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INNOVATIVE NUTRITIONAL APPROACH TO ATTENUATE THE PROGRESSION OFHIV TO AIDS AMONG PEOPLE LIVING WITH HIV (PLWH): A STUDYBASED IN ABUJA, NIGERIA.

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1.1 INTRODUCTION

Human Immunodeficiency Virus (HIV) is a severely infectious and fast replicating retro-virus,genetically made–up of a single stranded RNA molecule, which impairs and deteriorates the immune system's cells (WHO, 2006; AIDS, 2009; WHO, 2013; Amlogu et al., 2013; CDC, 2014). Acquired immunodeficiency syndrome (AIDS) is a progressive deterioration of the immune status of the individual. It is characterised by the progressive depletion of the CD4 T-lymphocyte population (*cells that produces a specific immunity to a particular antigen*), whichrepresents a major target of viral infection by the causative HIV (Table 1.1) (Vajpayee et al., 2005; Amlogu, et al., 2012). World Health Organization (WHO, 2006) provides a simplified HIV case definition designed for reporting and surveillance (Box 1.1).

The aetiology of AIDS has been identified as HIV-1 and HIV-2 (FMOH, 2007). This virus belongs to the Lentivirus group and Retroviridae family (Figure 1.1). The Family Retroviridae of viruses includes three sub-families: Oncovirinae, Lentivirinae and Spurnavirinae. All the members of the family contain an enzyme called reverse transcriptase that is used for the synthesis of proviral DNA from the infecting viral RNA.

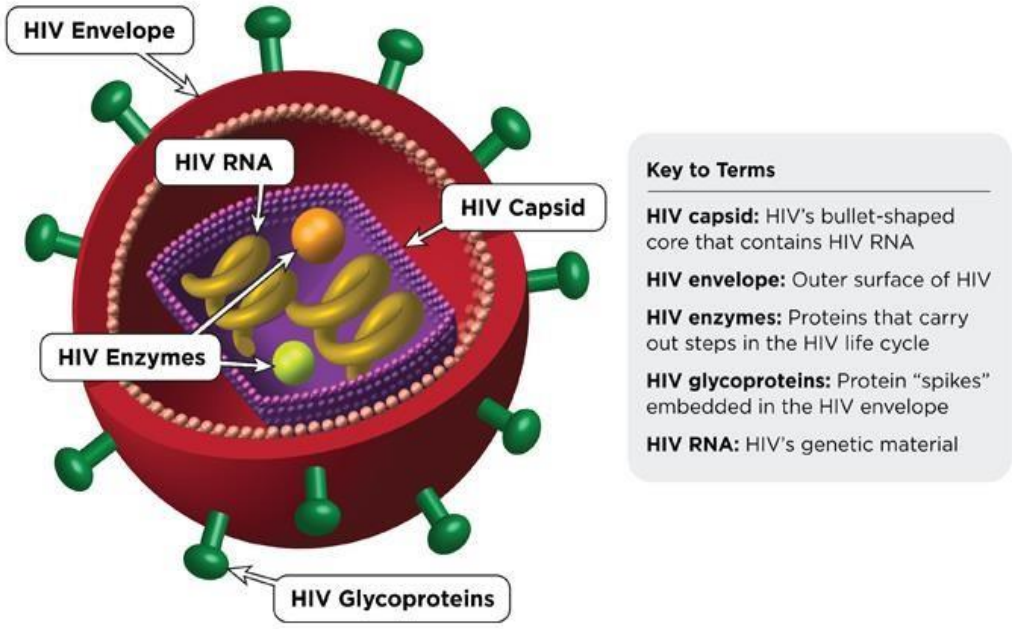

Figure 1.1: Structure of HIV. (Source: AIDS info. 2014}.

The HIV particle contains three components: the core, the surrounding protein matrix and the outer lipid envelop. The core contains genetic material, RNA, encapsulated by the capsid protein p24, which contains enzyme (reverse transcriptase, integrase and protease) involved inviral replication. The glycol proteins gp41 and gp120, which is attached to the envelop enableHIV to bind and fuse with target host cells (Pribram, 2011).

The primary receptor for HIV is the CD4 molecule on the human T-helper cells. CD4lymphocyte cells (also called T-cells or T-helper cells) are the primary targets of HIV. The CD4 count and the CD4 percentage mark the degree of immune compromise. The CD4 count is the number of CD4 cells per micro liter (µL) of blood. It is used to stage the patient's disease, determine the risk of opportunistic illnesses, assess prognosis, and guide decisions about whento start antiretroviral therapy (ART) (HRSA, 2011). Variation in CD4 receptor molecule on T-cell surface may influence the ability of HIV to bind and eventually penetrate the target cell (AIDS, 2013). Because HIV infects CD4 cells and uses them to produce more HIV copies, HIV infection is characterised by a progressive fall in the number of T-helper/inducer CD4 positive cells (Pribram, 2011; Amlogu et al., 2013).

Table 1.1: Centre for Disease Control and Prevention classification system for HIV infection

	Clinical categories		
	A	B	C
CD4+ T-cell count (cells/mm^3) (CD4%)	Asymptomatic, acute (primary) HIV or PGL*	Symptomatic, not A or C conditions†	AIDS-indicator conditions‡
> 500 (28%)	A1	B1	C1
200–499 (15–28%)	A2	B2	C2
< 200 (14%)	A3	B3	C3

*Category A: asymptomatic HIV infection, persistent generalized lymphadenopathy (PGL).

†Category B: oropharyngeal and vulvovaginal candidiasis, constitutional symptoms such as fever (38·5°C) or diarrhea lasting >1 month, herpes zoster (shingles).

‡Category C: *Mycobacterium tuberculosis* (pulmonary and disseminated), *Pneumocystis carinii* pneumonia, candidiasis of bronchi; trachea or lungs, extra pulmonary cryptococcosis, CMV, HIV-related encephalopathy, Kaposi's sarcoma, wasting syndrome due to HIV.

Box 1.1: WHO case definition for HIV infection (2006).

Adult and children 18 months or older:

- HIV infection is diagnosed based on: Positive HIV antibody testing (rapid or laboratory-based enzyme immunoassay). This is usually confirmed by a second HIV antibody test (rapid or laboratory – based enzyme immunoassay) relying ondifferent operating characteristics

and/or;

- A positive virologic test for HIV or its components (HIV – RNA or HIV – DNAor ultrasensitive HIV p24 antigen) confirmed by a second virologic test obtainedfrom a separate determination.

Children younger than 18 months

- HIV infection is diagnosed based on: A positive virologic test for HIV or its components (HIV – RNA or HIV – DNA or ultrasensitive HIV p24 antigen) confirmed by a second virologic test obtained from a separate determination taken more than four weeks after birth.

and/or;

- Positive antibody testing is not recommended for definitive or confirmatorydiagnosis of HIV infection in children until 18 months of age.

Only certain fluids — blood, semen (*cum*), pre-seminal fluid (*pre-cum*), rectal fluids, vaginal fluids, and breast milk from an HIV-infected person can transmit HIV. These fluids must comein contact with a mucous membrane or damaged tissue or be directly injected into thebloodstream (from a needle or syringe) for transmission to possibly occur (Figure 1.2). Mucousmembranes can be found inside the rectum, the vagina, the opening of the penis, and the mouth(AIDS, 2009; CDC, 2014).

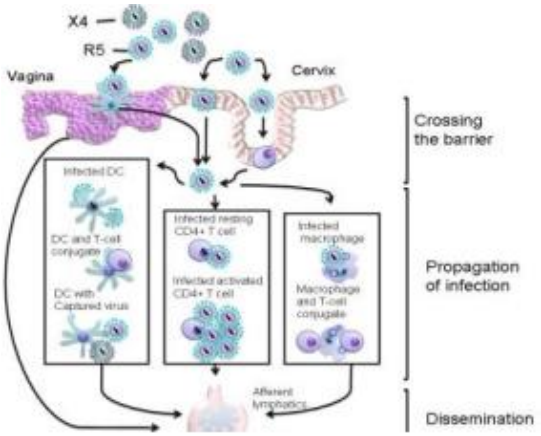

Figure 1.2: HIV Transmission (Source: Pope & Haase, 2003).

During early infection, HIV remains concentrated in the lymph nodes, where it replicates in huge numbers and infects more CD4+ T-cells. Swollen lymph nodes are often the only clinicalfeature seen in a person with HIV infection for the first months or years of infection.Progressive depletion of CD4+ T-cells is associated with progression of HIV disease and an increased likelihood of opportunistic infections and other clinical events associated with HIV,including wasting and death (WHO, 2006). The immune system eventually deteriorates to thepoint that the human body is unable to fight off other infections. The HIV viral load in the blood dramatically increases while the number of CD4+ T-cells drops to dangerously low levels (Figure 1.3). An HIV-infected person is diagnosed with AIDS when he or she has one or more opportunistic infections, such as pneumonia or tuberculosis, and has fewer than 200 CD4+ T- cells per cubic millimeter of blood (WHO, 2006; NIH, 2011).

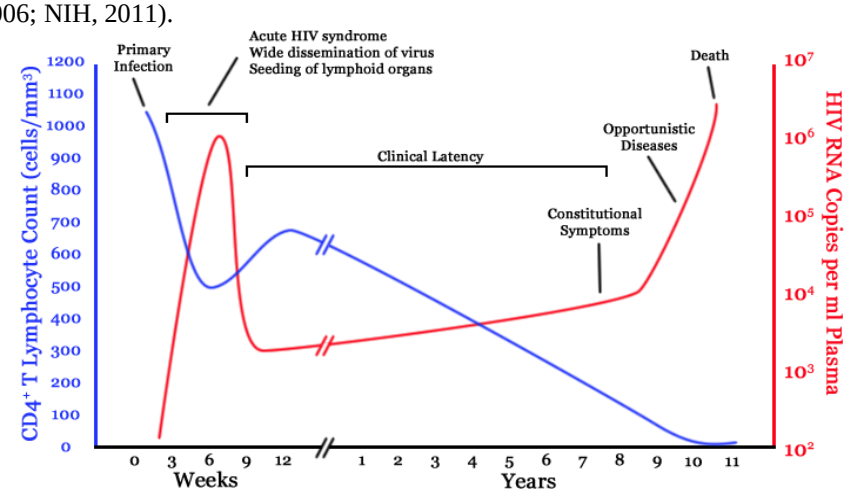

Figure1.3: Clinical progression of HIV to AIDS (Source: The naked scientist, 2007).

Acute infection stage

Within two to four *weeks* after HIV infection, many, but not all, patient develops flu-like symptoms, often described as "the worst flu ever." Symptoms can include fever, swollen glands, sore throat, rash, muscle and joint aches and pains, fatigue, and headache. This is called "acute retroviral syndrome" (ARS) or "primary HIV infection," and it's the body's natural response to the HIV infection. During this early period of infection, large amounts of virus are being produced in the body. The virus uses CD4 cells to replicate and destroys them in the process. Because of this, the CD4 count can fall rapidly. Eventually the immune responsewill begin to bring the level of virus in the body back down to a level called a *viral set point*, which is a relatively stable level of virus in the body. At this point, the CD4 count begins to increase, but it may not return to pre-infection levels (WHO, 2006; AIDS, 2013).

Clinical latency stage

After the acute stage of HIV infection, the disease moves into a stage called the "clinical latency" stage. "Latency" means a period where a virus is living or developing in a person without producing symptoms. During the clinical latency stage, people who are infected with HIV experience no HIV-related symptoms, or only mild ones. (This stage is sometimes called "asymptomatic HIV infection" or "chronic HIV infection"). During the clinical latencystage, the HIV virus continues to reproduce at very low levels, although it is still active. Patientson ART may live with clinical latency for several decades because treatment helps keep the virus in check. For those who are not on ART, the clinical latency stage lasts an average of 10years, but some people may progress through this stage faster. Therefore, intervention means to delay /attenuate the progressions of latency stage through adequate nutritional assistance warrant research investigation by health authorities (WHO, 2006; Pribram, 2011; Amlogu et al, 2012). It is important to remember that patients in this symptom-free stage are still able to transmit HIV to others, even if they are on ART, although ART greatly reduces the risk of transmission.

AIDS Stage

This is the stage of HIV infection that occurs when the immune system is badly damaged and become vulnerable to infections and infection-related cancers called *opportunistic infections*. When the number of your CD4 cells falls below *200 cells per cubic millimeter of blood (200cells/mm^3)*, patients are considered to have progressed to AIDS. In someone with a healthyimmune system, CD4 counts are between 500 and 1600 cells/mm^3. A patient is also consideredto have progressed to AIDS if he/she develops one or more opportunistic illnesses, regardless of the CD4 count (WHO, 2006). Without treatment, patients who progress to AIDS typically survive about three years. Once you have a dangerous opportunistic illness, life-expectancy without treatment falls to about one year. However, if a patient is taking ART and maintains alow viral load, then he/she may enjoy a near normal life span and will most likely never progress to AIDS (WHO, 2006).

1.2 Nutrition role in HIV

Nutrition has always been an important aspect of HIV care (Pribram, 2011). Similarly, HIV asa pandemic disease its impact is worsened by the presence of other conditions such as under- nutrition and opportunistic infections (Anabwani and Nazario, 2005; Amlogu et al., 2012). Since 2007, sub-Saharan Africa (SSA) remained the region most heavily affected by HIV/AIDS across the world (Figure 1.5), accounting for 70% of all people living with HIV andfor 75% of AIDS deaths (UNAID, 2011). HIV/AIDS scourge has had a devastating impact onhealth, nutrition, food security and overall socioeconomic development in countries that have been greatly affected by the disease. There is an urgent need for renewed focus on and use of resources for nutrition as a fundamental part of the comprehensive package of care at the country level (Anabwani and Nazario, 2005; FMOH, 2007; WHO, 2010; Ivers, 2014).

In human beings, HIV/AIDS and under-nutrition form a symbiotic relationship and one increases the prevalence and severity of the other (Pribram, 2011; Ivers, 2014). Moreover, despite the effectiveness of highly active antiretroviral therapy (HAART), there is evidence that HIV-related wasting remains an important co-morbidity factor in many patients (FAO/WHO, 2002; Tang et al, 2002; Pribram, 2011; Ivers, 2014).

Micronutrient deficiencies significantly contribute to HIV progression to AIDS; deficiencies of essential vitamins (A, B-complex, C and E) and minerals (selenium and zinc), are commonin People Living with HIV (PLWH) and these micronutrients are required by the immune system to combat infection (WHO, 2005; Barry et al., 2007; Duggal, 2012; Amlogu et al., 2013). Furthermore, deficiencies of antioxidants (vitamins and minerals) contribute to oxidative stress (a condition that may accelerate immune cell damage), increase risk of diarrheaand therefore associated mortality in HIV positive children, and increase the rate of HIV replication as illustrated in Table 1.2 (USAID, 2004; Piwoz, 2004; Drainl et al., 2007 and Ivers,2014).

Table 1.2: Contribution of HIV/AIDS to morbidity in Nigeria (FMOH, 2007)

S/N	Disease conditions	Contribution (%)
1	HIV/AIDS	16.0%
2	Respiratorydiseases	14.0%
3	Malaria	11.0%
4	Cardiovasculardiseases	10.0%
5	Childhooddiseases	9.0%
6	Diarrheadiseases	7.0%
7	Injuries (Roadaccidents,drowning,violence)	7.0%
8	Prenatalconditions	4%
9	Others (cancer, urinary diseases, TB, etc)	22%

The effects of undernutrition on the immune system are well documented and include decreasesin CD4 T-cells, suppression of delayed hypersensitivity and abnormal B-cell responses (USAID, 2004; Pribram, 2011). Interestingly, the immune suppression caused by protein- energy malnutrition mechanism is similar in many ways to the effects of HIV infection in PLWH as illustrated in Figure 1.4 (RCQHC and FANTA, 2003; FANTA, 2004; USAID, 2004;Pribram, 2011).

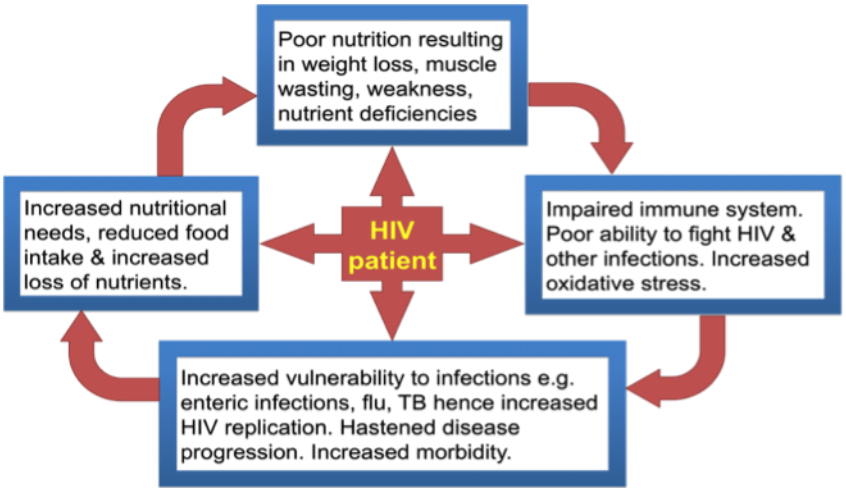

Figure 1.4: The vicious cycle of malnutrition in the HIV patient (Source: RCQHC and FANTA 2003)

Action and investment to improve the nutritional status of People Living with HIV/AIDS (PLWHA) should be based on sound scientific evidence, local resources, programmatic and clinical experience with the prevention, treatment, and management of the disease and relatedinfections (USAID, 2004; UNAIDS, 2008; Tewfik et al., 2010; UNAIDS, 2010; WHO 2010;
Amlogu et al., 2012). Although there are gaps in scientific knowledge, much can and should be done to improve the health, nutrition and quality of care for PLWHA and their families andcommunities (WHO, 2005; Barry et al, 2007).

An earlier review by Piwoz and Preble (2000) examined preliminary evidence that improvingnutrition status may improve some HIV-related outcomes (Amlogu et al., 2013). HIV infectionincreases energy requirements through increases in resting energy expenditure (REE 12% higher), while reduced food intake, nutrient mal-absorption, negative nitrogen balance and metabolic alterations exacerbate weight loss and wasting, perpetuating the cycle (Melchior et al, 1991; FAO/WHO, 2002; Piwoz, 2004; WHO, 2009). Increase in REE may be due to the production of tumor necrosis factor-alpha and /or interleukin-l in patients with AIDS.However, potential mechanisms of wasting invoked in AIDS patients and their impact on energy intakes (e.g., severe oral and /or esophageal candidiasis, viral esophagitis or extensive oral kaposis sarcoma) are perhaps more relevant. Anorexia can occur in response to systemicinfection or mental depression, and intestinal mal-absorption, increased loss of nutrients; muscle wasting, and weakness were also reported in AIDS (Melchior et. al, 1991).

1.3 Scale of the problem and epidemiology of HIV

At the end of 2010, an estimated 34 million people were living with HIV worldwide (Figure 1.5), up 17% from 2001 (UNAIDS, 2011). This reflects the continued large number of new HIV infections and a significant expansion of access to antiretroviral therapy, thereforedeclining mortality rates. Globally, there were 2.7 million new HIV infections in 2010, including an estimated 390,000 among children. However, SSA accounted for 70% of new HIV infections in 2010 (UNAIDS, 2011).

WHO reported in many countries surveyed in SSA, more than half the people estimated to be living with HIV are not aware of their HIV status. In some countries, significant proportions of pregnant women living with HIV either remains undiagnosed or, if diagnosed, do not start on ARV medicines for their own health and to prevent the mother-to-child transmission of HIV(WHO, 2013). Other studies in SSA showed that close to half the people who test HIV-positivewere lost between testing and being assessed for eligibility, and 32% of the people consideredeligible for ART were lost between being assessed for eligibility and initiating ART (WHO, 2013). WHO, UNAIDS and UNICEF (2011) also reported that AIDS had become one of the leading causes of adults dying in SSA and the full onslaught of the epidemic could not be felt until 2006, when more than 2.2 million people died each year from AIDS-related causes such as undernutrition, tuberculosis and other opportunistic infections (Table 1.3).

Malnutrition

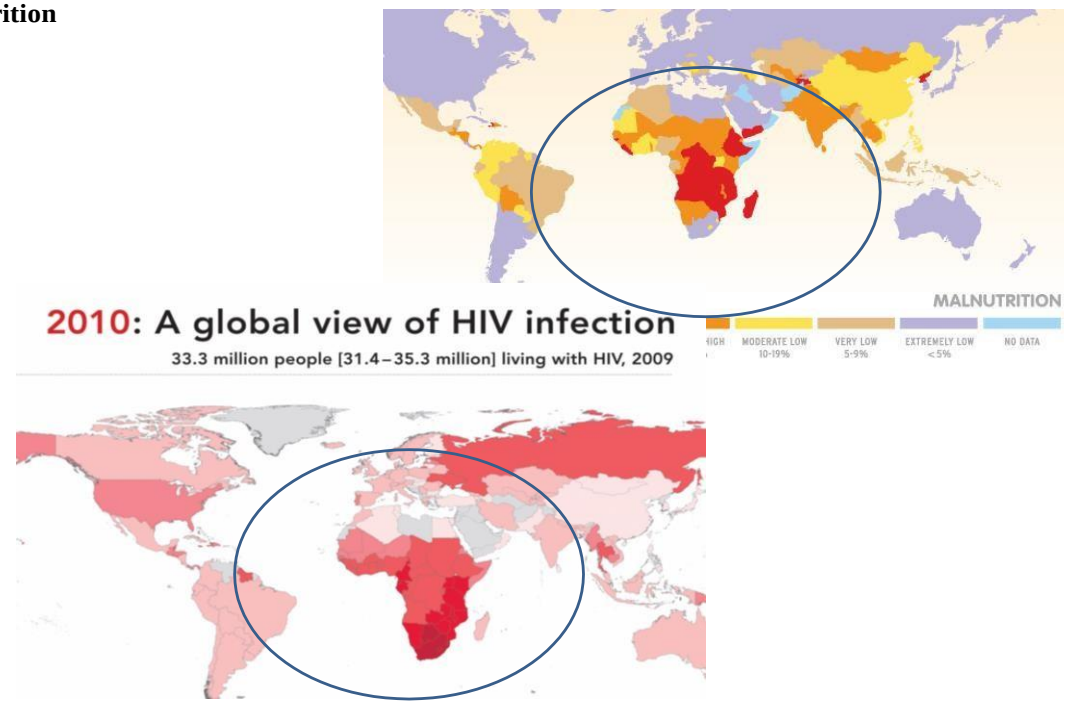

Figure 1.5: A global view of HIV infection (Source: UNAIDS, 2010; FAO, 2010).

Sixty-one per cent of people infected with HIV in SSA are women (Pribram, 2011) and severalpopulation-based survey in Africa have found extremely high rates of infection amongst youngwomen- for example, HIV infection rates of 5.1% among women between 25 and 29 years in rural South Africa (Pribram, 2011; NACA, 2012).

HIV remains the single greatest cause of death in SSA – responsible for more than 20% of death in the region (Pribram, 2011). Nigeria ranks second most affected by HIV/AIDS globally(CIA, 2012), after South Africa. Nigeria is among the 15-focus countries, which collectively represent 50% of HIV infections worldwide (Table 1.3).

Although the HIV prevalence of approximately 3.1% (UNAIDS, 2009; CIA, 2012) appears relatively low compared with other countries in SSA, it nevertheless translates into over 3.4 million people infected with HIV in Nigeria (UNAIDS, 2010).

Table 1. 3: Estimate of all people (adults and children) alive at year end with HIV infection, whether or not they have developed symptoms of AIDS (Source: CIA WorldFactbook, 2012).

Rank	Country	HIV/AIDS People Living With HIV/AIDS
1	**South Africa**	6,070,800
2	**Nigeria**	3,426,600
3	**India**	2,085,000
4	**Kenya**	1,646,800
5	**Mozambique**	1,554,700
6	**Uganda**	1,549,200
7	**Tanzania**	1,472,400
8	**Zimbabwe**	1,368,100
9	**United States**	1,200,000
10	**Malawi**	1,129,800

In 2007, approximately 750,000 PLWH in Nigeria required antiretroviral treatment (CD4 countis <350 cells/mm^3 as illustrated in Figure1.6) and this number was expected to double in the next five years. Also, in 2007, it was estimated that 200,000 people were receiving antiretroviral therapy (ART) from various providers in the country representing about

27% ofall the people who need the treatment (Fig.1.6). Between 2005 and 2010, the AIDS related deaths fell from 220,000 to 170,000 while those orphaned as a result rose from 1.6 million in 2005 to 2;6 million orphans in 2010. Estimates also show a cumulative death of 2.8 million people in 2010 (FMOH, 2007).

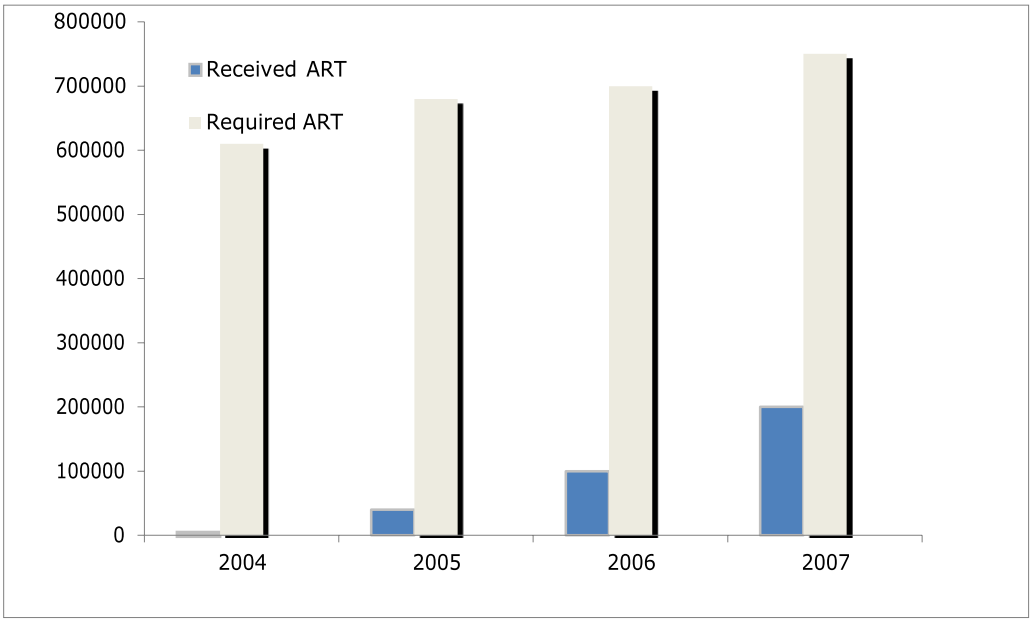

Figure 1.6: Number of PLWH who received ART against those who needed it. Thevertical bars represent the number of PLWH (Source: UNAIDS and WHO, 2009).

Figure 1.6 shows that there is a gradual progression in the number of PLWH receiving ART from less than 10,000 in 2004 to 200, 000 in 2007. According to National Agency for Controlof Aids (NACA),

1.4 HIV/AIDS as a Public Health Problem in Nigeria

The high burden of the disease with its associated morbidity and mortality despite the concertedefforts of the Federal Government of Nigeria and its international and local partners' efforts tocombat the disease, it continues to constitute a major public health concern for the country (*Tables 1.2 - 1.5*) (FMOH, 2007).The epidemic has further weakened and threatened to overwhelm the Nigerian health care system, increased the number of orphans and increased thecost of achieving set developmental goals by decreasing the size of the workforce, affecting asit does, mainly adults in their most productive years of life (15-60 years). The high manpower-intensive sectors of the economy are most affected; in Nigeria this includes the agricultural, educational and health sectors as well as the rural economy (FMOH, 2007; FMOH, 2010). In summary, the impact of HIV/AIDS on Nigeria's social fabric and on its economic developmentand well-being country to be pervasive and, unless controlled, will continue to undermine the quality of life of Nigerians (FMOH, 2007; FMOH, 2010).

Table 1.4: Cumulative HIV deaths in Nigeria (FMOH, 2005; FMOH, 2007).

	2005	**2006**	**2010**
No. of people infected	2.86 million	2.99 million	3.4 million
No. of new HIV infections:			
• Adults	296,320	305,080	346,150
• Children (<15 years old)	73,550	74,520	75,780
No. requiring ART:			
• Adults	412,450	456,790	538,970
• Children (<15 years old)	94,990	98,040	106,840
Annual HIV (+ve) births	73,550	74,520	75,780
Cumulative deaths	1.45 million	1.70 million	2.82 million

Table 1.5: HIV/AIDS Burden: Socio-economic implications in Nigeria (FMOH, 2007)

	2005	2010
Number of children orphaned due to AIDS	1,640,000	2,680,000
Number of orphans	7,820,000	9,130,000
Number of HIV positive pregnant women	227,900	223,300
Life expectancy	47 years	43.4 years

1.5 Nutrition problems in Nigeria

Malnutrition is a serious problem that aggravates the spread of HIV in Nigeria (Figure 1.7) (Amlogu et al., 2011; Amlogu et al., 2012; Amlogu et al., 2013). HIV prevalence in the countrycan be said to be stabilising but malnutrition is on the increase (FMOH, 2011). The Nigeria Demographic and Health Survey (NDHS) 2008 shows that 41% of children aged less than fiveyears were stunted, 23% were underweight and 14% were wasted. The Nigeria Food Consumption and Nutrition Survey (2003) also reported that 11.6% of women of childbearingage were suffering from chronic under-nutrition. Prevalence of micronutrient deficiencies wasalso high (FMOH, 2011). Among children under five years old, 29.5% suffered from vitamin A deficiency. 27.5% were iron deficient and 27.5% suffered various degrees of iodine deficiency. Among women of child bearing age, 13.1% were vitamin A deficient (19.1% of pregnant women), 12.7% iron deficient and 15.3% iodine deficient (FMOH, 2011).

Data on the prevalence of other micronutrient deficiencies like magnesium, selenium, and vitamin C are not available, but these nutrients, which are important for optimum immune functions, are also deficient among large sections of the population. It has long been establishedthat malnutrition impacts negatively on optimal immune function, thus increasing susceptibility to morbidity and mortality among HIV positive clients. It is therefore importantto include nutritional care and support in the provision of quality care and support for People Living with HIV (PLWHIV) (FMOH, 2011; Amlogu et al., 2013).

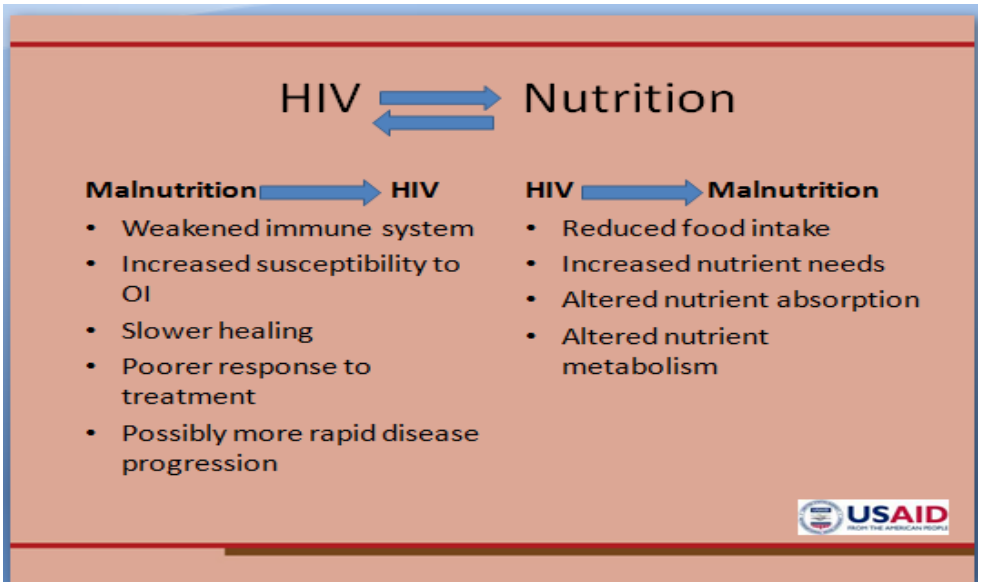

Figure 1.7: HIV/AIDS and under-nutrition form a symbiotic relationship (USAID,2004)

1.6 Additional energy requirements (Asymptomatic vs. symptomatic)

Asymptomatic HIV-positive adults need 10% additional energy (per day) than HIV-negative individuals of the same sex. The additional energy requirement for symptomatic HIV positive adults is 20 to 30% (per day) than HIV-negative individual of the same sex while children withgrowth faltering require 50 to 100% additional energy (Table 1.6) (Piwoz, 2004; FANTA, 2004; WHO, 2007). Therefore, macro and micronutrients from naturally occurring (as opposedto synthetic with a less bioavailability) components tailored to meet the additional energy requirements of PLWHA will enhance well-being and health and/or reduce the risk of diseaseor provide health benefit so as to improve their quality of life (Roberfroid, 2002; Amlogu et. al., 2013).

Table 1.3: WHO: PLWHIV Nutrient Requirement (WHO, 2003; FANTA/USAID 2007).

•Energy
10% increase for asymptomatic
20 – 30% increase for symptomatic
50 – 100% increase for children with growth faltering
•Protein
12 – 15% of energy intake to maintain and/or recover lean body mass
•Micronutrients
Essential micronutrients at RDA
High energy, nutrient dense food is required to meet needs – not just more of the same

1.7 The European Perspectives of Functional Foods

Because of increasing interest in the concept of "Functional Foods" (Figure 1.8) and "Health Claims", the European Union set up a European Commission Concerted Action on FunctionalFood Science in Europe (FUFOSE). The report takes the position that functional foods shouldbe in the form of normal foods and they must demonstrate their effects in amounts that can normally be expected to be consumed in the diet (EUFIC, 2006; Amlogu et. al., 2013).

Currently, health concerns of communicable and non-communicable diseases have necessitated investigating into options for dietary interventions including the role of tailored food recipes *(e.g. Amtewa meal)* in HIV/AIDS management. The outcome of the research as outlined in Amlogu et al., 2012; Amlogu et al., 2013 will have direct effect on 90% of HIV infected subjects in West Africa *vis-à-vis* slowing down /eliminating the progression of HIV toAIDS (EUFIC, 2006; Amlogu et al., 2013).

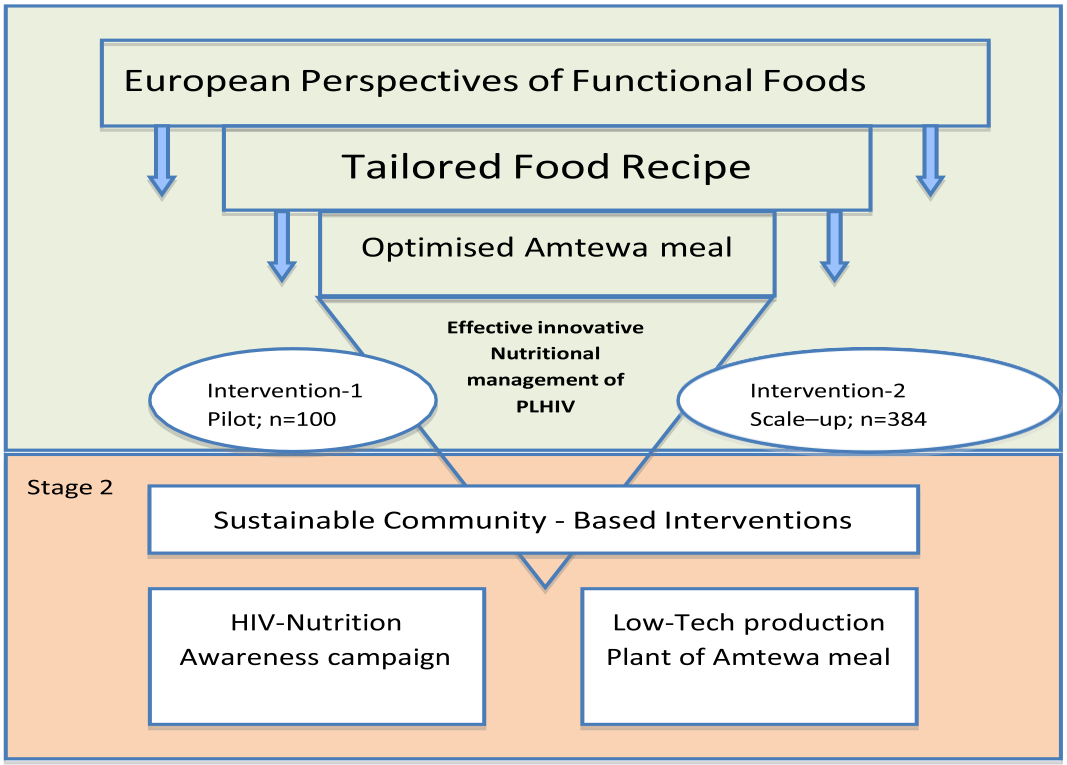

Figure 1.8: Concepts cascade to develop an effective nutritional management approach forPLHIV.

1.8 Justification for HIV nutrition intervention programme in Nigeria

Antiretroviral (ARV) drugs have been shown to reverse under-nutrition in HIV/AIDS but are usually used at the later stages of the disease when the patients are moribund (Kumar and Clark,2005; Boon and Walker, 2006). Thus, presently, 75% of Nigerians infected with HIV as recommended by WHO do not require ART (CD4 $\geq$ 350cells/mm^3) but should receive nutritional assistance to maintain the immune system, sustain healthy levels of physical activityand for optimal quality of life (WHO, 2010; Amlogu et al., 2012). Incidentally, in Nigeria all the HIV/AIDS programmes and

interventions at the moment focus on the remaining 25% of HIV infected subjects that require ART (CD4<350cells/mm^3) (UNAIDS, 2009). The implication of the reality on the ground is that all the interventions at the moment are grossly unable to cope with the treatment of those who require ART urgently.

In essence, the study proposed a nutrition intervention programme which was designed to circumvent undernutrition of the 75% of PLWHIV who do not require ART (and sustain theirCD4 count level ≥350 cells/mm^3 i.e. not require initiation of ART) and equally supporting the remaining 25% who are receiving ART treatment (CD4 count ≥200 cells/mm^3). Therefore, thefocus of the intervention was to develop an optimised meal containing macro and micro nutrients from natural food sources in Nigeria employing the tailored functional recipe (TFR*)concept (as outlined in box 1.2) to strengthen the immune system of PLWHIV.

Box 1.2: Definition of TFR

*TFR: Food that is naturally occurring, accessible, affordable and perhaps consumed in unnatural concentrations as part of the usual diet and has demonstrated physiological and or biomedical benefits in reducing the risk of chronic disease beyond basic nutritional functions (Amlogu, et al., 2012; Amlogu et al., 2013).

1.9 Originality of the nutrition intervention research

Development of 'Amtewa meal'

Under-nutrition and micronutrient deficiency remain significant contributors to morbidity andmortality in developing countries (FAO/WHO, 2002; Amuna et al, 2004; Amlogu et al., 2012)and in economic terms, remain a major challenge. Food-based approaches need to be innovative, culturally acceptable, accessible, affordable, reliable and requiring low-tech approaches in order to assure compliance, sustainability and cost-effectiveness (Zotor et al., 2006; Amlogu et al., 2013). It is possible to improve the nutritive value of local foods throughsimple but scientific combinations of food ingredient in form of food multimixes (FMM) to develop Amtewa meal (Amuna et al, 2004; Amlogu et al., 2013).

Nutrient deficiencies associated with HIV are: total calories, proteins, vitamin A, vitamin B 6,vitamin B 12, vitamin C, vitamin E, magnesium, selenium and zinc (Kotler, 1992; Beach et al.,1992; Baum et al., 1995; Cimoch, 1997; Van Staden et al., 1998; Kotler, et al., 1999; Periquet et al., 1995; Vilaseca, 2003 and Oguntibeju, 2008). Development of a biochemical deficiencyof vitamins A, B 6 and B 12[2] is associated with faster disease progression. Normalisation of plasma vitamin A, B 12 and zinc levels is linked to slower disease progression (Baum et al., 1995). Tang et al. (1997) confirm that low serum (>180ng/L) vitamin B 12 precedes disease progression. Patients often have multiple nutrient deficiencies at once, and many of the nutrients likely to be deficient are directly or indirectly involved in maintaining normal immunesystem function (Tang and Smit, 1998).

Table 1.7: Justification for the inclusion of some selected macro/micronutrients in the optimised meal (Amtewa meal) and the sources of the nutrients from Nigerian foods (Bijlsma, 2000; Zotor, et al., 2000; Piwoz and Preble, 2000; Amloguet al., 2013; Monica, 2013).

Nutrient	Deficiency	Sources	Literature support
Vitamin A	Faster disease progression	Dried moringa leaves, dried carrot roots	Bijlsma, 2000; Zotor, et al., 2000; Piwoz and Preble, 2000; Amlogu et al.,2013, Monica, 2013
Vitamin B1, B2&B3	Psychoneurological symptomsranging from peripheral neuropathies to spinal cord degradation and cognitive impairment	Dried moringa leaves	
Vitamin C	Decreases resistance to infection	Dried soya bean seeds, dried moringaleaves, dried carrot roots	
Phosphorus	Reduced utilization of energy and metabolism by cells	Dried soya bean seeds, dried moringaleaves, dried millet seeds	
Zinc	Faster disease progression	Dried soya bean seeds, dried moringaleaves, dried carrot roots, dried milletseeds	
Copper	Increased incidence of infectionand cell-mediated immunity	Dried moringa leaves, dried carrotroots, dried millet seeds	
Iron	Anaemia	Dried soya bean seeds, dried moringaleaves, dried carrot roots, dried milletseeds	
Manganese	Decreased mitochondria ability toreduce level of oxidative stress	Dried carrot roots, dried millet seeds	
Sodium	Hyponatremia, muscularweakness	Dried soya bean seeds, dried carrotroot, dried millet seeds	
Potassium	Hypokalemia, impaired cellularprocesses	Dried soya bean seeds, dried moringaleaves, dried carrot roots, dried milletseeds	
Magnesium	Decreased protein synthesis,decreased transmissionof nerve impulse	Dried soya bean seeds, dried moringa leaves, dried carrot roots, dried milletseeds	
Calcium	Decreased normal heart and muscle functions, blood clothingand pressure, and immune defence	Dried soya bean seeds, dried moringaleaves, dried carrot roots, dried milletseeds	
Selenium	Faster disease progression fromoxidative damage	Moringa leaves, whole grain	

Amtewa meal is a combination of these macro and micronutrients carefully selected from locally available food in Abuja Nigeria, analysed, optimised and formulated into a 100g pack for daily consumption and can contribute between 15 to 20% additional energy requirement byPLWHIV as recommended by WHO. This meal is a natural product that requires low- technology approaches in its development, has a greater bioavailability than synthetic nutritional supplements and the nutritional content of the meal is tailored to: decrease functional impairment from under nutrition, improve immune function, preserve or increase fat-free mass, limit disease specific complications, improve tolerance to antiretroviral therapy(ART), provide relief from/prevent symptoms of HIV and improve quality of life of PLWH inNigeria (Kotler, et al., 1999; Mahlungulu et al., 2009; Amlogu et al., 2013; Ukibe et al., 2013).

1.10 Discussion

Daily macro and micronutrient optimised in the formulation of Amtewa meal improved body weight and body cell mass, improved CD4 cell counts and reduced the incidence of opportunistic infections in a pilot (n=100) studies of adults PLWHIV in Nigeria, including those on antiretroviral therapy. The main outcomes were outlined in Amlogu et al., (2012); Amlogu et al., (2013) and Amlogu et al., (2014).

The findings from the nutrition intervention confirm that the 75% of Nigerians infected with HIV who does not require ART, but nutritional assistance to maintain their immune system, sustain healthy levels of physical activity and for optimal quality of life are guaranteed of decrease in progression of their HIV status to AIDS. Similarly, the remaining 25% of HIV infected subjects in Nigeria who are currently on the HIV care and support programmes can besustained by obviating their progression to AIDS.

The combination of Amtewa meal consumption in addition to the daily nutrient intake (DNI) has significantly improved the overall nutritional status of PLWHIV. These multi-levels improvement can be summarized as follows:

- Meeting the daily requirements of some essential minerals and vitamins (selenium,zinc, iron etc and vitamins - A, B, C, D, and E).
- Preserving or increasing fat-free mass.
- Achieving and maintaining an ideal body weight.
- Decreasing functional impairment from under-nutrition (muscular fatigue, bedriddenstate and work incapacity).
- Improving immune function.

Additionally, Amtewa meal may also assist in limiting disease-specific complications, improving tolerance to antiretroviral treatment, provide symptomatic relief and alleviating gastrointestinal symptoms of HIV illness (nausea, diarrhea and bloating) and improving qualityof life and survival of PLWHIV in Nigeria. (Amlogu et al., 2012).

The mechanism of improved immune and nutritional status achieved by Amtewa meal nutritionintervention has qualified Amtewa meal to assist in multidimensional facet as illustrated in Figure 1.9 below:

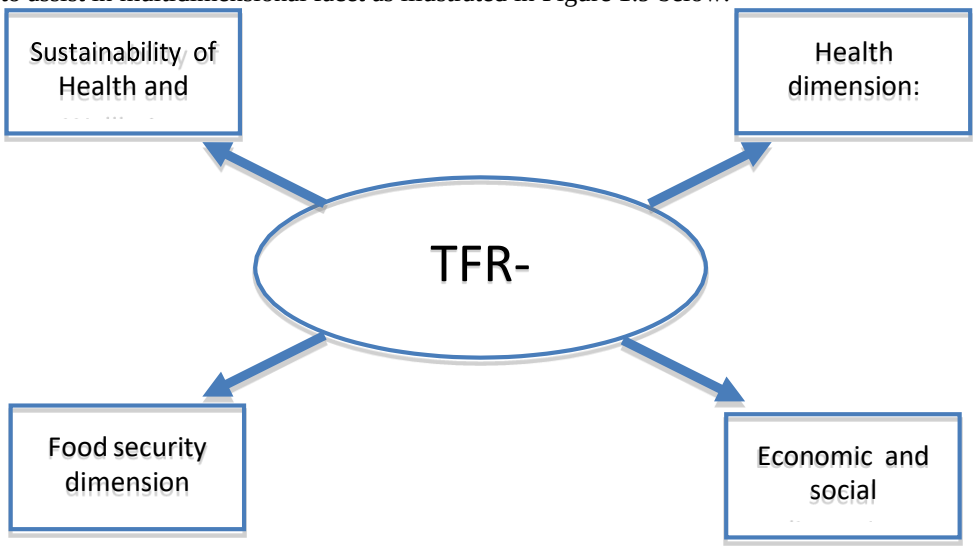

Figure 1.9: The Multi-dimensional advantages of Tailored Functional Meal - AMETWA

1.10.1 Health Dimension

The Amtewa meal nutrition intervention increased CD4 count cells and MUAC of PLWHIV. This supports other trials that have shown positive effect of vitamins B, C and E supplements on the immune status of HIV-infected persons and the relationships between micronutrients status and HIV disease progression among adults and children (Fawzi, 2003). In Kupka et al.,(2004) investigation, increased plasma selenium levels were related to a decreased risk of mortality. Although plasma selenium levels were not associated with time to progression to CD4 cell count < 200 cells/mm but were weakly and positively related to CD4 cell count in thefirst years of follow up. Selenium (present in moringa leaves) status is important for clinical outcomes related to HIV disease in SSA (Amlogu et al., 2012).

Vitamin C (present in carrot, moringa and soyabeans) is the most powerful, least toxic naturalantioxidant (Bendich and

Langseth, 1995). It is a water-soluble vitamin and is found in high concentration in many tissues. Vitamin E a generic description for all tocols and tocotrienol derivatives exhibits the biological activity of alpha tocopherol (Diplock et al., 1998). The richest sources of vitamin E in the diet are vegetables oils such as soyabean, maize, cottonseedand safflower seed (Diplock et al., 1998).

Carotenoids (present in Amtewa meal) are lipophilic antioxidants present in lipoproteins suchas LDL and HDL. Some of the major sources are carrots (alpha carotene and beta carotene), tomatoes, citrus fruits, spinach. Flavonoids are considered polyphenolic antioxidants that occurin several fruits, vegetables and beverages. Enzymes such as glutathione peroxidase and superoxide dismutase, which require a dietary supply selenium, copper and zinc respectively, contributed to the overall oxidative defence mechanism achieved by the intervention meal (Diplock et al., 1998).

Local food substances in Nigeria (soyabean, millet, carrot and moringa) that contain vitamin C, vitamin E, carotenoids and flavonoids provided antioxidant effect in the formulation of Amtewa meal. Therefore, the first strategy to balance oxidative damage and antioxidant defence of human cells and tissues in PLWHA was to enhance the antioxidant capacity by carefully selecting and optimizing the dietary intake (macro and micronutrients) of antioxidants.

According to Pribram (2011) the choice of MUAC in the assessment of the nutritional status in the intervention was based on the fact that MUAC is simple and minimally invasive and is rarely affected by oedema than other anthropometric measurements. Bishop et al, 1981classification of mean MUAC (cm) according to age groups confirmed that the mean MUAC for men within the age group 18 to 74 years is 31.8cm while that of women within the same age group (18 – 74 years) is 29.4cm. Although the MUAC results (Test versus control) in the intervention indicated that both groups are within the normal range as specified by Bishop et al. however, there was a consistent decrease in MUAC in the control (Pre-ART and ART) groups.

1.10.2 Economic and Social dimensions

The traditional diets of most societies in developing countries (like Nigeria) are good (FAO, 2014). Scientific approach in the development of a functional meal like Amtewa will help to protect, support and help preserve the many excellent existing local food sources nutritionallyvaluable in the management of some disease conditions like HIV. Although synthetic multivitamins are present in the Nigerian market, however, functional food such as Amtewa meal constituents (soyabeans, millet, carrot and moringa leaves) are readily available, accessible, affordable and more bio-available than the synthetic products. Synthetic multivitamins are very expensive food supplements which are not affordable by an average Nigerian, and if the country continues to import them, then foreign exchange is unnecessarily spent. The production of food comes mainly from agriculture. Nigeria has the human and material resources for the cultivation and production of the constituents of Amtewa meal. High-yielding varieties of the important cereals in Amtewa meal (soyabeans, millet) have been successfully developed, and much progress has been made in increasing food yields per hectareof land. Other forms of economic and social dimensions are:

- Improving the high manpower-intensive sectors of the economy that are most affectedby HIV disease in Nigeria. This includes the agricultural, educational and health sectorsas well as the rural economy.
- Decreasing the number of orphans and decreasing the cost of achieving set developmental goals by increasing the size of the workforce.
- Improving the quality of life of Nigerians thereby contributing positively to the economic development.
- Decreasing cumulative deaths which represent an incalculable loss of human potentialassociated with enduring trauma in households and communities.
- PLWHIV with a CD4 count above 200 cells/ mm^3 can be continually productive in theircommunity economy and sustain a little disrupted family life.

1.10.3 Food security dimension

Household food security depends on a nutritionally adequate and safe food supply in Nigeria, at the household level and for each individual; a fair degree of stability in the food availabilityto the household both during the year and from year to year; and access of each family memberto sufficient food to meet nutritional requirements (FAO, 2014). This last criterion includes notonly physical access but also economic and social access to foods that are culturally acceptable(Amtewa meal). Incomes received from cash crops or wage earnings and prices paid for purchased items influence a rural population's food security (FAO, 2014). However, IITA, (2004) reported that average household expenditure on non-staples in Nigeria was highest on fish (N140.84 approximately $1) followed by meat products (N81.54 approximately half a dollar). Here, the least weekly expenditure was on fruit (N13.62), followed by weekly expenditure on the leafy vegetables (N20.88). This suggests that most Nigerians have vegetablegardens in their neighborhood were these vegetables such as moringa leaves are easily accessedand may not need to purchase from the market. Food security can be threatened by increased prices, job loss, income reduction, rent increases, larger numbers of dependent persons (more children, or relatives moving into the household) and other factors (FAO, 2014, Ivers, 2009). Nonetheless, IITA (2004) report on frequently consumed staple and non-staple foods in Nigeriasuggests that the constituents of Amtewa meal (soyabeans, millet, carrot and moringa leaves) are available and affordable.

The concept of food security in the intervention research was to ensure both physical and economic access to food that meets dietary needs (in the form of a functional meal - Amtewa)of PLWHIV. Wang et al. (2011) reported that among HIV-infected participants receiving antiretroviral medications, food insecurity is associated with unsuppressed viral load and mayrender treatment less effective. Similarly, Palar (2012) reported that improvements in work andmental health status were identified as potential pathways through which ART may improve food security. Therefore, Amtewa meal nutrition

intervention may guarantee food security dueto the fact that the intervention meal meets the three pillars on which food security is built. These are:

- Amtewa meal constituents are readily available: sufficient quantities of soyabeans, moringa leaves, carrot and millet are available on a consistent basis (IITA, 2004 reporton Nigeria Food Survey).
- Amtewa meal constituents are accessible: having sufficient resources to obtain /affordthe constituents for a nutrition intervention (FAO, 2014; IITA, 2004).
- Amtewa meal formulation requires low technology: appropriate use based on knowledge of basic HIV nutrition and care, as well as adequate training on TFR concept(Amuna, et al., 2004; Amlogu et al., 2011; Amlogu et al, 2012 and Amlogu et al, 2013).

1.10.4 Sustainability and health promotion

The relationship between malnutrition and infection has been extensively studied and documented. There is no doubt that common infections such as diarrhoea, respiratory disease,intestinal worms, measles and HIV/AIDS are important causes of malnutrition (FAO, 2014).

Therefore, the urgent need to sustain the gain of Amtewa meal nutrition intervention in slowingdown the progression of HIV to AIDS is imperative.

Planning for sustainability in this public health nutrition intervention require a clear understanding of the concept of sustainability and operational indicators that may be used in monitoring sustainability over time in Nigeria. It also requires the use of programmatic approaches and strategies that favored long-term program maintenance in a resource limited setting. Broad-based support from the cross-section of service providers is necessary to overcome reasons related to limited financial resources, territoriality concern, local politics, limited time and lack of hospital management interest. In addition, quality control procedures and HIV treatment protocols implemented in HIV treatment centres to incorporate Amtewa meal nutrition intervention as a component of care in the treatment centres. However, the sustainability and health promotion approach focused primarily on the following:

- Three training-workshops to empower (capacity building) the PLHIV community: Topics covered in these workshops were: Basic health education on HIV/AIDS;Nutrition education on the macro/micronutrient contents of local fruit and vegetables; Formulation/preparation of Amtewa meal at home standardised but adaptable approaches in the design of the intervention.
- maintenance of research outcome (pilot and scale up) health benefits achieved throughthe intervention program with the health setting
- Presentation of research outcome at the Federal Ministry of Health Nigeria, National Agency for the Control of AIDS Nigeria, and publication in international journals.
- Level of institutionalization of a program within the health settings by incorporating Amtewa meal nutrition intervention in the HIV care program as a policy framework.
- Replication of Amtewa meal nutrition intervention in other HIV treatment centre in collaboration with the National Agency for the Control of AIDS (NACA) in Nigeria.

1.11 Conclusion

The success of recent nutrition interventions in HIV demonstrate the progress made in HIV care and support. The idea to adapt principles and technologies from the TFR concept to the development of a functional recipe to slow the progression of HIV to AIDS proves to be meaningful and realisable in Amtewa meal nutrition intervention approach.

Although the achieved results take the form of specific technology, it suggests that a prolong consumption of the intervention meal (Amtewa) will be suitable to sustain the gained improvements in the anthropometric and biochemical indices. The research highlighted crucialissues and identified key design parameters that require further attention and research in developing countries like Nigeria.

Overall, it addresses the synergistic relationship between nutrition and HIV infection, the nutritional requirement and nutritional care and support for PLWHIV in Nigeria. While the nutrition intervention demonstrated a positive effect, the study also suggests that the initial visitof a newly diagnosed HIV-positive patient should include screening for nutritional status, identify risks and offer appropriate nutrition counseling which was not in existence but currently has been imbedded as “Nutritional Framework” within the HIV care and support programme in one of the accredited HIV treatment centres in Nigeria. This NutritionalFramework has provided information to PLWHIV on their HIV medication and food interactions and about nutritional screening tools available in the health setting.

Finally, the research provides evidence which may be used as a basis for policy makers to incorporate Amtewa meal nutrition intervention in HIV care and support programme in other HIV treatment centres in Nigeria with a view of attenuating the progression of HIV to AIDS amongst PLWHIV in Nigeria.

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