets progress to AIDS more quickly and people with AIDS have higher nutritional requirements. Both malnutrition and HIV and AIDS have a direct bearing on the immune system, lowering people's capacity to resist and battle infection. However, nutrition interventions to reduce or avert the weight loss and wasting related with HIV may help to ensure good health, improve quality of life, and extend survival (Piwoz and Preble, 2000)

The prevalence of adult malnutrition in sub-Saharan Africa is challenging to assess and differs with natural and man-made causes, but an assessment of numerous demographic and

nutrition surveys projected that 10%–20% of African women aged 20–49 years are malnourished (mean BMI, 18.5 kg/m<sup>2</sup>) (United Nations ACC/SCN, 2000). Protein-calorie malnutrition, caused by deficient intake of both protein and energy, is a common form of malnutrition in areas categorized as food insecure. Similar to AIDS, protein-calorie malnutrition is related with defeat of the antigen specific arms of the immune system and several generalized host protection mechanisms. Protein calorie malnutrition is linked with repetition of viral infections, reversal of the ratio of T cell helpers to T cell suppressors (Gershwin, 1984) decreased T cell primary antibody response and memory response (Najera, 2007), and wasting of the lymph tissues (Savino, 2002). Marginal lymphocyte and eosinophil amounts may be reduced and natural killer cells show decreased activity. As with HIV infection, protein calorie malnutrition may also prompt a generalized pro-inflammatory reaction, especially in the mucosal barriers, causing increased exposure to environmental pathogens (Dulger, 2002). Persons with protein calorie malnutrition are more at risk to opportunistic infections and more likely to suffer greater sickness (Schaible, 2007).

HIV and AIDS reduce a household's labor, income and food supplies undermining food security. This contributes to majority of households with people living with HIV becoming food insecure (GOK, 2006). Where prevalence of HIV and AIDS is high, a whole community's capacity to produce and buy food declines. This is the case in Nyanza province where HIV prevalence is high (KAIS, 2007). As a coping strategy, people living with HIV and their families are frequently forced to seek alternative ill fated measures like, reduce food intake at each meal, skip meals, adopt risky behaviors such commercial sex, remove children from school which advances child labor practices, intensifies crime and migration, disregard nutrition recommendations, consume wild foods and fruits to cope with hunger, sell key assets for short term food security. All these coping strategies additionally increase food

insecurity among the households, adding to the threat of malnutrition among the people living with HIV.

According to WHO (2003), the HIV and AIDS epidemic is affecting populations where malnutrition is already prevalent. As an urgent priority, greater political, monetary and technical support should be provided to improve dietary quality and increasing dietary intake to the recommended levels. In addition, focused proven nutrition response should be part of all national AIDS control and treatment programs, e.g. the government of Kenya has started a cash transfer program which provides financial and social support to the poorest households containing OVC, with special concern for those children with or are affected by HIV and AIDS (Bryant, 2009). This is what most international NGOs are doing and to achieve greater success, there is need to correctly target the beneficiaries for nutrition support.

Under-nutrition and HIV status have negative feedback circles, leading to severe effects on the survival of individuals, households and communities. Such connection occurs at both the level of the HIV-infected individual and the level of the affected households in terms of medical, dietary, quality-of-life, and livelihood outcomes. At the individual level, a lack of access to adequate diet and the direct effect that HIV has on weakened metabolic functions in absorption, storage, and use of nutrients can result in compromised immunity, nutrient deficiencies, and increased susceptibility to infectious diseases (Katona and Katona, 2008). Inadequate food consumption or mal-absorption results in weight loss which further worsens the catabolic nature of HIV infection (Wheeler, 1999). Weight loss is itself an important, independent danger for AIDS-related mortality and HIV-associated wasting often continues even with use of ART (De Waal and Whiteside, 2003.) HIV disease and its difficulties drain nutritional stores as a result of the body's normal response to infection, therefore causing nutrition related problems. The serious levels in the decline of nutrition status tally with the

cutoff points for malnutrition, which for most interventions are set at BMI < 18.5 kg/m<sup>2</sup> for adults living with HIV, MUAC < 21 cm for pregnant women and WFA < -1.5 z-score for OVC, including young children( FANTA, 2009)

When weight alone is used as the sole criteria for the wasting progression, this may underrate the grade of tissue and functional losses (Zaneta, 2003). Metabolic stress responses cause breakdown of protein stores to release energy and increase the amino acid pool. Fluid movement also occurs, increasing fluids outside of cells while fluid inside the cell associated with protein stores is exhausted. HIV does not appear to be dormant and sends a continuous message to the body to react. Even with treatment, the virus may create a "set-point" and reproduce as much as necessary to keep that level of viral amount (Zaneta, 2003). This continuous attack may require alteration by the body to bear and endure the effects of the virus. For instance, if muscle stores are very low, the body may adapt by lowering energy levels therefore causing long-lasting weakness.

The aim of nutrition intervention for people living with HIV in need of ART is to improve their nutritional status before and during medication, help people provide more energy. In areas where food insecurity prevents access to or adhering to treatment, nutrition intervention plays a key role in improving uptake and adherence to medication (Megazzini et al, 2006). According to FANTA (2009), in resource-poor areas where poverty and food insecurity are prevalent, use of therapeutic and supplementary food is a crucial component of comprehensive care intervention, promoting adherence to medication and treating malnutrition during treatment. To attain maximum success, proper targeting must be put in place.

The major problem in dealing with adult under-nutrition during famine is the lack of clear difference between primary and secondary malnutrition. Currently, there are no one-off

measurements that can define the difference (Collins, 2000). In practice, admission into selective feeding programs should be done by chances criteria irrespective of whether it is due to primary or secondary malnutrition. Those with secondary malnutrition (for example, TB or HIV) will not respond effectively to medication. Adult selective feeding programs should therefore be planned in a way to allow for better referral to other appropriate support or treatment programs.

People with HIV are at higher risk of malnutrition than those who are not infected. HIV and secondary infections interfere with appetite and ability to eat therefore decreasing the dietary intake, causing mal-absorption, raising energy demand thus increasing nutrient needs and causing abnormal utilization of protein. During asymptomatic stage (WHO stage 1), HIV-positive adults need a 10 percent increase over the normal level of recommended energy intake for healthy HIV negative persons of the same characteristics (FANTA, 2004; WHO, 2003). In the presence of symptoms (WHO stage 2 and above), HIV positive adults, a 20 to 30 percent over the level of recommended energy intake for healthy non HIV infected persons is needed (WHO, 2003).

**Table 2 Stages of HIV infection progressing to full blown aids for adults**

Early Stage	Intermediate Stage	Late Stage
(Asymptomatic) • Weight loss of less than 5%. • Increased energy need (10% more). a) Largely no related symptoms (except in the first few weeks). b) Lymph glands enlarged. c) Immune system weakened and frequent upper respiratory tract infections. d) Normal activity.	(Early symptomatic) • Increased energy needs (20% more). • Weight loss greater than 10% failure to thrive. • Persistent fever and diarrhea • Early opportunistic infections: Mucous membrane and skin infection (e.g. Candidiasis) Recurring respiratory tract infections. • Normal or partial activity (bed ridden for less than 50% of the time)	(Full blown AIDS) • Increased energy requirement (30% more). • Weight loss greater than 10% and wasting. • Multiple signs and symptoms. • AIDS defining OIs: Chronic diarrhea Pneumonia Candidiasis Tuberculosis (TB) Kaposi sarcoma • Weight loss/wasting • Weak and low activity (bed ridden for more than 50% of the time).

**Source: WHO, 2003**

Research shows that HIV positive persons require the same amounts of protein as healthy HIV negative persons of the same age, sex, and physical activity level, though few studies have been done. The recommended protein levels for a healthy HIV negative adult is 12 to 15 percent of total energy needs, or 0.8g/kg body weight for females and 0.85g/kg body weight for males (WHO, 2003). HIV positive people normally have pre-existing protein-energy malnutrition (PEM) due to low intake or poor utilization of nutrients in the body (FANTA, 2004). Nutrition support interventions may need to address this by promoting food consumption to meet recommended intakes.

Poor food security and lack of knowledge on good nutrition in parts of Kenya where HIV prevalence is high, makes the situation worse (GOK, 2006). The major nutritional concerns for HIVpositive people include: the intake of a balanced diet on a regular basis, factors that disrupts food intake and utilization, drug/nutrient interactions, interventions to help manage malnutrition related conditions and chronic abnormalities such as diabetes mellitus. HIV and related malnutrition continuously impairs the immune system, lowering quality of life and chances of survival. Nutritional support as a support intervention to ART treatment will promote rehabilitation, improve antiretroviral therapy and increase adherence to treatment (WHO, 2008). Ensuring adequate food intake and nutrient levels to meet the high nutritional needs of people with HIV is therefore important.

Proper nutrition may contribute to lowering the progression of HIV (Castleman, 2004). Nutrition interventions help to improve the benefits of antiretroviral drugs (ARVs) and may increase adherence to medication, both of which are necessary to prolonging the lives of those with HIV and to prevent the transmission from mother to child. The Academic Model for Prevention and Treatment of HIV and AIDS (AMPATH) started one such intervention in 2002 in western Kenya with a large scale expansion with the support of World Food Program food donations and fresh foods cultivated on AMPATH production farms (Byron, Gillespie and Nangami, 2006).

Patients with acute HIV and AIDS related malnutrition are grouped based on their inability to eat, their appetite status and the level of gut infections or inability to utilize nutrients. For these individuals, therapeutic nutrition interventions should be used to rehabilitate or prevent the worsening of malnutrition. The feeding options are voluntary oral sip feeding and non-voluntary therapeutic enteral and parenteral nutrition services. The nutrition provider must make sure the food have nutrients in correct amounts (GOK, 2006).

High energy needs for HIV positive persons, harmful side effects of treatment that may be made worse by malnutrition (but more likely to be reduced by nutrition intervention), and the risks due to declines in adherence and drug resistance, are all justifications to design more and adequate nutrition interventions for individuals on medication (Paton, 2006). These needs apply to any situation where malnutrition and high or rising HIV prevalence coexists.

The occurrence of oral infections further contribute to rise in caloric and nutrient needs. In addition, psychological stress impacts on nutrient intake and can increase the risk of malnutrition. Nutrition management of HIV and AIDS related signs can prevent malnutrition and promote the general health and nutrition of people with HIV. They can also help reduce some symptoms, such as nausea and constipation and decrease the severity of symptoms by supplying particular nutrient needs (FANTA, 2004). The target beneficiaries and composition of food for intervention should be based on the program's objectives and the quality of the patients' diet as well as their eating habits and consumption patterns.

Their food should be fortified with micronutrients or be nutrient dense. It is very important to know the acceptability of available foods especially considering their eating and digestive difficulties related to HIV (FANTA, 2004). To treat and prevent malnutrition, the intervention should ensure that the ration will be received and utilized by the intended beneficiary. Therefore intervention should be based on a specific criterion for beneficiary selection which in most cases BMI is used. Greenaway et al. (2004) noted that program sustainability may depend on designing a criterion for beneficiary selection and a program exit strategy.

## 2.4 The Cycle of Malnutrition and HIV Infection

Malnutrition prevalence is on the rise in the African region (WHO, 2005). Food insecurity and malnutrition coexist with HIV and AIDS to lead some countries to a big crisis. Additionally, food is often cited as the most common and crucial need by people living with HIV and AIDS and others affected by the condition (WHO, 2005). Noted since the start of the AIDS pandemic, (Serwadda, 1985) malnutrition is common and a sign of poor diagnosis among HIV infected people (Suttman, 1995). Food insecurity and malnutrition are main causes of the problems and suffering focused on by all other millennium development goals (MDGs) (FAO, 2005).

For people living with HIV the condition causes or worsens malnutrition as a result of reduced food intake, poor nutrient absorption and rising caloric needs. Malnutrition consequently can worsen the disease and its effects by disturbing the immune function, increasing risk of infections and in some cases compromising effectiveness of treatment (A compendium of promising practices, 2008).

### Cycle of malnutrition in HIV

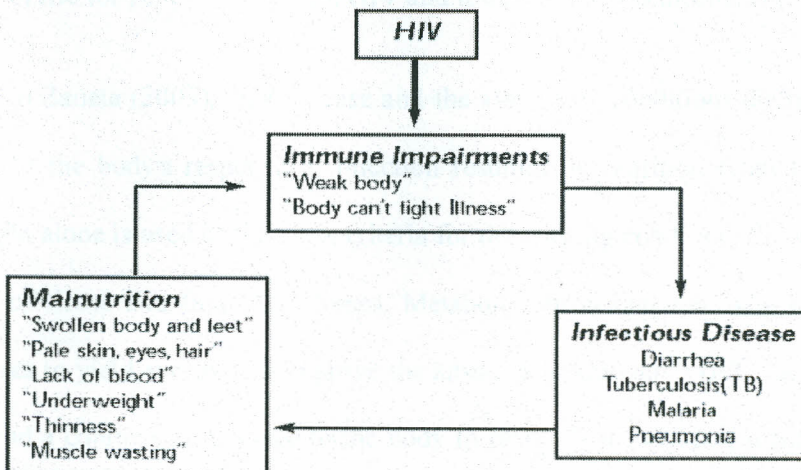


Figure 3: Cycle of malnutrition in HIV 'Source: FANTA, 2005

Nutrition and food support for HIV affected individuals can break this vicious cycle. Nutrition analysis, nutrition education, counseling and provision of fortified foods to those living with HIV help to reduce malnutrition, improve effectiveness of treatment and controlling symptoms.

Proper use of medication prolongs life and promotes better life and nutrition, as a necessary intervention to antiretroviral treatment (ART) will improve rehabilitation, immunity and adherence to medication. Some drugs lead to a decrease in nutrient absorption and utilization and may require increased consumption of foods rich in particular nutrients or may require supplementation. In a study done by Byron, Gillespie and Nangami (2006), the nutrition intervention is a major source of food to the most vulnerable patients getting treatment from AMPATH, with the additional food improving dietary diversity and amounts for patients and their households. Some ARVs cause side effects which interfere with food intake and some of these effects can be dealt with through specific food interventions. Reaction between ARV drugs and traditional therapies such as garlic, need more research. Managing interactions between ART and nutrition affects the degree to which the treatment is effective in promoting the quality of life for people living with HIV and lowering the advancement of HIV.

According to Zaneta (2003), HIV disease and the associated conditions diminish nutritional stores due to the body's response to infection resulting in nutrition related abnormalities. When weight alone is used as the main criteria for the wasting condition, this may understate the extent of tissue and functional losses. Metabolic stress reaction causes breakdown of protein stores to yield energy and improve the amino acid amounts. HIV does not appear to rest and send a continuous message to the body to react. Even with treatment the virus may set a "set-point" and increase as much to maintain the same amount of viral load. This

continuous increment may need adaptation by the body to bear and withstand the impacts of the virus.

Assessment of nutritional condition and risks include determining the patient's food consumption and anthropometric and body composition measures e.g. weight, body mass index (BMI), weight for age in children and middle upper arm circumference (MUAC). Clinical and laboratory analysis of hemoglobin, blood count and nutrient biochemistry, among other tests are important for early discovery of poor nutrition (GOK, 2006). According to the study, ideally these services are theoretically available in all health facilities serving people living with HIV and AIDS. BMI is recommended as criterion for adults and selecting people living with HIV who require intervention with supplementary food.

Middle Upper Arm Circumference is used for adults and children who cannot stand up straight for weight and height measurements, which are conventionally used for screening in children. MUAC values have a strong correlation with body mass index in men. In women, the cut-off point  $MUAC < 23.3$  cm has a high correlation with BMI. Without corroborated BMI and MUAC cut-offs to categorize malnutrition among the elderly (Onis, 1997), cut-off level for adults suggested by Shetty & James, (1994) for BMI and by James et al (1994)." for MUAC may be used. Because of variations in body structure, the soundness and understanding of these cut-offs for the elderly and the bedridden, mainly those over 70 years, are questionable. This study seeks to bridge this gap by exploring BMI based on arm-span.

## **2.5 Food and Nutrition Implications of Antiretroviral Therapy**

Access to antiretroviral drugs (ARVs) is rising among people living with HIV in developing countries as a consequence of combined local, national and international efforts (FANTA, 2004). Latest reports show that in health interventions medicines are of little or no use with no adequate food and nutrition. With limited access to antiretroviral treatment, proper

nutrition becomes even more essential. In sub-Saharan Africa only one in four people in need of treatment gets it and does not usually begin before the condition is well progressive, making the requirement for adequate food even more vital (WHO, 2003). HIV positive persons and caregivers need clear facts on nutritional attention and support because food insecurity can bring major challenges to appropriate management of food and nutrition consequences of ART. Poor food security can inhibit ART clients from obtaining adequate amounts of the foods required to ensure healthy dietary consumption and cope with the side effects and interactions between drugs and food (FANTA, 2005).

Knowing the target for ART coverage in Kenya and the existence of food insecurity, dealing with food and nutrition issues related to ART is a major component in ensuring successful treatment. Nutritional care as a key intervention to ART viral treatment, will promote body restoration, improve antiretroviral therapy and increase adherence to ART. Interactions between ARVs with food and nutrition considerably impacts on the success of anti-retroviral therapy by disturbing adherence to treatment, nutritional status of people living with HIV and effectiveness of medication. Some ARVs need to be taken with food, others without and still others are should not be taken with certain foods (UNGASS, 2008).

Early deaths while on ART treatment is common in many interventions, with individuals coming for care with very progressive disease and multiple infections (Braitstein, Brinkhof and Dabis, 2006). Infections such as tuberculosis, malnutrition, diarrhea and malaria are common in these areas and all have a harmful interaction with HIV infection (Van Lettow, Fawzi and Semba, 2003). In addition to ART treatment, PLWHA usually take other drugs to manage co-morbidities, such as tuberculosis, thrush, pneumonia and intestinal infections, which occur due to weakened immune systems. People living with HIV and AIDS also use drugs to treat other common illnesses such as malaria. Nutrition is an important factor in the

safety and effectiveness of many other medications commonly used by people living with HIV and AIDS.

ARVs can interact with food and nutrition in a number of ways, causing both positive and negative results (FANTA, 2004). Some foods affect the effectiveness of certain ARVs by influencing their absorption and utilization. Food improves the effectiveness of some ARVs and reduces the effectiveness of some. For example, a high calorie, high fat, high protein meal inhibits absorption of the PI indinavir (Pronsky, Meyer and Fields, 2001) while a high fat meal increases the bioavailability of the tenofovir.

Certain protease inhibitors, such as ritonavir and nelfi navir can cause alteration in the metabolism of lipids (fats), resulting in elevation rise in blood cholesterol and triglyceride levels (Currier, 2001). Increased blood cholesterol and triglyceride levels can heighten the risk of coronary heart disease. Such interactions may require nutritional intervention, such as decreased consumption of saturated fats if other food options are available. Lipodystrophy, due changes in body fat supply, has been associated with consumption of some PIs and NRTIs (Ibid). Consumption of some protease inhibitors has been shown to affect carbohydrate metabolism, leading to insulin resistance (Gelato, 2003), a condition associated with a high risk of diabetes.

The side effects of some drugs can cause reduced food consumption or reduced nutrient absorption that promotes the weight loss and nutritional problems faced by people living with HIV and AIDS (FANTA, 2004). ARV side effects such as nausea, taste changes and loss of appetite may lead to decreased food consumption while side effects such as diarrhea and vomiting may promote nutrient losses. For example, the NRTI zidovudine can cause anorexia, nausea, vomiting, and side effects of the NRTI didanosine include diarrhea and vomiting, poor appetite and dryness of the mouth (Pronsky, Meyer and Fields, 2001) ARVs

can also have harmful side effects that are not associated to food intake or nutrient absorption but require food and nutritional intervention. Some studies have shown that certain ARVs heighten the risk of osteopenia and osteoporosis, although further research is underway on the subject. These conditions result in poor bone health. Ensuring sufficient vitamin D and calcium intake is a desirable nutritional intervention for patients with osteoporosis (Mondy and Tebas, 2003).

The increased nutritional requirements that HIV and opportunistic infections cause, together with the compromised food consumption that the symptoms create, make adequate nutritional intake challenging for many people living with HIV and AIDS irrespective of the treatment especially in poverty stricken situations. ARVs can, to a large extent, improve the health of those taking them but can also create high food and nutrition needs and challenges (FANTA, 2004).

## **2.6 Ready to Use Therapeutic Food (RUTF) in the Management of Severe Acute**

### **Malnutrition**

Home-based care for severe malnutrition has been a breakthrough in different settings (Collins, 2001). Though most researches have focused on children, they can be reproduced in the malnourished HIV patients. The new achievement of home-based care has been seen in combination with the accessibility of a new product, a spread form of ready-to-use therapeutic food (RUTF) (Sandige, Ndekha, Briend, Ashorn and Manary, 2004). The RUTF paste is made of crushed ingredients entrenched in a lipid rich paste, producing an energy dense food resistant to microbial contamination (Briend, 2002). RUTF is a mixture of milk powder, vegetable oil, sugar, peanut butter, powdered vitamins and minerals. As the name suggests, RUTF does not need to be cooked in any way before eating, making it possible for use where cooking fuel and facilities are not easily available. RUTF has a very limited water

activity and therefore it is impossible for substantial bacterial decay to occur in these foods (Briend, 1997). By eating just a few spoonful of RUTF five to seven times daily, a severely malnourished child can achieve adequate nutrient intake to completely regain their weight. RUTF must be taken with water, but no other foods are needed for the rehabilitation of the malnourished child (Mark, 2006).

Severe acute malnutrition rests a major killer of children under five years of age. Until recently, treatment has been confined to hospital-based approaches, narrowing its coverage and impact. New studies suggests, however, that many children with severe acute malnutrition can be managed in their communities without being admitted to a health facility or a therapeutic feeding centres (WHO, 2007) and therefore community management of acute malnutrition is primarily encouraged.

The community based care includes well timed detection of severe acute malnutrition in the community and delivery of treatment for those with no medical complications using ready-to-use therapeutic foods or other nutrient-dense foods at home and at the health facility level. F75 is given on admission for those with medical complications and F100 to enable catch-up growth. If properly operated with a facility-based intervention for those malnourished children with medical complications and programmed on a large scale basis, community-based management of severe acute malnutrition may reduce mortality rates of children. The same is being applied in the HIV context for both children and adults (Dibari, 2008).

Many HIV-positive children having severe acute malnutrition will benefit from community-based treatment using RUTF. However, studies have shown that rates of weight gain and recovery are inferior among HIV positive children compared to those those who are HIV negative and their death rates are higher. The poorer weight gain is possibly associated with the higher cases of infections in children who are HIV positive (WHO, 2007). Given the

intersection of severe acute malnutrition and HIV and AIDS in both children and especially in poor areas, strong association between community-based management of severe acute malnutrition and AIDS programs are necessary.

With the current treatment and enhanced access to treatment, case-mortality rates can be as low as 5 per cent, both in the community and in health care facilities. Community-based management of severe acute malnutrition was initiated during an emergency context. It stemmed up in an improved increase of the program coverage and subsequently, the number of malnourished children who were managed successfully leading to low death rates (WHO, 2007). The same approach can be replicated in non-emergency and HIV contexts with a high prevalence of severe acute malnutrition, preventing many deaths when applied at scale.

## **2.7 Nutrition Intervention Programs and their Targeting Criteria**

Selective food and nutritional intervention to individuals with HIV and their households has the possibility to improve nutrition (Kadiyala and Gillespie, 2004) and may reduce exposure to HIV infection (Gillespie and Kadiyala, 2005). Targeted food support may improve adherence to treatment while protecting assets by not having to dispose them to afford food (Gillespie, 2004).

Providing RUTF to HIV infected persons to supplement food rations given to affected households appears to have the ability to improve nutritional achievements across the household (Louise, 2009). RUTF provides a nutrient dense supplement that can be targeted to the HIV infected individual, with other foods in the basket helping to cushion other family members from shortage of food for consumption. Fortified blended foods and RUTFs have important effects on illness and nutritional results as shown among refugees in Algeria (Collins, 2006), Nepal (Shrimpton, Tripp and Lyman, 2002), Bangladesh (USAID, 2003),

and Zambia (Seal, 2005). RUTFs are also progressively being used in HIV programs (Ulysse, Jarlyne and Ivers, 2008).

In the United States, nutritional support to prevent weight loss and wasting in HIV infected patients have regularly focused on advocating and nutrient supplements instead food rations to promote energy and protein intake (McDermott and Shevitz, 2003). Many such interventions have been shown to be very effective (ANSA, 2006). Interventions that try to enhance the skills and actions of mothers with respect to nutrition have been known for years as being beneficial for child nutrition (Andersen, 1994). Although methods and message content differ greatly between programs, communicating exact evidence on nutrition is constantly related with a positive result (Webb and Block, 2004).

Targeted food support may also allow enlarged labor supply and the efficiency of that labor, the benefits of which might include improved local production of food and increased income earning, both of which add to household food security. In other words, food and other nutritional intervention programs have the possibility to lower the progression of HIV disease in developing countries, where malnutrition and food insecurity are major simultaneous factors.

Various nutritional programs for HIV and AIDS have been initiated, but few have shown the ability to make a sustainable improvement to a large number of affected individuals, their households and their communities. Routine nutrition screening can enable rapid treatment and nutrition interventions which consequently can decrease the rate and length of opportunistic infections as well as avert weight loss (Cimoch, 1997).

Effective targeting of food support is crucial to the management of few resources, but little evidence to guide programs as to which individuals or households to select in places where

high food insecurity and a high prevalence of HIV coexist (Louise, 2009). Programs are frequently targeted to individuals receiving medication, but it is highly reasonable that food support would advantage those not yet receiving ART, possibly preventing the advancement of HIV disease and deferring the need for ART.

The concurrent use of a variety of targeting tools is required to make sure that the most vulnerable individuals/households are known and included for provision of food rations or participation in other food security support. Striking the right balance between accuracy and value for money is challenging. It is vital to widen the criteria extensively by openly linking community structures, home based care providers, traditional healers, etc. using standards and arrangements sufficiently delicate to avoid the exclusion of those who should be qualified and exact to ensure that those considered not qualified are, omitted (Taylor, Anna, Seaman and John, 2004). In a high prevalence settings where adults, rather than children, include the main target set, old targeting methods BMI), may not be suitable (especially those using anthropometric measures such as weight-for-height. When assessing chronically ill adults, the level of outcomes is often disguised by numerous concurrent interventions. Targeting grounded on anthropometry, if functional at all in this context, must be used only in combination with other criteria.

Research findings suggest that unintended weight loss can advance even when nutrition support are provided. Unintentional weight loss, irrespective of treatment status, is a strong predictor of death among people living with HIV and AIDS (Wanke and Kotler, 2004). As low as 5 percent accidental weight loss from a standard body weight, or weight first noted in the medical record, has been related with meaningfully increased risk of oral infections and death. It could consequently be used as a measure to select for the necessity of particular food products. Nevertheless, weight loss alone should not be used to recommend particular food,

products as patients who are having decreasing subcutaneous fat with conservation of muscle mass may not benefit from improved caloric consumption (PEPFAR, 2008).

Nutrition support timely in the disease progression or before the development of opportunistic infections can avert unintentional weight loss positively (Chlebowski, 1995). Such timely nutrition interventions can only be possible if people living with HIV and AIDS are regularly screened for malnutrition. Regrettably, this important care component is not readily available to all people living with HIV and AIDS.

Notwithstanding the current understanding of the multifaceted interaction between HIV infection, food intake and low revenue, the measurable clinical benefits of food support to individuals with HIV infection, the suitable admission criteria for targeted food programs, the correct extent of food support and the effects of such programs on household members persist to be largely undocumented (Venable PA, Carey, Blair and Littlewood, 2006). According to Collins (2000), no particular definition or classification of acute adult malnutrition has been generally accepted, but temporary methods may be recommended until additional research explains criteria. MUAC together with clinical signs should be used to select adult admission into feeding center (Collins, 2000). The BMI is unsuitable for this purpose as it is influenced by edema, body shape and challenges faced when measuring weight and height. In any specific situation, health care staff should only use these recommended criteria as a preliminary point and adapt them to context specific factors. Admission criteria into adult therapeutic feeding programs should be based on the following cutoffs (FANTA, 2004).

1. MUAC < 160 mm regardless of clinical signs
2. MUAC 161-185 mm plus one of the following:
  - People with bilateral pitting edema (3 or worse)
  - People who are unable to stand.

- People with severe dehydration.
- People with famine edema (grade 3 or worse) alone as examined by a clinician to eliminate other causes.

Adults' body mass, shape and structure differ with age (Forbes, 1976). Adults tend to lose fat free mass (FFM) and gain fat mass (FM) with age (Forbes & Reina, 1970). These variations may change the functional meaning of BMI at different ages. Some NGOs use different cut-off points for older adults when admitting individuals to a nutrition support program. For adults aged over 50 years or over Action Contre La Faim (ACF) enrolls adults to therapeutic feeding centers and supplementary feeding program based on the cut-offs of  $15\text{kg}/\text{m}^2$  and  $16\text{kg}/\text{m}^2$  respectively, but enrolls those aged less than 50 years at  $16\text{kg}/\text{m}^2$  and  $17\text{kg}/\text{m}^2$ . Most programs agree that ART clients should be selected to make sure that food support is targeted only at the nutritionally susceptible ART clients. FANTA (2005), wanted to design a universal criteria that can be employed in detecting or screening clients for suitability for food support using both anthropometric and social economic characteristics in Kenya. Table 3 gives criteria suggested by patients on ARVs and health care providers for targeting people for food assistance.

**Table 3: Suggested criteria for targeting food assistance to ART clients**

Criteria suggested by service providers and programmers	Criteria suggested by PHA/ART clients
<ul style="list-style-type: none"> <li>• ART patient on T.B medication</li> </ul>	<ul style="list-style-type: none"> <li>• “Poor patients who are just starting ART. The first three months are the most difficult”.</li> </ul>
<ul style="list-style-type: none"> <li>• ART patients with many children and with low or no income</li> </ul>	<ul style="list-style-type: none"> <li>• Members of the support group – as an encouragement</li> </ul>
<ul style="list-style-type: none"> <li>• Single parent households where the patient has no source of income and is not sustained by relatives (the abandoned). Households with orphaned children who have negligible provision from relatives.</li> </ul>	<ul style="list-style-type: none"> <li>• Very sick ART clients. “Especially in hospitals, we should have “distinctive” food for patients with AIDS”.</li> </ul>
<ul style="list-style-type: none"> <li>• Patients who are sickly and with under-nutrition.</li> </ul>	<ul style="list-style-type: none"> <li>• “Some ART clients stay with extended families when they are very sick. Many times the families they are dependent on are also poor and it is good to just carry something. They are seen to be adding something and get good care that way”.</li> </ul>
<ul style="list-style-type: none"> <li>• ART clients who are jobless and have no source of revenue and from households with no sources of income</li> </ul>	<ul style="list-style-type: none"> <li>• ART clients from poverty stricken areas and who do not have sources of livelihood</li> </ul>
<ul style="list-style-type: none"> <li>• Use of BMI (different cut-off points are used) + 24 hr dietary recall</li> </ul>	<ul style="list-style-type: none"> <li>• Those who are thin and severely wasted.</li> </ul>

Source: FANTA, 2005

According to Collins (2000), in 1996, Ferro-Luzzi and James adapted their theoretical approximation of the lowest BMI harmonious with life down from 12 kg/m<sup>2</sup> in order to explain for the very low BMIs being documented in Somalia during the famine in 1992. They

set two new BMI cut-offs of  $<13 \text{ kg/m}^2$  and  $<10 \text{ kg/m}^2$ , representing severe wasting and severe wasting respectively. These standards did not consider the Somali long-legged genes (Hiernaux, 2000 as cited by Collins, 2000), a significant factor clarifying the very low BMIs observed. Thus the cut-off values they suggest are perhaps too low. One of  $13 \text{ kg/m}^2$  possibly signifies a grade of thinness where marginal stores have been finished, a matching increase in central breakdown. This level is therefore perhaps unsuitably low to be used as a cut-off for enrollment into an adult therapeutic feeding.

AMPATH was introduced in 2001 and supports an estimated 52,000 HIV positive patients in western Kenya. AMPATH uses an inclusive methodology to HIV and AIDS, attending to medical care, nutritional adequacy and financial security. It supports patients and their relatives by providing education, protective services, treatment and nutrition support and by helping them cultivate food and create employments. Once individuals with HIV and AIDS are capable to yet again earn a living and come to be energetic members of their community, even the stigma connected with HIV and AIDS fades. For them, food recommendation is done by the nutritionist for sick person and household and the kinds of food are at the decision of the nutritionist. The target group are individuals at progressive infection phase (stage two and three),  $\text{CD4} < 200$  and  $\text{BMI} < 18.5$  (Byron, Stuart, and Nangami, 2006).

Concern International carried out an emergency nutrition intervention in Damot-Weyde, Ethiopia using MUAC, BMI and cormic index adjusted for persons aged over 18 years (Dolline, 2002). The occurrence of malnutrition was reported for calculated BMI and adjusted BMI (cormic index) for adults aged between 18 and 49 years and those aged over 49 years. There were large variations between the rates stated for observed BMI and adjusted BMI. Applying a BMI cut-off of  $<17 \text{ Kg/m}^2$ , the rate of malnutrition in younger adults (18-49) was 1.7% (adjusted cormic index) and 10.7% (unadjusted). The rate in older individuals

(over 49 years) was 2.0% and 24.5% for adjusted and unadjusted rates respectively. MUAC cut-off of 180mm detected same percentage of adults with malnutrition to the one using a BMI of  $<16 \text{ Kg/m}^2$ . Mean BMI and mean MUAC considerably reduced with age. The example of Action Contre La Faim exemplified how adults and older persons were chosen for admission in a therapeutic feeding intervention in Juba Sudan. BMI was used as the main selection indicator.

Help Age international runs a nutrition intervention program for the HIV positive patients in Kenya. They have documented that in every four new ART patients clinically malnourished (BMI  $<18.5$ ), one is severely malnourished (BMI  $<16$ ). The average period for ART patients to move up from nutrition support (BMI  $>20$ ) is 90 days for patients with BMI 16-18.5 at admission and 150 days with BMI  $<16$ .

AMREF Kibera HIV project classifies the patients on ART and those on T.B treatment to be more vulnerable if they have BMI of  $<18$ . These are delivered with food support till they achieve a BMI of 22. Additionally to BMI, 24 hour dietary recall is done and social workers interview and carry out home visits to assess suitability of beneficiaries using additional socio-economic indicators to estimate whether the beneficiary has access to extra sources of livelihood. Only those who are considered more vulnerable using anthropometric and social indicators are admitted for nutrition support. At Kenyatta National Hospital, BMI of  $< 16$  is used as cut off level for therapeutic assistance.

MSF-France delivered 2000 Kcal/day (4 sachets of peanut-based RUTF, Plumpynut) to HIV positive adults, with BMI  $<17 \text{ kg/m}^2$  and/or MUAC  $<185\text{mm}$  and/or edema in Homa Bay hospital (Dibari, 2008). All these programs use BMI as their key criteria and none of them have used the BMI based on arm-span.

## 2.8 Body mass index and its role in nutrition assessment

The field of anthropometry includes a diversity of human body dimensions, such as weight, height, and size; including skin fold thicknesses, circumferences, lengths and breadths. Anthropometry is a major element of nutritional status assessment in children and adults (Simko, 1995). Anthropometric information for children indicates their general health status, dietary sufficiency, growth and progress with time. In adults, body measurement information are used to assess health and dietary adequacy, disease vulnerability and body composition variations that happen through the adult lifespan.

Body weight is used as a sign of an individual's health status. It is usually compared to tables which shows "ultimate" or "desired" weight ranges for particular heights. Some of these tables use standards collected from research findings, while some include the heights and weights of individuals who have taken life insurance (e.g., the metropolitan height and weight tables). An individual's weight can be defined as a fraction of the ultimate or desired weight recorded and can also be considered as healthy, underweight, over-weight or obese. Nutritional screening and assessment includes a reference point physical exam to detect any disorders requiring management that may impact on the nutritional status. Anthropometric measurements can be used to estimate BMI. BMI is used as an indicator of nutritional status (underweight, normal, or overweight) and any variations with time (Castleman, Seumo-Fosso and Cogill, 2004). The use of mid-upper arm circumference (MUAC) is recommended for determining nutritional status in pregnant women and may be used when measurement equipment are not available.

Body mass index (BMI) is an assessment of body composition that relates an individual's weight and height to individual's body mass (Carole, 2003). The BMI is therefore an indicator of weight adjusted for height. Body mass index is calculated by dividing weight in

kilograms by height in meters squared. It can also be calculated by dividing weight in pounds by height in inches squared and multiplying by 705. High figures can point to too much fat stores, while low values can show diminished fat stores. In this way, the BMI is a diagnostic tool for both overweight and under-nutrition. The BMI has also been related with risk of death, with higher values generally associating with longer life (Maskarinec, 2000).

When an adult is very sick to stand or has a spinal abnormality, the half arm-span should be measured. This is the measure from the middle of the sternal notch to the tip of the middle finger with the arm held out straight to the side. Both sides should be measured. If there is a difference, the measurements should be taken again and the longest one used in calculation. The height (in metres) can then be estimated as follows:  $\text{Height} = [0.73 \times (2 \times \text{half arm-span})] + 0.43$ . The BMI is then derived from the estimated height and measured weight (WHO, 1999). However, when calculating the BMI, several features of an individual need to be identified. An individual's gender, ethnicity, and level of health must be reflected when using BMI to define health risk. Additionally, the significance of the BMI is influenced by disease condition and dehydration status. Similar to other assessment tools, the BMI is more useful when used in combination with other measurements (White, 1999).

Tables are available which can be used to check the significance of the BMI. Calculations centered on values for ultimate body weight suggest the BMI for healthy men and women should range between 19 and 27 kg/m<sup>2</sup>. This range matches with the 25<sup>th</sup> to 75<sup>th</sup> percentile values documented from adults followed in the 1971–1974 National Health and Nutrition Examination Survey. Tables also detail the levels of protein-energy malnutrition and obesity. These values were calculated by studies in which height, weight, and age were linked with functional measurements and health consequences.

A BMI between 13 and 15 tallies with 48 to 55 percent of appropriate body weight for a specified height and define the lowest body weight that can sustain life. Body weight at this level comprises of less than 5 percent fat. The highest survival body weight is about 500 kg, which matches BMI of nearly 150. Studies with children show annual rise in BMI are usually because of rise in lean mass rather than fat tissue (Collins, 2000). Not till late adolescence does fat mass start to impact on the BMI and adult figures begin to be attained. There is a strong relationship between BMI and whole fat mass, though individual difference in body type or height can cause wrong classification (Seidel, 2001). Comparisons of BMI between various populations can be done using a correction factor built upon the mean cormic index for every population. Such adjustments should always be done when BMI is used to associate the nutritional status of diverse populations. According to Norgan (1994) as cited by Collins (2000), if BMI is used to evaluate an individual for under-nutrition the approximation of the individual's cormic index should be used as an alteration factor. Without this alteration the sensitivity and specificity of BMI as a screening tool may be poor.

During emergencies, specifically at the peak of a famine relief program, when there are huge numbers of people competing for limited resources, there is virtually never enough time or staff to carry out this adjustment. Therefore BMI may be unsuitable for this purpose. The rising incidence of kyphosis and scoliosis with age further obliges the use of alternatives for height when assessing the nutritional status of older individuals (Ismail & Manandhar, 1999).

**Table 4 Significance of BMI values for adults**

Condition Indicated	Men	Women
Protein-calorie malnutrition	< 17	< 17
Underweight	< 20	< 19
Acceptable weight	20.7 – 27.8	19.1 – 27.3
Intervention indicated	> 26.4	> 25.8
Obese	> 27.8	> 27.3
Severely obese	> 31.1	> 32.2
Morbidly obese	> 45.4	> 44

**Normal BMI Values for Infants and Children**

Infants (at birth) 13

1 year 18

6 years 15

Source: (FANTA, 2005).

Unfortunately, similar BMI value can be associated with a range of body-fat percentage. For example, athletes ordinarily have large skeletal muscles (which weigh more than fat) and therefore higher BMI, but they are not overweight. Shorter persons can also be classified as overweight, since their BMIs are normally high. An older person may have a higher body-fat percentage than a younger person, but have similar BMI. Adult females can have a BMI of 20, which is associated to a body-fat proportion of 13 to 32 %, while adult males can have a BMI of 27 and a body-fat proportion of 10 to 31%.

Height reductions over an individual's lifetime occur as a result of vertebral firmness, loss of muscle tendency, and stance collapse. One may therefore have a height which is no longer correct, and the subsequent value will be inferior than the value that really defines the

individual, probably resulting to the erroneous intervention. Studies have shown that both high and low BMIs can be a sign of high morbidity and mortality risk (Seidel, 2001). A low BMI, normally a sign of protein-energy malnutrition or the impacts of degenerative or a disease course, is an important predictor of death amongst young and old admitted patients. A high BMI has been revealed to be predictive of death only among young hospitalized patients, frequently a consequence of cardiovascular disease and overweight. Risk of death is only marginally raised at the highest BMI for elderly in-patients.

Because ethnicity has been found to necessitate alterations to the heights of concern for the BMI, caution must be taken when relating diverse population groups. BMI and waist circumference have been used to assess health risks connected with overweight and obesity. Because both are easy to take, adjustment of both are encouraged for extensive use as a reference.

## **2.9 Problems with BMI**

Even in non-emergency context the calculation of BMI and cornic index may be unfamiliar to field workers and therefore problematic. ACF have designed tables of weight-for-height which have BMI ranges (like those used for children) that may lessen this struggle (Collins, 2000). Many features other than nutritional status affect BMI values. Most significant of these is body shape specifically ratio of leg length to trunk length differs both between populations and within populations causing world wide disparity in the upright height to upright height from 0.48 in Australians (Norgan, 1994 as cited by Collins, 2000) up to 0.55 in the Japanese. This has substantial impact on BMI because most of the weight originates from the viscera enclosed in the trunk.

Adults' body size, shape and structure vary with age (Wang et al, 1994). Adults are more likely to lose fat free mass and increase fat mass with age (Forbes and Reina, 1970). These

variations may change purposeful meaning of BMI at different ages. Some NGOs adopt different cut off levels for older adults when enrolling individuals to a nutrition program, for example Action Contre La Faim (ACF) admits adults aged 50 years and over to therapeutic and supplementary intervention support using the cut offs of  $15\text{kg/m}^2$  and  $16\text{kg/m}^2$  respectively, but admits those aged less than 50 years at  $16\text{kg/m}^2$  and  $17\text{kg/m}^2$ . This corresponds with the criteria used by MSF as suggested by Collins, (2000). These are common adjustments to the ordinary cut-off points for the use of BMI to measure malnutrition.

Adult nutritional edema is prevalent during famine and its occurrence surges weight, resulting in an increasing bias in BMI. In adults the recurrent co-occurrence of pitting edema and ascites means that edema fluid can be as much as over 10% of body weight. Famine edema is also connected with poor diagnosis. Consequently, patients with severe edema regularly have a poorer diagnosis the higher their admission BMI, the contrary of the condition in marasmic patients. BMI is therefore, not a suitable pointer for people suffering from famine edema. This may be adjusted by using an adapted screening standards i.e. BMI below a cut-off point or the occurrence of edema. However, as the presence of edema, mainly in older adults, may not always be symbolic of under-nutrition it could also be as a result of aging.

The height and weight measurements needed to evaluate BMI are often hard to obtain throughout famine. Chairs and bed-scales are usually inaccessible and thus patients must have the capacity to stand. Normally, majority of the most severely under nourished adults in need of admission to therapeutic nutrition programs cannot stand and BMI cannot be easily assessed. Additionally many studies have documented prevalence of gross weaknesses, flexor contractions or scoliosis. This prevents many patients from standing straight adequate for precise height approximation. Because height is a squared measure, these errors are amplified

in BMI calculation therefore increasing exclusion error. Nutritional anthropometric calculation of an elderly person can be improved by the use of alternative measurement because problem related with movement do not affect these approaches of gathering measurements (Waterlow et al, 1977) knee height (Waterlow, 1972) and arm-span/demi arm-span (Beaton et al,1990) can be used to approximate the height. The aging progression does not affect the length of extensive bones such as these in arms and legs as it does vertebral with height.

### **2.10 Height and Arm-span/Demi arm-span in nutrition assessment**

Height is a valuable indicator of body mass to be used in clinical settings and also for studies in health and nutrition (Suzana and Ng See, 2003), for estimation of basic caloric needs, adjustment of measures if physical dimensions and for planning of drug administration (Lucia et al, 2002). In combination with body weight, height is a useful measure used to estimate creatinine height index, basal expense, basal metabolic rate, vital capacity, calculation of nutrient needs) and estimation of body composition (Chumlea et al, 1998. However, in certain contexts, the precise height cannot be measured because of abnormalities of the limbs or in bedridden patients. In such situations, an approximation of the height has to be made from other body parameters (Hepper et al, 1965). These approximations are also useful in calculating age related loss in height, detecting individuals with uneven growth, abnormalities and height loss during medical procedures on the vertebral column (Mohanty et al, 2001).

Several researches have documented the efficacy of using various body measures in estimating body height (Jalzem and Gledhill, 1993), and arm-span/demi arm-span proved to be the most reliable. It is taken as a useful proxy of height especially among the elderly, as it does not differ considerably with age (Reeves et al, 1996).

According to study by Lucia et al, (2002), there is a strong relationship between arm span/demi arm-span and height. BMI calculated from on arm-span can therefore be approximated in adults with disorders limiting their capability to stand straight providing a simple and easy way of evaluating nutritional status of bedridden HIV positive patients. In agreement with the suggestion by Mohanty et al (2001) and Lucia et al (2002), more studies are needed to the similar variances in groups in Africa, especially the Luo, and other regions of the world.

### **2.11 Predictive equation for estimation of stature**

According to Bassey (1986), height loss among Caucasians population is 1.2cm for every 20years after 30years of age. Standing height is difficult to measure among the HIV positive patients due to conditions such as opportunistic infections that makes them bedridden especially at later stages of AIDS blow (from observation at the HIV clinics in Kenya) (Dibari, 2008). Long bones have been found to change less with aging (Mitchell, & Lipschitz, 1982).

Attempts have been made to design equations to estimate height of long bones such as knee height (Chumlea et al, 1992), arm-span (Reeves, et al 1996 and Brown et al 2000) and demi arm-span (Bassey, 1986). However the precision of the equations is lost if used to estimate height in people in which the equation has not been designed from (Cockram and Baumgartner, 1990), for example Myers et al, (1994) documented a methodical error when the equation designed for Caucasians was applied to calculate height in Japanese Americans. Equations determining height from other anthropometric have been designed for Caucasians, but only one research has come up with an equation from arm-span/demi arm-span for Asian people (Suzana and Ng See, 2003). While estimated height from arm-span from equations designed for Caucasians was steadily higher than height calculated from equations designed

(Bassey, 1986). The variation may be as a result of body composition and height among indigenous groups.

## **2.12 Summary of the literature search**

BMI is a simple measurement to take, only requiring a stadiometer, bathroom scale and a calculator. However, for individuals who cannot stand up straight for an precise height measurement, either due to disease progression, weakness or kyphosis (abnormal backward bending of the spine), BMI may not be easy or accurate valuation instrument to use. A method to accurately estimate height among the patients who are unable to stand, such as the bedridden HIV positive patients need to be established.

Most programs use BMI as one of their key targeting criteria. Little or no consideration has been made regarding the severely malnourished bedridden HIV patients. This study therefore aims to fill these gaps.

## **CHAPTER THREE: METHODOLOGY**

### **3.1 Research design**

Cross-sectional survey design was adopted for the study. Measurement of weight, height, MUAC and arm-span/demi arm-span of healthy adults (BMI>18.5) at the MSF HIV clinic in Homabay, Nyanza Province, Kenya, were taken using (1) Bathroom scale, (2) a stadiometer, (3) MUAC, (4) tailors tape respectively. The correlation of the arm-span/ height and BMI was calculated to extrapolate a formula to adjust the arm-span/demi-arm-span estimate into the real height in bedridden patients or with gross muscle weakness.

### **3.2 Study Population**

The study population included patients who were residents of Nyanza province, Nilotic, Luo speakers (Joluo) and enrolled in MoH/MSF HIV program in April/May 2010.

#### **3.2.1 Inclusion criteria**

The inclusion criteria included adults who are not malnourished (BMI>18.5), aged 18-60 years and were at the first stage of HIV (asymptomatic stage).

#### **3.2.2 Exclusion criteria**

People who were non-Luo, verified by national ID and did not belong to any of the Joluo clans, aged less than 18 years or over 60 years or aged (over 18 years) in doubt due to lack of documentation were excluded from the study. The HIV cases with severe cerebral palsy, those with amputated limbs, those with general mental health problems and those not possible to measure height or arm-span/demi arm-span due to other severe health conditions were also excluded from the study.

### **3.3 Research Variables**

#### **3.3.1 Independent variable**

The independent variable in this study was height.

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#### 3.3.1 Independent variable

The independent variable in this study was height.

#### 3.3.2 Dependent Variables

The dependent variables included arm-span and demi-arm-span.

### 3.4 Sample size and sampling technique

The sample size was 500 HIV positive patients who were not malnourished at Homa Bay MSF HIV clinic in April/May, 2010. Calculations based on the formula by Kish (1995) gives a sample size of 464 but the figure was inflated to 500 to reduce the standard deviation.

Below is the explanation of the formulae. The sample size  $n$  and margin of error  $E$  are given by

$$n = N x / ((N-1) E^2 + x)$$

$$x = Z(c/100)^2 r (100-r)$$

$$E = \sqrt{[(N - n) x / n (N-1)]}$$

Where  $N$  is the population size,  $r$  is the fraction of responses, and  $Z(c/100)$  is the critical value for the confidence level  $c$  (1.96). (95% confidence level), 4.5% margin of error ( $E$ ), and 50% level of response ( $r$ ) and since population is high, 20000 ( $N$ ) is recommended.

Since anthropometric measurements are independent of socio-economic factors all patients attending the HIV clinic from Monday to Friday between 8am-5pm and met the inclusion criteria, formed the sampling frame. A total of 4,673 males and 5256 females met the inclusion criteria. Files belonging to all those patients who qualified (stage one based on patients' history as per the hospital records) were given numbers. Simple random sampling technique was adopted, where the numbers were written on small papers, folded and picked by lottery until five hundred was reached. The study focused on the relationship between

height and arm-span/demi arm-span, and not on attained height or the prevalence of malnutrition.

### **3.5 Data Collection Procedures**

At the study site, anthropometric measurements were taken twice, and an average of the two readings calculated by the researcher. A tailors' tape measure was employed for the arm-span/demi arm-span measurement and the reading were taken to the nearest 0.1 cm. Arm-span was measured while the subject stood erect and looking straight ahead, with the back against the wall to provide support. The arms were outstretched at right angles to the body with palms facing forwards. The measurement was taken from one middle fingertip to the other middle fingertip, with the tape passing in front of the clavicles. Demi-arm-span was measured as the length between sternal notches to the web of the middle finger. The arms were outstretched at right angles to the body with palms facing forwards (Fidanza, 1991). The standing height were measured using portable Seca stadiometer, with the subject standing straight, both hands at the side and eyes looking straight at  $90^0$  to the body. To aid straightening the spine, the reading was taken while the subject inhaled deeply.

Body weight was taken using Seca digital scale and recorded to the nearest 100g. Subjects were asked to remove footwear, heavy clothes and any item from their pockets. Mid upper arm circumference (MUAC) was taken using Medecins Sans Frontieres MUAC tape. The shoulder of the left hand was located then the patients were asked to bend the elbow and the tip of the elbow was located. The tape was placed at the tip of the shoulder then pulled past the tip of the elbow. The midpoint was then marked and this was where the MUAC tape was positioned. Readings were taken to the nearest 0.1 cm.

#### **3.5.1 Reliability and Validity**

Before the actual data collection, a sample of 10% of the actual sample size was used to pre-

test the data collection tools and at the same time to check their reliability. Test-retest method was used to check reliability of the tools and intra-observer reliability. A sample of 50 patients was taken from Homabay general hospital and their anthropometric measurements taken twice. The percentage coefficient of variation within samples was all less than 7%. This indicated that the within-subject variation of results was small and the results on the same subject were reproducible.

During data collection, tools were calliberated before each measurement was taken and all the measurements were taken twice. This quality control measures improved the confidence of the data quality.

### **3.5.2 Data collection Instruments**

An anthropometric questionnaire was used to collect data. The questionnaire was in a table form and was used to record anthropometric measurements of the study subjects.

### **3.6 Data analysis and Presentation**

Collected data was entered using EPI-data and analyzed by use of SPSS statistical computer packages. Means and standard deviations were obtained for all anthropometric variables. Body mass index (BMI-ht) based on height and arm-span/demi arm-span (BMI-as) were determined in the group for both sexes. Descriptive and inferential analysis, that is, correlations and *t*-test were done to establish the relationships. Correlation was calculated between the arm-span/demi arm-span and actual height, BMI-as and BMI-ht, and weight and mid upper arm circumference (MUAC). Analyzed data was presented on tables, showing anthropometric characteristics of the population, correlation coefficient between standing height and arm-span/demi arm-span measurements, correlation coefficient between weight and mid upper arm circumference, and scatter plot diagrams showing correlations of arm-span/ demi- arm-span and height and correlation between BMI-as and BMI-ht.

### 3.7 Logistical and ethical consideration

Before the study begun, the patients were asked for voluntary participation. Explanation about the aim of the study was given. Only those patients who gave their consent were included in the study. Participants were ensured of confidentiality. All the information from the patients were kept confidential and only used for research purposes.

## CHAPTER FOUR: RESULTS AND DISCUSSION

### 4.1 Anthropometric characteristics

The findings of the study are presented in this section. Table 5 shows the mean age, height, arm-span, demi arm-span, weight, BMI and MUAC of the study population. The average age of the subjects was 33.7 and 39.2 years for females and males respectively. The mean height was 163.1cm (6.6) and 173.1(6.7) cm for females and males respectively. The mean arm-span was 171.5cm (7.8) and 185.5(8.3) for females and males respectively. Generally, the average arm-span was higher than the standing height. This therefore led to a lower BMI based on arm-span (20.1) and (18.5) for females and males respectively, than BMI based on standing height (22.1) and (21.3) for females and males respectively in both sexes.

**Table 5: Gender difference in anthropometric characteristics of the study population**

Parameters	Females (n = 252)			Males (n = 248)			
	Mean	SD	Range	Mean	SD	Range	P*
Age, years	33.7	8.6	42.0	39.2	10.5	42.0	0.0001
Height (cm)	163.1	6.6	40.0	173.1	6.7	41.3	0.0001
Arm-span (cm)	171.5	7.8	52.9	185.5	8.3	46.7	0.0001
Demi arm-span (cm)	83.0	3.8	26.5	89.9	4.1	23.3	0.0001
Weight (kg)	59.1	7.3	36.1	63.8	6.6	35.1	0.0001
BMI (height) (kg/m <sup>2</sup> )	22.1	2.0	10.5	21.3	1.7	8.9	0.0001
BMI (arm-span) (kg/m <sup>2</sup> )	20.1	1.9	8.7	18.5	1.7	9.5	0.0001
MUAC (cm)	27.1	2.9	13.6	26.7	2.5	16.2	0.05

\*Difference was assessed using *t*-test

This study showed that males and females from Luo community have significant physical differences. Except for age, all other findings are consistent with other previous studies which reported differences in anthropometric measurements between males and females (Lucia et al, 2002 and Chumlea et al, 1986 and Reeves et al, 1996). Lifestyle and stigma might be the possible explanation for age difference in that young men might be feeling stigmatized to

## 4.2 Arm-span and height Correlation

Null hypothesis ( $H_{01}$ ) There is no correlation between arm-span/demi arm span and height among the Luo community.

An examination of the scatter plot diagrams of height verses arm-span and demi arm-span revealed linear relationships hence the linear regression model was deemed appropriate.

There was a strong linear relationship between arm-span/ demi arm-span and height in both males and females from the Luo community (0.86,  $P=0.001$ ). The correlation between arm-span and height and between demi arm-span and height were the same in both males and females (0.86,  $P=0.001$ ) and (0.85,  $P=0.001$ ) for arm-span and demi arm-span respectively.

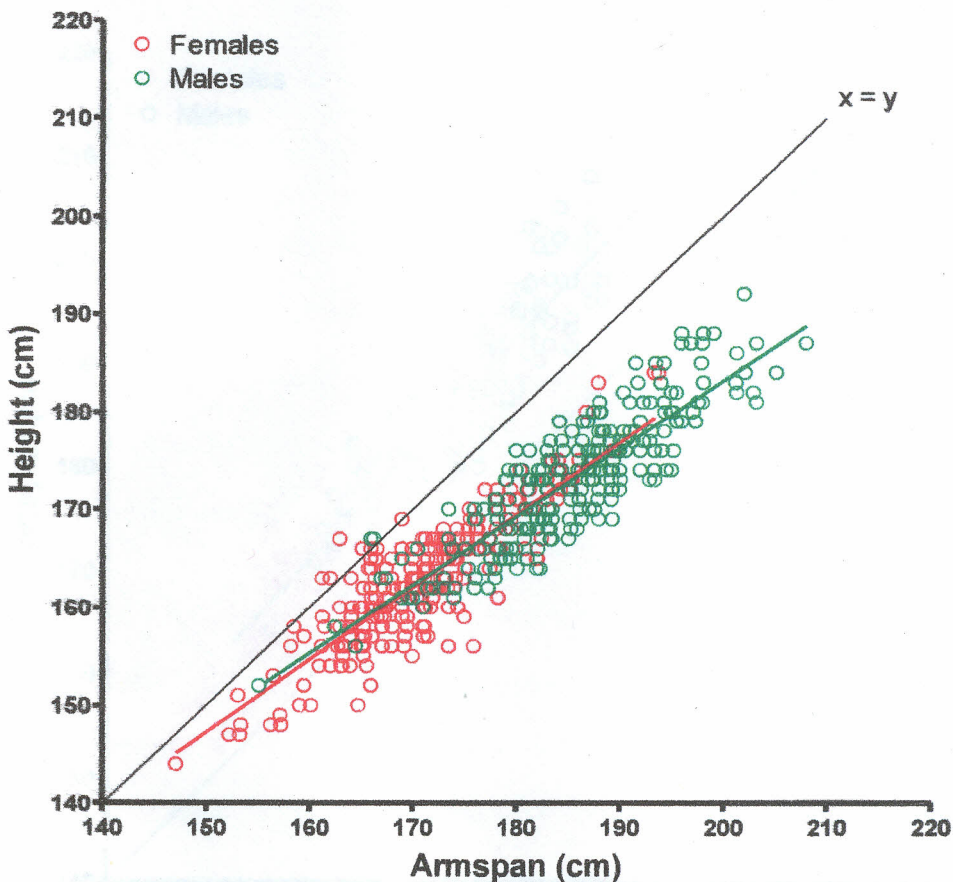
Table 6 shows the arm-span, demi arm-span and height correlations by sex. These findings had a  $P<0.05$  hence the null hypothesis was rejected.

**Table 6: Correlations between height, arm-span and demi arm-span by sex**

Parameters	Males	Females	P value
Arm-span/Height	0.86	0.86	0.001
Arm-span/Demi arm-span	0.94	0.96	0.001
Demi arm-span/Height	0.88	0.85	0.001

All correlation coefficients had  $p < 0.01$

When looking at the correlation coefficients there is no clear difference is shown, as the association of arm-span and demi arm-span with height is similar (0.86) for males and female as well as the association between arm-span and demi arm-span. However, after plotting the data a particular pattern emerges (figure 4). As arm-span increases, the greater the difference in relation to the identity line ( $x = y$ ). The lower line of the scatter plot shows the arm-span/height correlation. As arm-span increases, there is a bigger difference from the identity line  $X=Y$



**Figure 4: Scatter plot showing correlation between height and arm-span**

This means that in people with greater arm-span, the arm-span-to-height ratio will be greater than that in people with lower arm-span. This trend suggests that if arm-span is used directly

to calculate BMI, it is likely to mis-classify individuals. This trend is similar in both sexes as the regression line for each sex overlaps (red line for females, green line for males (Figure 4).

The trend found in figure 4 however, cannot be explained by the subject's height confirming that it is explained by the arm-span (figure 5). The relationship between arm-span to height does not vary as height increases. There is however, a sex difference as males have a greater arm-span-to-height ratio than females, as seen by the difference between the green and the red regression lines.

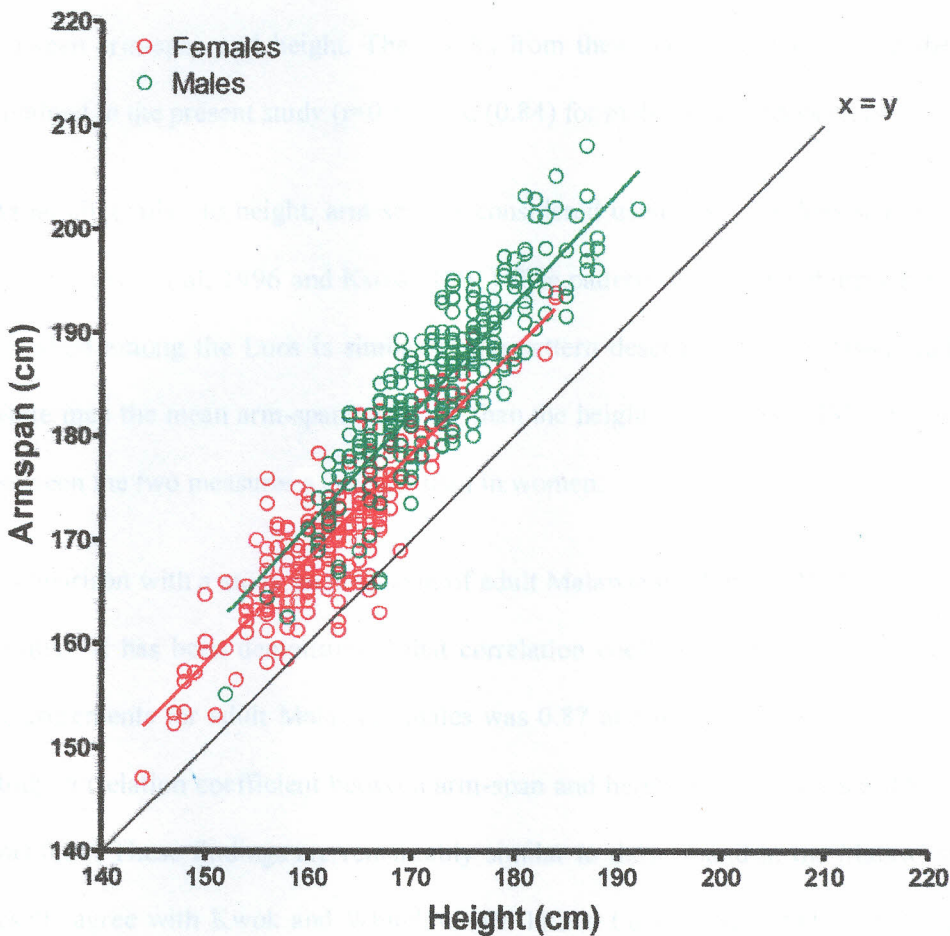


Figure 5: Scatter plot showing relationship between arm-span and height

Estimation of height using various physical measurements has been attempted by many authors as a way of improving accuracy of BMI. Chumlea (1985) estimated stature from knee height, while Mitchel (1982) correlated arm length with height. The one variable that proved to be consistently reliable in estimating height was the arm-span. Steele and Chenier (1990), in a study on black and white women in the age group 35–89, reported correlations of arm-span and height of 0.852 and 0.903 for black and white women respectively. In a similar study of blacks of both sexes in the age group 22–49, a correlation of 0.87 was observed between arm-span and height. The results from these studies are similar to the correlation obtained in the present study ( $r=0.84$ ) and (0.84) for males and females respectively.

As an alternative to height, arm-span is considered useful since it does not differ across all ages (Reeves et al, 1996 and Kwok, 1991). The pattern of stature and arm-span relationship observed among the Luos is similar to the pattern described for Caucasian and Asians. In white men the mean arm-span is greater than the height (Engstrom, 1981) and the difference between the two measures is larger than in women.

Comparison with a study on arm-span of adult Malawians (Zverev, 2005) indicated the same results. It has been demonstrated that correlation coefficient between height and arm-span measurements for adult Malawian males was 0.87 and for females was 0.82. In the present study correlation coefficient between arm-span and height for Luo women 0.86 and for men was 0.86. These findings are remarkably similar to those found in the Malawi study. These results agree with Kwok and Whitelaw (1991) and Lucia et al (2002) who found that arm-span correlates better with height. Strong and significant correlation between the two anthropometric parameters indicated that height can be predicted from arm-span measurements in the Luo community as a way of improving admission criteria for nutrition rehabilitation based on BMI.

### 4.3 Prediction equations for height

A step wise forward analysis was done to determine the best equation for height estimation from arm-span and demi arm-span as a way of improving admission criteria based on BMI. The association between height and arm span alone was assessed in model 1, column two table 7. In column three (model 2,) the association between height and arm-span controlled for sex was assessed. In column four (model 3); association between height and arm-span controlled for age was assessed. In column five (model 4); the association between height and arm-span controlled for sex and age was assessed.

Arm-span alone accounted for 83.6% of the variability in height (model 1). The addition of sex (model 2), age (model 3) or both (model 4) to prediction equation did not change the predictive value ( $R^a$  does not change) as shown in table 7.

**Table 7: Prediction models for height based on arm-span**

Parameter	Model 1		Model 2		Model 3		Model 4	
	$\beta$	s.e.	$\beta$	s.e.	$\beta$	s.e.	$\beta$	s.e.
Arm-span	0.71	0.01*	0.72	0.02*	0.71	0.01*	0.72	0.02*
Sex			-0.10	0.40			-0.20	0.41
Age					0.01	0.02	0.02	0.02
Constant	40.86	2.55*	40.35	3.25*	40.72	2.55*	39.67	3.32*
$R^a$	0.836		0.836		0.836		0.836	

Similarly, step wise analysis was done for height and demi arm-span. The association between height and demi arm span alone was assessed in model 1 was done in column two table 8. In column three (model 2), the association between height and demi arm-span

controlled for sex was assessed. In column four (model 3), association between height and demi arm-span controlled for age was assessed. In column five (model 4), the association between height and demi arm-span controlled for sex and age was assessed.

Demi arm-span alone accounted for 83.5% of the variability in height (model 1). Controlling for sex (model 2), age (model 3) or both (model 4) to prediction equation did not change the predictive value ( $R^a$  does not change, 83.5%) as shown in table 8.

**Table 8: Prediction models for height based on demi arm-span**

Parameter	Model 1		Model 2		Model 3		Model 4	
	$\beta$	s.e.	$\beta$	s.e.	$\beta$	s.e.	$\beta$	s.e.
Demi arm-span	1.44	0.03*	1.45	0.04*	1.44	0.03*	1.45	0.04*
Sex			-0.08	0.40			-0.24	0.42
Age					0.02	0.02	0.03	0.02
Constant	43.28	2.51*	42.90	3.20*	43.00	2.51*	41.81	3.27*
$R^a$	0.835		0.835		0.836		0.836	

\* $P < 0.01$

#### 4.3.1 Sex specific regression equations relating arm-span/demi arm-span and height

From the stepwise analysis, the following equations were developed for the estimation of height from arm-span and demi arm span. Though both males and females had differences in anthropometry, regression equations for height estimation in both sexes are similar.

**Table 9: Sex specific regression equations relating arm-span/demi arm-span and height**

Sex	Regression equation( $y=mx+c$ )	$r^a$	$r^2$
Female	Height=(0.71) arm-span+(40.86)	0.84	0.74
	Height=(1.44) demi arm-span+(43.28)	0.84	0.74
Male	Height=(0.71) arm-span + (40.86)	0.84	0.74
	Height=(1.44) demi arm-span+(43.28)	0.84	0.74
Combined Male and Female	Height=(1.44) demi arm-span+(43.28)	0.84	0.74

$p < 0.01$  for all coefficients

$r^a$  = correlation coefficients,  $r^2$  = variance

$y=mx+c$  Where  $y$  is height,  $M$  is gradient,  $x$  is arm-span and  $c$  is the value of arm-span when height is zero.

The final equations developed for both males and females (Height= (0.71) arm-span + (40.86) and Height= (1.44) demi arm-span+(43.28)) had a high  $R^2$  and low s.e. When these equations were applied in the validation group, there was small insignificant difference between measured and predicted height which indicated that the equation had good predictive qualities. Age was significantly associated with stature while the addition of age did not improve the regression model. This was in agreement with the fact that BMI is independent of age. Gender difference between equations was not significant.

This was not the case in a study among Malawians equations which had gender differences (Zverev, 2005). This may have been because they used a smaller sample size than this study. This equation can be used to develop a table showing arm-span and weight with their corresponding BMI values. This will be useful for health workers who may not be comfortable with calculation of BMI using the equation. This will save time and improve accuracy as some mistakes can easily be made during calculations. This was not done in this study as it was not among the objectives of the study. The equation is more precise than the

normal method of BMI calculation as it will estimate the BMI more accurately among the bedridden, facilitating early detection and prevention of malnutrition related mortality.

If applied in the population used in this study, height estimated from equations derived from other populations tends to overestimate height compared to the height derived from equations developed in this study. Estimated height from arm-span from equations developed for Afro-Caribbean and Asian (Reeves, 1996) showed a high difference. The regression equations developed for the Afro-Caribbean's are: [Height =  $54.9 + (0.66 \times \text{Arm-span})$  for men and Height =  $66.9 + (0.57 \times \text{Arm-span})$  for women] (Reeves 1996) and for the Asians [Height =  $53.4 + (0.67 \times \text{Arm-span})$  for men and Height =  $81.0 + (0.48 \times \text{Arm-span})$  for women] (Bassey, 1986).

Estimated height from arm-span using the equations developed for Caucasian populations was consistently higher than height estimated from equations developed in this study. The differences may be due to variation in body composition and stature among ethnic groups, i.e. Luo populations may be shorter as seen in other studies (Attallah, 1986).

#### **4.4 Possibility of using BMI based on arm span for screening**

Conventionally, MUAC is used as a screening tool for mortality risk and this study explored the possibility of using BMI developed from estimated height from arm span and demi arm-span for the same purpose. This was done by calculating the correlations between MUAC and height estimated using arm span and demi arm-span.

Partial correlations (controlled by sex) were obtained between BMI and MUAC as a proxy measure of the diagnostic potential of BMI, obtained using arm-span or predicted height (from arm-span/demi arm-span), for the prediction of mortality (table 10). BMI obtained

from predicted height using arm-span and obtained using arm-span alone provided the highest and lowest correlation values respectively compared with BMI obtained from height.

**Table 10: Partial correlation between MUAC and BMI obtained using measurements**

Parameters	Correlation	P value
MUAC/BMI – height	0.65	0.001
MUAC/BMI – arm-span	0.57	0.001
MUAC/ BMI – predicted height from arm-span	0.63	0.001
MUAC/ BMI – predicted height from arm demi arm-span	0.60	0.001
*.all correlations were controlled for sex and had $p < 0.01$		

To further explore the possibility of using estimated height from arm span and demi arm-span as a screening tool, partial correlation between MUAC and BMI estimated from different parameters was done. This was to check the ability of the equation to be used as a screening tool for malnutrition. The correlation between MUAC and BMI based on height had the highest correlation (0.65) equally as BMI based on height estimated from arm-span (0.63).

There was a low correlation between MUAC and BMI based on arm span which has also been shown by other studies (Mitchel, 1982, Mohanty, 2001). The high correlation between MUAC and BMI based on predicted height shows that there is some possibility to be used as a screening tool for risk of malnutrition, though more research is needed to get more evidence.

#### 4.5 Body mass indices

Null hypothesis ( $H_{01}$ ) There is no relationship between the BMI-as and BMI-htg among the Luo community.

To further explore the possibility of using estimated height from arm span and demi arm-span for BMI calculation, partial correlation between BMI from actual height and BMI from height estimated from arm-span and demi-arm-span was done. The linear relationship between BMI from actual height and BMI height estimated from arm-span was the same among females (0.86) and males (0.86) as shown by scatter plot in figure 6. Similar results were found for demi arm-span.

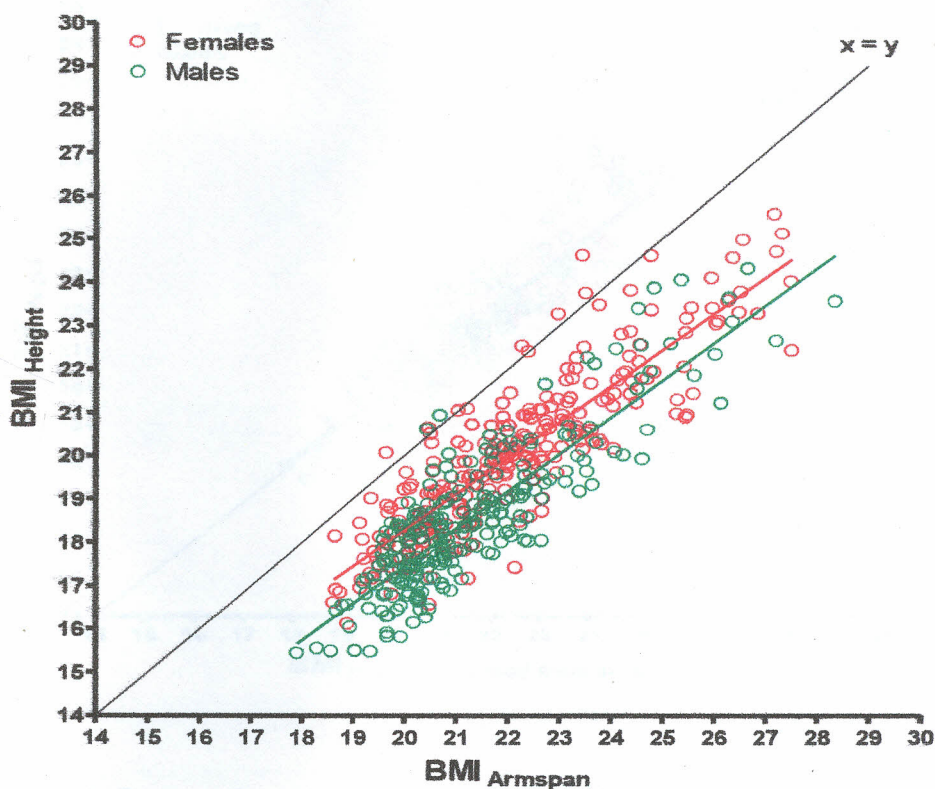
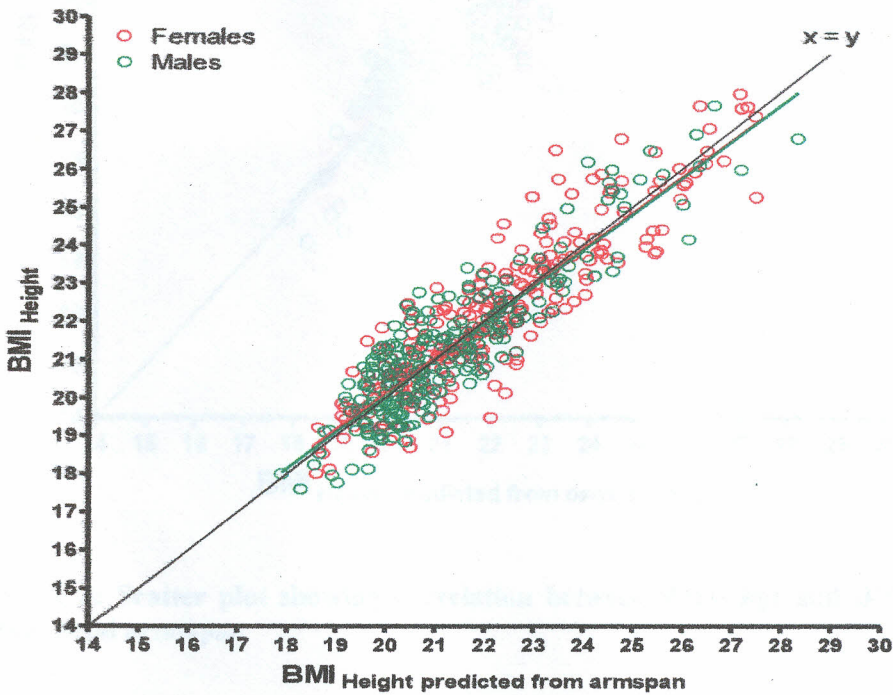


Figure 6 Scatter plot showing correlation between BMI-as and BMI-ht

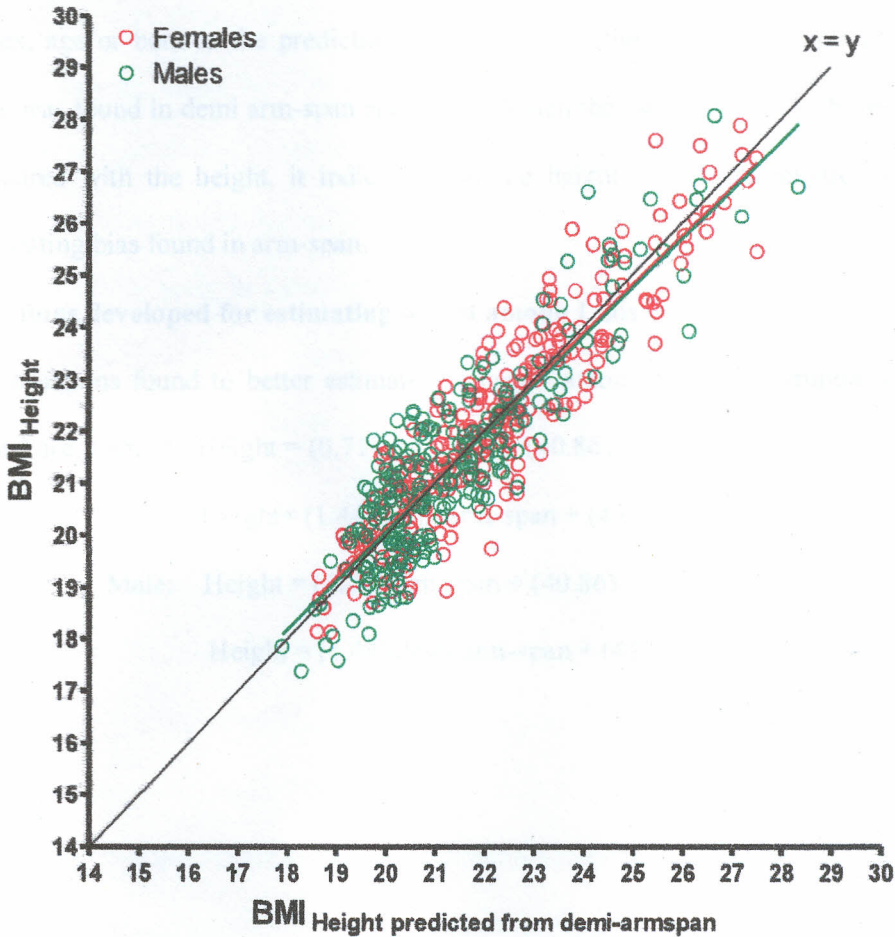
Bland-Altman assessment of agreement showed no difference in the use of either predicted height from arm-span or demi arm-span to calculate BMI. The main bias was -0.001 and 0.001 for BMI obtained using predicted height from arm-span and demi arm-span respectively (limits of agreement -1.75 to 1.75 and -1.74 to 1.74 for arm-span and demi arm-span respectively).

However, there was a high correlation between BMI based on height and BMI based on height derived from arm-span using the equation developed for height estimation. The scatter plot figure 7 shows the correlation between BMI based on height and BMI based on height predicted from arm-span.



**Figure 7: Scatter plot showing correlation between BMI- hgt and BMI-hgt predicted from arm-span**

Similar results were for demi arm-span. There was a high correlation between BMI derived using height and that derived using height predicted from demi arm-span, equally like the BMI derived from arm-span. This is shown by the scatter plot in figure 8. Based on these findings, the null hypothesis was rejected.



**Figure 8: Scatter plot showing correlation between BMI- hgt and BMI-hgt predicted from demi arm-span**

It has been demonstrated that a high proportion of normal Spiro metric data may be misleading when arm-span is directly substituted for height. Therefore it is more appropriate to estimate height from arm-span using the equations (Reeves, 1996). However estimation of height from arm-span measurement is may not be accurate for most of African populations as

correlation between these two anthropometric parameters has not been widely studied. This study has filled this gap in the Luo community.

From the analysis, arm-span alone accounted for 83.6% of the variability in height. Additions of sex, age or both to the prediction equation add nothing to the prediction equation. The same was found in demi arm-span and height. When the estimated height from arm-span was compared with the height, it indicated that the height prediction equation is effective in eliminating bias found in arm-span.

### **Equations developed for estimating height among Luos**

The equations found to better estimate the height among the Luo community as shown in table 9 are; Female: Height = (0.71) arm-span + (40.86).

$$\text{Height} = (1.44) \text{ demi arm-span} + (43.28).$$

$$\text{Male: Height} = (0.71) \text{ arm-span} + (40.86).$$

$$\text{Height} = (1.44) \text{ demi arm-span} + (43.28)$$

## CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

The study highlighted variations in the anthropometric characteristics between arm-span and height among males and females from the Luo community. The study found a high, significant correlation (0.86) between arm-span/ demi arm-span and height. Therefore, the null hypothesis stating that there is no correlation between arm-span and height was rejected. These findings were in agreement with findings from other studies which have shown high correlations between arm-span and height, which forms the basis to developing equations to be used in estimating height among those who are unable to stand due to gross muscle weaknesses.

The high correlation between arm span and height showed the viability of developing an equation to be used for height estimation in the Luo community. The differences in anthropometric characteristic between males and females justified the need to develop sex specific regression equations. These regression equations are used in development of guidelines for the assessment of the nutritional status of the bedridden HIV positive adults from the Luo community.

The equations developed for height estimation include; Female:  $\text{Height} = (0.71) \text{ arm-span} + (40.86)$ ,  $\text{Height} = (1.44) \text{ demi arm-span} + (43.28)$  and Male:  $\text{Height} = (0.71) \text{ arm-span} + (40.86)$ ,  $\text{Height} = (1.44) \text{ demi arm-span} + (43.28)$ . These equations showed good predictive values in that when used in the scatter plots, they were very close to the normal height of the samples measured while they stood up. These equations are useful in finding out the alterations in the height of an individual that may occur due to progressive deformities of the spine.

The findings from this study further showed that the height estimated from arm-span is as useful as the normal height in calculation of the BMI. BMI based on normal height and that based on height estimated were highly correlated (0.86) and significant. Therefore the null hypothesis stating that there is no relationship between the BMI-as and BMI-hgt among the Luo community was rejected. This means that arm-span can be a useful proxy indicator for height among the bedridden HIV positive adults from the Luo community.

Based on the findings from this study, there is a possibility of using the BMI based on estimated height from arm-span, though more studies are needed to establish the trend in other communities. This is because there was a high correlation between the BMI based on predicted height and MUAC (0.63) which is currently the indicator used. Though the BMI based on arm-span cannot be used to replace the MUAC as a screening tool, it can be used under conditions where MUAC cannot be taken. BMI based on height estimated from arm-span can be determined in subjects with conditions limiting their ability to stand straight (e.g. kyphosis) offering a simple and easy way of assessing nutritional status of older adults.

This study has demonstrated the importance of arm-span in estimating height among the bedridden HIV positive adults in the Luo community. This will go a long way in ensuring that malnutrition is detected early enough and managed to prevent unnecessary deaths.

## **5.2 Recommendations**

1. Additional research is needed to determine the anthropometric characteristics in other groups in Kenya, Africa and in other regions of the world.
2. More research is needed to determine the correlation between arm-span and weight and arm-span and height to validate the use of arm-span in calculation of BMI.
3. Adoption of this equation for estimation of height at the MSF Homa bay HIV clinic during targeting for the bedridden patients.

4. There is need for policy guidelines in assessing for malnutrition among the bedridden HIV positive adults in Kenya.

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## APPENDICES

### 6.1 Informed Consent Form

I agree to participate in the arm-span/height correlation study done by Weldon Ngetich at MSF HIV clinic in Homabay under supervision of Dr. George Rombo and Dr. Margaret Wagah from Kenyatta University. I understand that this participation is voluntary and I can withdraw my consent at any time without penalty and have the results of the participation, identified as mine, removed from the study or destroyed.

The study has been explained to me as follows;

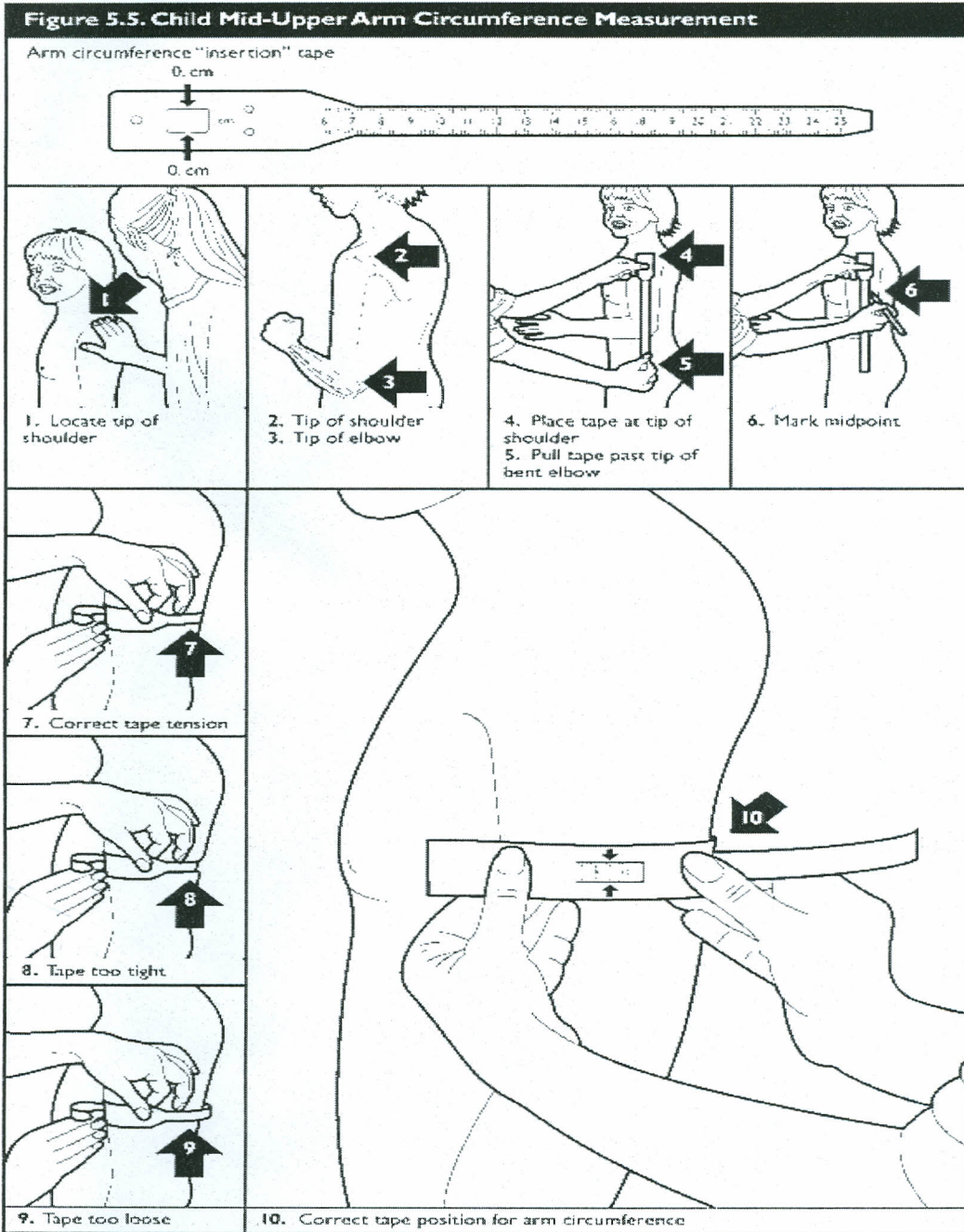
- The objective of the study is to determine the correlation between arm-span and height in the Luo community so as to develop a tool to improve admission criteria into therapeutic programs based on BMI.
- During the normal clinic visits, participants will be required to spend about 10 minutes, during which the researcher will take anthropometric measurements including: weight, height, arm-span, demi arm-span and MUAC
- Participants' identity will be kept confidential in any report generated from this study. Any measurements taken during the study will only be used for the purpose of research and will not be shared with anyone.

Name \_\_\_\_\_ Sign \_\_\_\_\_

Date \_\_\_\_\_



6.3 MUAC Measurement



Source: How to Weigh and Measure Children: Assessing the Nutritional Status of Young Children, United Nations, 1986.