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<b>FY 2020 Houston EMA Ryan White Part A/MAI Service Definition Medical Nutritional Therapy</b>	
HRSA Service Category Title: <b>RWGA Only</b>	<b>Medical Nutritional Therapy</b>
Local Service Category Title:	<b>Medical Nutritional Therapy and Nutritional Supplements</b>
Budget Type: <b>RWGA Only</b>	<b>Hybrid</b>
Budget Requirements or Restrictions: <b>RWGA Only</b>	<p><b>Supplements:</b> An individual client may not exceed \$1,000.00 in supplements annually without <b>prior</b> approval by RWGA.</p> <p><b>Nutritional Therapy:</b> An individual nutritional education/counseling session lasting a minimum of 45 minutes. Provision of professional (licensed registered dietician) education/counseling concerning the therapeutic importance of foods and nutritional supplements that are beneficial to the wellness and improved health conditions of clients. Medically, it is expected that symptomatic or mildly symptomatic clients will be seen once every 12 weeks while clients with higher acuity will be seen once every 6 weeks.</p>
HRSA Service Category Definition: <b>RWGA Only</b>	<b>Medical nutrition therapy</b> is provided by a licensed registered dietician outside of a primary care visit <b>and may include the provision of nutritional supplements.</b>
Local Service Category Definition:	<p><b>Supplements:</b> Up to a 90-day supply at any given time, per client, of approved nutritional supplements that are listed on the Houston EMA/HSDA Nutritional Supplement Formulary. Nutritional counseling must be provided for each disbursement of nutritional supplements.</p> <p><b>Nutritional Therapy:</b> An individual nutritional education/counseling session lasting a minimum of 45 minutes. Provision of professional (licensed registered dietician) education/counseling concerning the therapeutic importance of foods and nutritional supplements that are beneficial to the wellness and improved health conditions of clients. Medically, it is expected that symptomatic or mildly symptomatic clients will be seen once every 12 weeks while clients with higher acuity will be seen once every 6 weeks. Services must be provided under written order from a state licensed medical provider (MD, DO or PA) with prescribing privileges and must be based on a written nutrition plan developed by a licensed registered dietician.</p>
Target Population (age, gender, geographic, race, ethnicity, etc.):	HIV/AIDS infected persons living within the Houston Eligible Metropolitan Area (EMA) or HIV Service Delivery Area (HSDA).
Services to be Provided:	<p><b>Supplements:</b> The provision of nutritional supplements to eligible clients with a written referral from a licensed physician or PA that specifies frequency, duration and amount and includes a written nutritional plan prepared by a licensed, registered dietician.</p> <p><b>Nutritional Supplement Disbursement Counseling</b> is a component of</p>

	<p><i>Medical Nutritional Therapy. Nutritional Supplement Disbursement Counseling</i> is a component of the disbursement transaction and is defined as the provision of information by a licensed registered dietitian about therapeutic nutritional and/or supplemental foods that are beneficial to the wellness and increased health condition of clients provided in conjunction with the disbursement of supplements. Services may be provided either through educational or counseling sessions. Also included in this service are follow up sessions with clients' Primary Care provider regarding the effectiveness of the supplements. The number of sessions for each client shall be determined by a written assessment conducted by the Licensed Dietitian but may not exceed twelve (12) sessions per client per contract year.</p> <p><b>Medical Nutritional Therapy:</b> Service must be provided under written order of a state licensed medical provider (MD, DO, PA) with prescribing privileges and must include a written plan developed by state licensed registered dietitian. Client must receive a full range of medical nutritional therapy services including, but not limited to, diet history and recall; estimation of nutrition intake; assessment of weight change; calculation of nutritional requirements related to specific medication regimes and disease status, meal preparation and selection suggestions; calorie counts; evaluation of clinically appropriate laboratory results; assessment of medication-nutrient interactions; and bio-impedance assessment. If patient evaluation indicates the need for interventions such as nutritional supplements, appetite stimulants, or treatment of underlying pathogens, the dietitian must share such findings with the patient's primary medical provider (MD, DO or PE) and provide recommendations. Clients needing additional nutritional resources will be referred to case management services as appropriate and/or local food banks.</p> <p>Provider must furnish information on this service category to at least the health care providers funded by Ryan White Parts A, B, C and D and TDSHS State Services.</p>
<p>Service Unit Definition(s): <b>RWGA Only</b></p>	<p><b>Supplements:</b> One (1) unit of service = a single visit wherein an eligible client receives allowable nutritional supplements (up to a 90 day supply) and nutritional counseling by a licensed dietitian as clinically indicated. A visit wherein the client receives counseling but no supplements is <u>not</u> a billable <u>disbursement transaction</u>.</p> <p><b>Medical Nutritional Therapy:</b> An individual nutritional counseling session lasting a minimum of 45 minutes.</p>
<p>Financial Eligibility:</p>	<p>Refer to the RWPC's approved <i>Financial Eligibility for Houston EMA/HSDA Services</i>.</p>
<p>Client Eligibility:</p>	<p><b>Nutritional Supplements:</b> HIV-infected and documentation that the client is actively enrolled in primary medical care.</p>

	<b>Medical Nutritional Therapy:</b> HIV-infected resident and documentation that the client is actively enrolled in primary medical care.
Agency Requirements:	None.
Staff Requirements:	The nutritional counseling services under this category must be provided by a licensed registered dietician. Dieticians must have a minimum of two (2) years experience providing nutritional assessment and counseling to PLWHA.
Special Requirements: <b>RWGA Only</b>	<p>Must comply with Houston EMA/HSDA Part A/B Standards of Care, HHS treatment guidelines and applicable HRSA/HAB HIV Clinical Performance Measures.</p> <p>Must comply with the Houston EMA/HSDA approved Medical Nutritional Therapy Formulary.</p>

***FY 2022 RWPC “How to Best Meet the Need” Decision Process***

<b>Step in Process: Council</b>		Date: <b>06/10/2021</b>
Recommendations:	Approved: Y: _____ No: _____ Approved With Changes: _____	If approved with changes list changes below:
1.		
2.		
3.		
<b>Step in Process: Steering Committee</b>		Date: <b>06/03/2021</b>
Recommendations:	Approved: Y: _____ No: _____ Approved With Changes: _____	If approved with changes list changes below:
1.		
2.		
3.		
<b>Step in Process: Quality Improvement Committee</b>		Date: <b>05/18/2021</b>
Recommendations:	Approved: Y: _____ No: _____ Approved With Changes: _____	If approved with changes list changes below:
2.		
2.		
3.		
<b>Step in Process: HTBMTN Workgroup #2</b>		Date: <b>04/20/2021</b>
Recommendations:	Financial Eligibility:	
1.		
2.		
3.		

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**FY 2019 PERFORMANCE MEASURES  
 RYAN WHITE GRANT ADMINISTRATION  
 HARRIS COUNTY PUBLIC HEALTH (HCPH)**

Ryan White Part A  
 HIV Performance Measures  
 FY 2019 Report

**Medical Nutritional Supplements  
 All Providers**

<b>HIV Performance Measures</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>Change</b>
75% of clients for whom there is lab data in the CPCDMS will be virally suppressed (<200)	388 (84.3%)	376 (81.7%)	<b>-2.6%</b>
90% of clients diagnosed with wasting syndrome or suboptimal body mass will improve or maintain body mass index (BMI) in the measurement year	8 (66.7%)	3 (50.0%)	<b>-16.7%</b>

*HCPH is the local public health agency for the Harris County, Texas jurisdiction. It provides a wide variety of public health activities and services aimed at improving the health and well-being of the Harris County community.*

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# Can Nutritional Supplements Help Fight HIV?

By [James Myhre and Dennis Sifris, MD](#) |  Medically reviewed by [a board-certified physician](#) | Updated on January 11, 2020

Proper nutrition is as important to the long-term health and well-being of a person living with [HIV](#) as it is to anyone else. But oftentimes, dietary needs require adjustments as the body responds to different medications or the disease itself.

Vitamins and minerals can often be depleted during severe or prolonged bouts of [diarrhea](#), the condition of which can be induced by certain infections or medications. Changes in body fats, also associated with [treatment](#) or HIV infection, can demand marked changes to one's diet.

Far more concerning, however, is the impact of malnutrition on people with HIV. Vitamin A and B12 deficiency, for example, has been associated with faster disease progression in both resource-rich and resource-poor settings. Low serum levels of micronutrients, commonly seen in malnourished individuals, demand greater vitamin intake—often in the way of nutritional supplements.

Without question, nutritional supplements have their place in the treatment of malnutrition or a diagnosed deficiency, whether it be caused by an HIV-related condition or poor nutrition itself. This is particularly true in late-stage disease when weight loss and [HIV wasting](#) are frequently seen.

But, what about everyone else? Do people with HIV inherently need nutritional supplements? Do these products complement therapy in a way that either reduces the incidence of infection, delays disease progression, or reconstitutes a person's key immune functions? Or are we just hoping they will?

## The Supplements Industry

According to the U.S. Centers for Disease Control and Prevention (CDC), nearly half of all Americans consume dietary supplements, including vitamins, minerals, and herbals. This expansive range of products is regulated by the U.S. Food and Drug Administration (FDA), which defines dietary supplements simply as products “intended to add further nutritional value to (supplement) the diet.”

In accordance with this definition, multivitamins and other nutritional supplements are regulated as a category of food, rather than as a pharmaceutical product. They neither have to go through stringent, pre-market safety and effectiveness testing nor does the FDA have the authority to require such testing.

Instead, the FDA relies primarily on post-market surveillance—monitoring consumer complaints and requiring manufacturers to maintain a roster of adverse events. However, these adverse event reports (AERs) are only sent in instances of serious to life-threatening side effects. Mild to moderate events, such as headache or gastrointestinal distress, are not reported unless the manufacturer voluntarily chooses to do so.

This is in stark contrast to the pharmaceutical industry, which spends an average of \$1.3 billion dollars *per drug* in research and development costs in order to obtain FDA approval. In 2011, sales of dietary supplements hit \$30 billion in the U.S., more than twice the size of the global HIV drugs market.

## Can Supplements "Boost" Immunity?

Good nutrition by means of a balanced diet can help ensure proper immune function *in conjunction* with the timely and informed use of [antiretroviral medications](#). The role of vitamins and other nutritional supplements, by contrast, remains debatable.

Confusion is rife in the consumer marketplace, often fueled by manufacturer claims about products that are thinly supported by research. And while the FDA tries to regulate these claims, a 2012 assessment by the Department of Health and Human Services reported that as much as 20 percent of the supplements reviewed made wholly prohibited claims, oftentimes around the issue of “immune support.” It’s not so much that these claims are patently false. It’s simply that the evidence referred to is generally inconclusive or anecdotal at best.

A number of manufacturers, for instance, regularly point to a 2004 study by the Harvard School of Public Health, which looked at the effect of multivitamins on disease progression in 1,097 HIV-positive pregnant women in Tanzania. At the end of the trial, 31% who had taken



the supplements had either died or acquired an [AIDS-defining illness](#) vs. 25% in the placebo group. Based on this evidence, the researchers concluded that the daily use of a multivitamin (specifically B, C, and E) not only delayed HIV progression, but it also provided “an effective, low-cost means of delaying the initiation of antiretroviral therapy in HIV-infected women.”

Upon publication of the research, a number of manufacturers pointed to the study as “scientific proof” of their product’s immune-boosting properties. What most failed to do, however, is contextualize the study, ignoring the numerous co-factors that contributed to the results—not least of which are the high levels of poverty, hunger, and malnutrition that exist within an indigent African population.

Ultimately, nothing in the study suggested that multivitamins, in and of themselves, would demonstrate the same benefits—or afford the same conclusions—in the resource-rich settings like the U.S. or Europe. Results from follow-up studies have been largely inconsistent, including a 2012 study that showed that high-dose multivitamins might actually increase the risk of death in severely malnourished individuals. Other clinical studies have shown benefits only in those with advanced disease (CD4 counts under 200 cell/mL), while others still have shown no benefit at all.

What most studies have supported is the *safety* of multivitamins in recommended daily doses, particularly for people with HIV who are either undernourished or in advanced stages of disease.

## When Supplements Do More Harm Than Good

Far less is known about the benefits of individual vitamins, minerals, and other trace elements. A number of studies in recent years have focused on the role of [selenium](#), a nonmetal mineral with known antioxidant properties. Research seems to suggest that the loss of selenium in early HIV infection parallels the loss of [CD4 cells](#) at a time when malabsorption and malnutrition are generally not seen to be factors.

As compelling as this relationship might seem, research has not yet been able to support any true benefit of selenium supplementation, either in the avoidance of HIV-related illness or the reconstitution of CD4. Similar results have been seen with magnesium and zinc supplements, whereby increases in plasma levels have had no correlative association to either disease progression or outcome.

The prolific use of supplements by some HIV-positive people is underpinned by the belief that “natural” products provide natural immune support that can readily complement HIV therapy. This is often not the case. In fact, a number of supplements can have a profoundly *negative* impact on people with HIV, either by interfering with the metabolism of their drugs or by causing toxicities that mitigate any possible benefit of supplementation.

Among the potential concerns:

- **Megadose vitamin A:** High doses of vitamin A (above 25,000 IUs daily) can increase the risk of liver toxicities, internal bleeding, spontaneous fractures, and weight loss. The World Health Organization (WHO) does not recommend the use of vitamin A supplements in pregnant, HIV-positive women, with research showing that a daily 5,000 IU dose might actually increase the risk of [mother-to-child transmission](#).
- **Megadose vitamin C:** While some research has suggested that high doses of vitamin C may play a significant role in cellular immunity, the evidence is highly contradictory. What we do know is that high doses of vitamin C can cause gastrointestinal distress and diarrhea (the latter of which can impact absorption of certain HIV medications). Vitamin C doses above 1000 mg per day are also known to reduce Crixivan (indinavir) levels in some.
- **Vitamin B6 (pyridoxine):** Excessive intake of vitamin B6 (above 2,000 mg per day) can cause reversible nerve damage, exacerbating [peripheral neuropathy](#) in HIV-positive patients already affected by the condition.
- **Vitamin E:** High doses of vitamin E (above 1,500 IUs) can interfere with blood clotting, while prolonged, excessive use can result in diarrhea, muscular weakness, and nausea.
- **St. John’s Wort (hypericin):** An herbal preparation popularly used to treat mild depression, St. John’s Wort is known to reduce the levels of all protease inhibitor (PI) and non-nucleoside reverse transcriptase inhibitor (NNRTI)-class drugs, putting the patient at risk of drug resistance and treatment failure.
- **Garlic:** Garlic pills and supplements have been shown to reduce serum levels of certain HIV drugs, particularly Invirase (saquinavir) which can be reduced by half when taken concurrently with garlic supplements. By contrast, fresh or cooked garlic is not seen to affect serum drug levels.
- **Grapefruit juice:** An eight-ounce glass of fresh grapefruit juice taken with Crixivan can reduce serum drug levels by 26%, while a similar size glass of juice can increase Invirase levels by up to 100% (increasing potential side effects). While grapefruit juice should not necessarily be omitted from one’s diet, it should not be taken either two hours before or two hours after a drug dose.

## A Word From Verywell

The importance of proper nutrition and a healthy, balanced diet cannot be overstressed. Nutritional counseling may help those with HIV better understand their dietary needs in order to better:

- Achieve and maintain a healthy body weight
- Maintain healthy lipids levels, including cholesterols and triglycerides
- Foresee dietary complications that may result from some [antiretroviral medications](#)
- Address dietary complications that may arise from [HIV-related symptoms](#)
- Implement food measures to avoid possible food-borne [opportunistic infections](#)

The role of exercise cannot be ignored, with benefits to both physical and mental health (including a reduction in the risk of [HIV-associated neurocognitive impairment](#)).

In terms of supplementation, a daily multivitamin can help ensure that micronutrient needs are met, particularly in those unable to achieve nutritional goals. However, taking vitamins in excess of their recommended daily allowance is not advised. There is also no data to support the use of herbal supplements in either treating HIV infection or increasing the efficacy of antiretroviral drugs by reducing the HIV viral load.

Please advise your doctor about any supplements you may be taking when discussing the management and treatment of your HIV.

### Article Sources

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- Fawzi, W.; Msamanga, G.; Spiegelman, D.; et al. [A randomized trial of multivitamin supplements and HIV disease progression and mortality](#). *New England Journal of Medicine*. 351(1):23-32.
- Isanaka, S.; Mugusi, F.; Hawkins, C; et al. [Effect of high-dose vs standard-dose multivitamin supplementation at the initiation of HAART on HIV disease progression and mortality in Tanzania: a randomized controlled trial](#). *Journal of the American Medical Association*. October 17, 2012; 308(15):1535-1544. DOI: 10.1001/jama.2012.13083.

## Chapter

# Basic Principles of Nutrition, HIV and AIDS: Making Improvements in Diet to Enhance Health

*Ezinna E. Enwereji, Martina C. Ezeama  
and Prince E.N. Onyemachi*

## Abstract

The relationships among nutritional status, infectious diseases and immune system suggest nutrition as a cofactor in human immunodeficiency virus (HIV) progression. Poor nutritional status and HIV infection interact with each other leading to the development of opportunistic infections, malignancies, debilitation and death. Infection by human immunodeficiency virus (HIV) is characterized by progressive destruction of immune system. Malnutrition that is multifactorial is, therefore, one of the major complications of HIV infection that is poorly addressed in HIV intervention. Early nutritional intervention when individuals living with HIV show active weight loss is important in maximizing gain of lean body mass. Since malnutrition is the major complication of HIV infection, which results in wasting syndrome, it should be termed as a prognostic factor in advanced HIV infection though malnutrition is a result of not only HIV infection but also numerous HIV-associated complications. Studies have recommended clinical trials to evaluate prevalence of malnutrition among those living with HIV so as to examine the efficacy of supplementing with specific nutrients at various stages of HIV infection as well as combining therapeutic foods for treating malnutrition with antiretroviral treatment in children of HIV-positive mothers. Therefore, good nutrition guarantees excellent health in HIV infection.

**Keywords:** HIV, malnutrition, nutrition security, therapeutic foods, lipodystrophy, opportunistic infections

## 1. Introduction

Infants born to mothers living with HIV have poorer growth and higher morbidity and mortality than those born to mothers who are not infected with HIV. Furthermore, abnormalities in growth are common in children infected with HIV. Children living with HIV and AIDS are at increased risk of malnutrition. Chronic infections, especially HIV and AIDS, can lead to poor appetite and growth because food intake and nutrient absorption which the body needs in order to fight the infection are defective. The result is a weakened immune system that is ill equipped to fight the virus and other infections like tuberculosis. This accounts for the severe acute malnutrition seen in most people living with HIV. To increase the chances of survival of these people, therapeutic foods for reducing malnutrition should be combined with antiretroviral

treatment to stop the infection from progressing [1, 2]. Studies indicate that multiple nutritional abnormalities occur relatively early in human immunodeficiency virus (HIV) infection, and also that decreased plasma levels of vitamins B6, B12, A, E and zinc are correlated with dietary intake and associated with significant alterations in immune response and cognitive function for people living with HIV infection. To determine the level of intake consistent with normal plasma nutrient levels, there is a need to examine nutrition status in relation to food consumption and nutrient supplementation in HIV seropositives [3, 4].

In developing countries where most families live in abject poverty and are exposed to infections due to poor nutrition and sanitation and contaminated drinking water, the benefits of HIV-positive mothers breastfeeding infants will greatly reduce the risk of HIV infection when ARVs are combined with good nutrition. In this instance, the nutrients and antibodies present in breast milk will make the healthiest food for such babies, thereby providing them with unmatched protections from HIV infection, diseases and even death. Therefore, good nutrition will lay the foundation for healthy thriving and productivity of people living with HIV. Now more than ever, there is global recognition that good nutrition is the key to sustainable development. But good nutrition is more than about just ending hunger: it is also crucial to achieving some targets, including ending poverty, achieving gender equality, ensuring healthy lives, promoting lifelong learning, improving economic growth, building inclusive societies and ensuring sustainable consumption [5–7]. Nutritional status may have an impact at all stages of HIV disease since most of the clinical features of HIV infection originate from nutritional problems which are exacerbated by the presence of malnutrition. However, inadequate food intake, due to a variety of etiologies, malabsorption and altered metabolism, may also contribute to malnutrition. Additionally, factors in food, including reduced micronutrient levels, can negatively affect the immune functions and result in increase in the progression of HIV infection at all stages [8–11].

The frequent weight loss in people living with HIV worsens the prognosis of the infection. Their reduced dietary intake, increased digestive problems and energy expenditure result in severe malnutrition. Therefore, the nutritional support and its association with anabolic agents to promote tissue growth and physical activity should be carefully selected [12–14]. The adverse effects of some new antiretroviral drugs could influence the patients' nutritional state as well as compliance to treatments. In cases where lipodystrophy, whose etiology is still unknown and no treatment has yet been found, and metabolic disorders like dyslipidemia, glucose intolerance and others occur, particular attention should be given since these conditions are likely to increase cardiovascular risks and, moreover, they are generally sensitive to a dietary approach [2, 15, 16].

Achieving and maintaining optimal nutrition is considered an important strategy for ensuring food security for people infected with HIV. A good nutrition can improve an individual's immune function, limit disease complications, and improve quality of life and survival. This is necessary because macronutrient interventions, such as balanced diet of high protein, high carbohydrate and high fat, will reduce morbidity and mortality of people living with HIV infection. Evidence has shown that macronutrient supplementation will reduce HIV-related complications, such as opportunistic infections or death. Food insecurity has been recognized as the key driver of HIV epidemic and a potential cause of poor health outcomes among people living with HIV and AIDS. Food insecurity is linked with heart disease, diabetes, obesity, depression and is independently associated with incomplete HIV RNA suppression among HIV-infected individuals [17]. These call for holistic and comprehensive response in minimizing chronic nutrition insecurity among HIV-positive persons. Therefore, the need to elucidate ways of sustaining long-term nutritional support for HIV-positive individuals to minimize nutritional insecurity and guarantee security in livelihood should not be underestimated.

## 2. The foundations of good nutrition

Nutrition is defined as the sum total of the processes by which a living organism receives materials from its environment and uses them to promote its own vital activities. The materials which it receives are known as nutrients. Nutrition is also the science that interprets the relationship between the food consumed and its function on the living organism. It relates to food intake and functions in the body for the overall well-being of the individual. It includes the intake of food, liberation of energy, elimination of waste and all the synthesis or processes that are essential for the maintenance of growth and reproduction of the individual [18]. The relationship between nutrition and HIV is a vicious cycle, similar to the relationship between nutrition and other infections. Compromises in nutritional status and poor nutrition further weaken the immune system and thereby increase susceptibility to opportunistic infections. Poor nutrition increases the body's vulnerability to infections, and infections aggravate poor nutrition. Inadequate dietary intake leads to poor nutrition and lowers immune system functioning. Poor nutrition reduces the body's ability to fight infections and therefore helps increase the incidence, severity and length of infections. Research has shown that clinically, there are synergistic interactions between infection, nutritional status and immune functions. Infectious diseases, no matter how mild, will influence nutritional status and conversely cause nutrient deficiencies that are sufficiently severe to impair resistance to infection [19, 20].

The foundations of good nutrition include improving women's nutrition before, during and after pregnancy; promoting and supporting exclusive breastfeeding for the first 6 months of a child's life, and continued breastfeeding up to age 2 or beyond; providing timely, safe, appropriate and high-quality complementary foods as well as micronutrient interventions. In this regard, nutritional status should be assessed using biochemical measurement of nutrient levels, dietary history, anthropometry and clinical examination for the signs and symptoms of nutritional deficiency or excess. In managing emergencies, UNICEF's programs have concentrated their interventions on foundations of good nutrition, prevention and treatment of malnutrition to vulnerable groups including those living with HIV and AIDS irrespective of whether or not they are using highly active antiretroviral therapy (HAART) which has been postulated to reduce the occurrence of human immunodeficiency virus (HIV)-associated weight loss and wasting. To this assumption, studies have shown that there is no difference in the extent of wasting experienced between those who received HAART and those who did not. It has been shown that the weight loss or wasting in HIV infection can be radically reduced with nutrition intervention. The good news is that the goal of nutritional intervention is usually to preserve lean body mass and provide adequate nutrients as well as minimize symptoms of malabsorption and thereby improve quality of life. This is why specific nutritional therapy ranges from oral supplements to home total parenteral nutrition (TPN) which is individualized [21, 22].

Following interventions proffered by several organizations and researchers to reduce malnutrition among persons living with HIV, the definition of wasting developed by the Centers for Disease Control and Prevention (CDC) in 1987 has been adopted by researchers. This definition requires an involuntary weight loss of >10% of baseline body weight plus diarrhea, fever, or weakness for >30 days to be termed as wasting. Most researchers have now dropped the comorbid conditions of wasting and have simply espoused weight loss >10% as the definition of HIV-associated wasting. In the CDC definition, "baseline weight" is neither defined nor time frame specified for the weight loss. Presently, most researchers are using the definition of wasting as that which will require a weight loss >5% in a 6-month period and that in which the weight loss is sustained. Some other studies have

shown that this level of weight loss can predict mortality and infectious complications in individuals with AIDS and that reduction in a body mass index to  $<20 \text{ kg/m}^2$  in a 6-month period should be used as an index of wasting among HIV and AIDS clients when intervening for malnutrition. Because of the uncertainty as to which of these definitions given above should be adopted as the standard definition of wasting for intervention, the three presented criteria are now being used. Therefore, weight loss and wasting continue to be common problems for individuals infected with HIV as well as for those treated with HAART in whom either HAART has failed or there is lack of tolerance for HAART regimens [23, 24].

Studies have been done to determine whether specific nutrient abnormalities occur in earlier stages of HIV infection, thereby preceding the marked wasting and malnutrition that accompany later stages of the infection. It has been found that even as life expectancy increases with antiretroviral therapy (ART), age-related comorbidities now contribute to the main burden of disease associated with HIV infection. These comorbidities have been reported to occur regularly among HIV-infected individuals, thereby resulting in conditions associated with nutritional deficiencies that are typically seen in the elderly and in middle-aged HIV-infected individuals. This suggests that age decline occurs independent of chronological age in the HIV-infected individuals. These observations have led to the conclusion that HIV infection accelerates the biological aging process. Therefore, aging in HIV infection is a multifactorial process involving complex interplay of biological and non-biological constructs which may differ depending on the socioeconomic and nutritional statuses of HIV individuals. The prolonged nutritional deficiencies with chronic coinfections and exposures to more toxic antiretroviral drugs constitute risks to people living with HIV and AIDS [24]. However, evidence has shown that patients who enrolled in food supplement intervention while on treatment regimens self-reported greater adherence to their medications, fewer side effects, increased weight gain, recovery of physical strength and the resumption of labor activities. Therefore, promoting sound feeding practices is one of the strategies to ensure good health for people living positively with HIV and AIDS.

## 2.1 Nutrition for sustainable development

Ideally, good nutrition lays the foundation for healthy and productive environments for people living positively with HIV infection. Well-nourished HIV individuals are more resistant to diseases and crises, and can perform their daily duties better than those that are poorly nourished. This shows that well-nourished HIV persons are better able to participate in and contribute to the development of their communities. Therefore, the benefits of good nutrition for people living positively with HIV act as the “glue” binding together and supporting their contributions to various facets of a nation’s development, especially now that there is a global recognition that good nutrition is the key to sustainable development. Specifically, the objective of Goal 2 of the 2015 Sustainable Development Goals (SDGs) aims to “end hunger, achieve food security, improve nutrition, and sustainable agriculture” and thereby promote good health. Therefore, good nutrition is more than just about ending hunger: it also includes achieving many SDG targets, such as ending poverty, achieving gender equality, ensuring healthy lives, promoting lifelong learning, improving economic growth, building inclusive societies and guaranteeing sustainable consumption of quality foods. This will reduce inequalities among persons living with HIV and make sure that guidelines on appropriate feeding are available to all, including those with limited access to health care services. Convinced that it is now time for governments in developing countries to renew their commitment to protect and promote optimal feeding that will guarantee good health for persons living with HIV and AIDS.

The level of total intake (diet plus supplements) for all nutrients that would guarantee optimal health for persons living with HIV should be clearly emphasized to achieve normal plasma nutrient values since persons living with HIV and AIDS appear to require nutrient intake in multiples of the recommended dietary allowance (RDA) for vitamins A, E, B6, B12, iron, zinc and others. Therefore, effective program for nutritional supplements may be beneficial in maintaining adequate plasma nutrient levels for persons living with HIV and AIDS. This means that the biochemical measurements of nutrient status, dietary history, anthropometry, clinical signs or symptoms that will show nutritional excesses or deficiencies among persons living with HIV and AIDS should be regularly done to ascertain their health statuses since provision of nutritional supplements acts as an adjunct to ART. Though studies have identified the fear of persons living with HIV developing too much appetite but not having enough to eat as the major obstacle to their non-acceptance of nutritional supplements, it should be emphasized that this obstacle should not preclude the provision of adequate dietary supplements to improve both adherence and prognosis to those living positively with HIV and AIDS [25, 26]. Therefore, the need to increase and integrate nutritional supplements into ART programs to improve adherence and maximize the benefits of therapy should not be underestimated.

This means that the principles of healthy eating for HIV-positive persons to ensure sustainable development will require that all the necessary food nutrients are added in the daily meals and in the right proportions. Therefore, meals that will guarantee optimal health for HIV-positive persons should include:

- a diet high in vegetables, fruits, whole grains and legumes
- lean and low-fat sources of protein
- limited sweets, soft drinks and foods with added sugar
- proteins, carbohydrates and a little good fat in all meals and snacks

Specifically, the HIV-positive individuals should be encouraged to add foods rich in calories. Foods rich in calories will provide the body with fuel to maintain lean body mass. To get enough calories, they need to consume the following in these proportions:

- 17 calories per pound of the body weight so as to maintain body weight
- 20 calories per pound of the body weight if an opportunistic infection has occurred
- 25 calories per pound if there is loss of body weight

Protein will help to build the muscles and organs and guarantee strong immune system for HIV-positive persons and should be consumed in enough quantity. To get the right proportion and types of protein, HIV-positive persons should aim at having these in the diet:

- 100–150 grams a day, if an HIV-positive man
- 80–100 grams a day, if an HIV-positive woman
- If there is kidney problem, more than 15–20% of the calories from protein should not be consumed. This is because too much of such calories will put stress on the kidney and thereby compromise kidney function.



Also, lean meat such as pork, beef, skinless chicken, fish and low-fat dairy products should be consumed. To get extra protein, there is need to add vegetable proteins such as legumes, nuts, vegetables and others. For carbohydrates which will give energy, HIV-positive persons should eat the right types and proportions of carbohydrates by:

- Eating five to six servings of fruits and vegetables each day.
- Adding to the meals fruits with a variety of colors so as to get a wide range of nutrients.
- Eating legumes and whole grains, such as brown rice, corn and others. However, if HIV individuals do not have gluten sensitivity, whole-wheat flour, oats and barley may be good enough for them. But if there is gluten sensitivity, whole-wheat flour should not be taken. Then, brown rice and potato should form useful sources of carbohydrate. If HIV individuals are diabetic or pre-diabetic or have insulin resistance, most of their carbohydrates should come from vegetables.
- The practice of consuming much of simple sugars, such as candy, cake, cookies and ice cream should be limited for HIV-positive persons.

Fat will provide extra energy. For HIV-positive persons to get enough of the right kinds of fat for energy, the following should be observed:

- 10% or more of daily calories should come from monounsaturated fats like nuts, seeds, avocado, fish, canola and olive oils.
- less than 10% of daily calories should be made up of polyunsaturated fats such as fish, walnuts, flax seed, corn, sunflower, soybean and safflower oil.
- less than 7% of daily calories should be saturated fats like fatty meat, poultry with skin, butter, whole-milk dairy foods, coconut and palm oils.
- 30% of daily calories should come from fat like omega-3 fatty acid.

Omega-3 fatty acids are essential fats that must be present in the diet of HIV-positive individuals. Consuming these healthy fats that the body cannot produce unlike other fats has important benefits for the HIV persons' body and brain. However, most HIV-positive people whose meals are mainly made up of standard Western diet end up not eating enough omega-3 fats. Omega-3 fatty acids are polyunsaturated fats that the body needs but cannot produce on its own. For this reason, omega-3 fatty acids are classified as essential fatty acids. There are basically three important types of omega-3 fatty acids that are beneficial to the health of HIV-positive individuals. The first is eicosapentaenoic acid (EPA). This is a 20-carbon-long chain omega-3 fatty acid, primarily found in fatty fish, seafood and fish oils. EPA is important in the formation of signaling molecules like eicosanoids that will reduce inflammation. EPA is effective in protecting HIV persons against depression. The second type of omega-3 is docosahexaenoic acid (DHA). DHA is a 22-carbon-long chain omega-3 fatty acid primarily found in fatty fish, seafood, fish oils and algae. The main role of DHA is to serve as a structural component in cell membranes, particularly in the nerve cells of the brain and eyes. DHA constitutes about 40% of the polyunsaturated fats in the brain. DHA is very important during pregnancy and breastfeeding. It helps in the development of the nervous system

of the fetus. Breast milk contains significant amounts of DHA. The third type of omega-3 is alpha-linolenic acid (ALA), an 18-carbon-long chain omega-3 fatty acid found in high-fat plant foods like flax seeds, cotton seed, walnuts and others. Though it is the most common omega-3 fatty acid found in the diet, it is not very active in the body. ALA needs to be converted to EPA and DHA before it can be active. Unfortunately, only about 5% of ALA gets converted to EPA and as little as 0.5% will be converted to DHA. For this reason, HIV-positive persons' consumption of omega-3 fatty acids should consist mainly of EPA and DHA than ALA. Most of the ALA eaten is simply used for energy [27–29].

### *2.1.1 Health effects of omega-3 fats*

Omega-3 fatty acids have both negative and positive effects when consumed in certain proportions. On the positive side, omega-3 fatty acids have several health benefits in various body systems. For example, studies have shown that omega-3 supplements will significantly lower blood triglycerides. Consuming foods such as salmon, sardines, cod liver oil and others that contain enough amounts of omega-3 has been linked to reduced risk of colon, prostate and breast cancers. Taking omega-3 fatty acid supplement helps to reduce excess fat in the liver. Consuming omega-3 supplements like fish oil helps to reduce symptoms of depression and anxiety. Inflammation, pain and other symptoms of autoimmune diseases such as in rheumatoid arthritis have been reduced using omega-3 supplements. Omega-3 has been found effective in controlling menstrual pains and in preventing asthma in children and young adults. DHA if taken during pregnancy and breastfeeding has been found to improve the intellectual and eye development of the child. Studies have linked a higher intake of omega-3 to a reduced risk of Alzheimer's disease and dementia. However, for optimal health, mainstream health organizations like the World Health Organization and European Food Safety Authority recommend a minimum of 250–500 mg combined EPA and DHA each day for healthy adults. The American Heart Association recommends eating fatty fish at least two times per week in order to ensure optimal omega-3 intake for heart disease prevention. For pregnant and breastfeeding women, it is recommended to add an additional 200 mg of DHA to the recommended intake.

On the negative side, consuming more than the upper limit of omega-3 fatty acid will have adverse health effects. According to food and drug agencies (FDA), taking up to 2000 mg of combined EPA and DHA per day from supplements will be safe, but in high doses, omega-3 fatty acids can cause blood thinning and excessive bleeding. Therefore, care should be taken in the consumption of omega-3 if an individual has a bleeding disorder or is taking blood-thinning medications. It has been shown that some omega-3 supplements, especially fish oil, can cause digestive problems and unpleasant fish oil burps because many omega-3 supplements are high in calories. For example, cod liver oil is very high in vitamin A, and can be harmful when taken in large doses. The bottom line is that taking up to 2000 mg of omega-3 per day from supplements is safe according to the FDA, but anything more than this is classified as lethal. The fact remains that getting enough omega-3 fatty acid is not difficult when one eats fishes. For instance, when one consumes salmon, one gets 4023 mg per serving (EPA and DHA). For cod liver oil, one gets 2664 mg per serving (EPA and DHA); for sardines, 2205 mg per serving (EPA and DHA); for anchovies, one gets 2338 mg of ALA per serving; for chia seeds or cotton seeds, one gets 2338 mg of ALA per serving; and for walnuts, 2542 mg of ALA per serving. Consuming other foods that are high in EPA and DHA such as fatty fish, meat, eggs and dairy products from grass-fed or pasture-raised animals and other common plant foods high in the ALA such as soya beans, hemp seeds, walnuts, spinach and Brussels sprouts can be deleterious to health. However, excess omega-3 in the body

will be used as a source of energy like other fats. Assuming HIV-positive individuals have no opportunity of eating fatty fish or seafood, taking omega-3 supplement to improve both physical and mental health as well as reduce the risk of disease infections should be seriously considered [30–32].

## 2.2 Vitamins and minerals

Vitamins and minerals regulate body processes and so people who are HIV-positive need extra vitamins and minerals in the diet to repair and heal damaged cells. They need extra vitamins and minerals to boost the immune system. These vitamins and minerals which should be added in the diet include:

- Vitamin A and beta-carotene, from dark green, yellow, orange, or red vegetables and fruits including liver, whole eggs, and milk
- Vitamin B, from meat, fish, chicken, grains, nuts, white beans, avocados, broccoli and green leafy vegetables
- Vitamin C, from citrus fruits
- Vitamin E, from green leafy vegetables, peanuts and vegetable oils
- Selenium, from whole grains, nuts, poultry, fish, eggs and peanut butter
- Zinc, from meat, poultry, fish, beans, peanuts, and milk and other dairy products

Because of the difficulty for HIV-positive persons in getting enough of all the nutrients needed for optimal health from foods, it is recommended that a multivitamin/mineral tablet (without extra iron) but containing 100% of the recommended daily allowance (RDA) should be taken. If at least three servings of high-calcium food such as green leafy vegetables or dairy foods are not eaten on daily basis, calcium supplements could be taken in the diet.

### 2.2.1 Nutrition and HIV: coping with special problems

HIV-positive persons could have a variety of reactions including side effects from ART medications which should be managed. Here are some of the problems that HIV persons need to control:

#### **Nausea and vomiting:**

To manage nausea and vomiting, they need to:

- Eat bland, low-fat foods, such as plain pasta, canned fruit, or plain broth.
- Eat smaller meals every 1–2 hours.
- Avoid greasy or spicy foods, or foods with strong odors.
- Drink ginger tea or ginger ale or ginger.
- Eat more cold foods and less hot foods.
- Rest after meals, but not to lie down flat.
- Receive medications for nausea.

**Diarrhea: for diarrhea, they need to:**

- Drink more fluids than usual including diluted juices.
- Limit taking milk, sugary or caffeinated drinks.
- Eat slowly and more frequently.
- Avoid greasy foods.
- Add briefly in the diet bananas, rice, apple sauce and toast (B.R.A.T).
- Avoid eating uncooked foods including vegetables but rather eat well-cooked ones.
- Take calcium carbonate supplements or fiber supplements such as wafers.

**Lack of appetite: for lack of appetite they need to:**

- Add ginger in the diet to help stimulate appetite and improve digestion.
- Avoid drinking too much fluid before meals.
- Make meals as attractive as possible.
- Take smaller but frequent meals.
- Add foods rich in antioxidants such as ginger, cranberries, raspberries, blackberries, walnuts and others.
- Take medications that will stimulate appetite.

**Too much weight loss: for this, HIV-positive persons should:**

- Include enough protein, carbohydrates and fats in the diet.
- Increase the intake of dietary iron foods such as lean red meat, chicken, fish, beans, lentils, cashew, spinach, whole-grain bread and others to reduce anemia.
- Eat vitamin C-rich foods during meals to increase the absorption of non-heme iron.
- Take cereals and add ice cream to desserts.
- Eat dried fruits or nuts for snacks.
- Add nutrition supplements, such as boost, carnation instant and others in the breakfast.
- Take medications that stimulate appetite and also treat nausea.

**Mouth and swallowing problems: these can be controlled by:**

- Eating only soft foods such as yogurt, mashed potatoes, or rice.
- Not eating raw vegetables.

- Eating softer fruits, such as bananas or pears.
- Avoiding acidic foods, such as oranges, lemons and tomatoes.
- Visiting a doctor to rule out opportunistic infections.

**Lipodystrophy (fat redistribution syndrome): this can be controlled by:**

- Avoiding saturated and trans fats in the diet.
- Taking unsaturated fats and sources of omega-3 fatty acids, such as salmon and tuna.
- Restricting the consumption of alcohol, and refined sugars.
- Preventing insulin resistance by avoiding foods that can raise glucose and insulin levels, primarily the carbohydrates.
- Eating fiber-rich whole grains, fruits and vegetables.

Even in the absence of opportunistic infections, many people with HIV infection may experience these health problems; therefore, the relationships between health problems and nutritional status of HIV-positive persons must be addressed to achieve the benefits of optimum health [14, 33].

### 3. Conclusion

Malnutrition can be used as a measure of food insecurity and HIV individuals with compromised immune system will be at risk of infections when malnourished. HIV infection leads to many nutritional problems. Conditions such as malnutrition and opportunistic infections exacerbate HIV infection. The increased caloric requirements of HIV-positive individuals, the undesirable side effects of treatment that may be worsened by malnutrition, and the declines in adherence and possible drug resistance are justifications for strengthening the nutrition security of HIV-positive individuals including those receiving antiretroviral treatment.

For a long time, the wasting syndrome has been the most frequently reported feature of HIV and AIDS. Nutritional and micronutrient deficiencies play important role in immune degradation and impaired development in HIV infection. Proper nutrition complemented by careful implementation of antiretroviral drugs is essential in the response to HIV and AIDS pandemic. Realizing the value of nutrition to the health of people living positively with HIV and AIDS, especially those suffering from severe acute malnutrition, UNICEF supports them with therapeutic feeding and antiretroviral therapy. That is, UNICEF provides support for nutritional assessments and counseling to manage HIV infection and the side effects of antiretroviral drugs. Therefore, body wasting, characterized by loss of body cell mass, which is frequently experienced by people with HIV infection and a factor in survival itself can be reduced by UNICEF's intervention and thereby minimize rapid weight loss typically associated with episodes of secondary infections. Therefore, adequate nutrition is a panacea for the good health of HIV persons.

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## References

- [1] UNGASS (United Nations General Assembly Special Session on HIV/AIDS). Article 28 in Declaration of Commitment by the United Nations General Assembly Special Session Dedicated to HIV/AIDS. New York: United Nations. 2006. Available from: <http://www.ungass.org>
- [2] Semba RD, Tang AM. Micronutrients and the pathogenesis of human immunodeficiency virus infection. *The British Journal of Nutrition*. 1999;**81**:181-189
- [3] World Health Organization. Nutrient Requirements for People Living with HIV/AIDS: Report of a Technical Consultation. Geneva: WHO; 2003
- [4] Mangili A, Murman DH, Zampini AM, Wanke CA. Nutrition and HIV infection: Review of weight loss and wasting in the era of highly active antiretroviral therapy from the nutrition and healthy living cohort. *Clinical Infectious Diseases*. 2006; **42**:836-842
- [5] Laurent C, Ngom Gueye NF, Ndour CT, Gueye PM, Diouf M, Diakhate N, et al. Long-term benefits of highly active antiretroviral therapy in Senegalese HIV-1-infected adults. *Journal of Acquired Immune Deficiency Syndromes*. 2005;**38**:14-17
- [6] Miller CJ, Baker JV, Bormann AM, Erlandson KM, Huppler Hullsiek K, Justice AC, et al. Adjudicated morbidity and mortality outcomes by age among individuals with HIV infection on suppressive antiretroviral therapy. *PLoS One*. 2014;**9**:e95061
- [7] Guaraldi G, Orlando G, Zona S, Menozzi M, Carli F, Garlassi E, et al. Premature age-related comorbidities among HIV-infected persons compared with the general population. *Clinical Infectious Diseases*. 2011;**53**:1120-1126
- [8] Pathai S, Gilbert C, Weiss HA, Cook C, Wood R, Bekker LG, et al. Frailty in HIV-infected adults in South Africa. *Journal of Acquired Immune Deficiency Syndromes*. 2013;**62**:43-51
- [9] Levett TJ, Cresswell FV, Malik MA, Fisher M, Wright J. Systematic review of prevalence and predictors of frailty in individuals with human immunodeficiency virus. *Journal of the American Geriatrics Society*. 2016;**64**:1006-1014
- [10] Erlandson KM, Allshouse AA, Rapaport E, Palmer BE, Wilson CC, Weinberg A, et al. Physical function impairment of older, HIV-infected adults is associated with cytomegalovirus immunoglobulin response. *AIDS Research and Human Retroviruses*. 2015;**31**:905-912
- [11] Dannhauser A, van Staden AM, van der Ryst E, et al. Nutritional status of HIV-1 seropositive patients in Free State Province of South Africa: Anthropometric and dietary profile. *European Journal of Clinical Nutrition*. 1999;**53**:165-173
- [12] Stolbach A, Paziana K, Heverling H, Pham P. A review of the toxicity of HIV medications II: Interactions with drugs and complementary and alternative medicine products. *Journal of Medical Toxicology*. 2015;**11**:326-341
- [13] Niyongabo T, Henzel D, Ndayishimyie JM, et al. Nutritional status of adult inpatients in Bujumbura, Burundi (impact of HIV infection). *European Journal of Clinical Nutrition*. 1999;**53**:579-582
- [14] Castetbon K, Kadio A, Bondurand A, et al. Nutritional status and dietary intakes in human immunodeficiency virus (HIV)-infected outpatients in Abidjan, Côte D'Ivoire, 1995. *European Journal of Clinical Nutrition*. 1997;**51**:81-86

- [15] Ehrenpreis ED, Carlson SJ, Boorstein HL, et al. Malabsorption and deficiency of vitamin B12 in HIV-infected patients with chronic diarrhea. *Digestive Diseases and Sciences*. 1994;**39**:2159-2162
- [16] Koch J, Neal EA, Schlott MJ, et al. Zinc levels and infections in hospitalized patients with HIV/AIDS. *Nutrition*. 1996;**12**:515-518
- [17] Allard JP, Aghdassi E, Chau J, et al. Oxidative stress and plasma antioxidant micronutrients in humans with HIV infection. *The American Journal of Clinical Nutrition*. 1998;**67**:143-147
- [18] Dudgeon WD, Phillips KD, Carson JA, Brewer RB, Durstine JL, Hand GA. Counteracting muscle wasting in HIV-infected individuals. *HIV Medicine*. 2006;**7**:299-310. DOI: 10.1111/j.1468-1293.2006.00380.x
- [19] Mastroiacovo P, Ajassa C, Berardelli G, et al. Antioxidant vitamins and immunodeficiency. *International Journal for Vitamin and Nutrition Research*. 1996;**66**:141-145
- [20] Look MP, Rockstroh JK, Rao GS, et al. Serum selenium, plasma glutathione (GSH) and erythrocyte glutathione peroxidase (GSH-Px)-levels in asymptomatic versus symptomatic human immunodeficiency virus-1 (HIV-1) infection. *European Journal of Clinical Nutrition*. 1997;**51**:266-272
- [21] Semba RD, Kumwenda N, Hoover DR, et al. Assessment of iron status using plasma transferrin receptor in pregnant women with and without human immunodeficiency virus infection in Malawi. *European Journal of Clinical Nutrition*. 2000;**54**:872-877
- [22] Antelman G, Msamanga GI, Spiegelman D, et al. Nutritional factors and infectious disease contribute to anemia among pregnant women with Human Immunodeficiency Virus in Tanzania. *The Journal of Nutrition*. 2000;**130**:1950-1957
- [23] Falutz J, Tsoukas C, Gold P. Zinc as a cofactor in human immunodeficiency virus-induced immuno-suppression. *Journal of the American Medical Association*. 1998;**259**:2850-2851
- [24] Clark RH, Feleke G, Din M, et al. Nutritional treatment for acquired immunodeficiency virus-associated wasting using beta-hydroxy beta-methylbutyrate, glutamine, and arginine: A randomized, double-blind, placebo-controlled study. *Journal of Parenteral and Enteral Nutrition*. 2000;**24**:133-139
- [25] Baum MK, Shor-Posner G, Zhang G, et al. HIV-1 infection in women is associated with severe nutritional deficiencies. *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology*. 1997;**16**:272-278
- [26] Wheeler DA, Gilbert CL, Launer CA, et al. Weight loss as a predictor of survival and disease progression in HIV infection. Terry Bein community programs for clinical research on AIDS. *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology*. 1998;**18**:80-85
- [27] Melchior JC, Niyongabo T, Henzel D, et al. Malnutrition and wasting, immunodeficiency, and chronic inflammation as independent predictors of survival in HIV-infected patients. *Nutrition*. 1999;**15**:865-869
- [28] Gibert CL, Wheeler DA, Collins G, et al. Randomized, controlled trial of caloric supplements in HIV infection. Terry Bein community programs for clinical research on AIDS. *Journal of Acquired Immune Deficiency Syndromes*. 1999;**22**:253-259
- [29] Bogden JD, Kemp FW, Han S, et al. Status of selected nutrients and progression of human



immunodeficiency virus type 1 infection. *The American Journal of Clinical Nutrition*. 2000;**72**:809-815

[30] Coutsooudis A, Moodley D, Pillay K, et al. Effects of vitamin A supplementation on viral load in HIV-1-infected pregnant women. *Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology*. 1997;**15**:86-87

[31] Kelly P, Musonda R, Kafwembe E, et al. Micronutrient supplementation in the AIDS diarrhoea wasting syndrome in Zambia: A randomized controlled trial. *AIDS*. 1999;**13**:495-500

[32] Au JT, Kayitenkore K, Shutes E, et al. Access to adequate nutrition is a major potential obstacle to antiretroviral adherence among HIV-infected individuals in Rwanda. *AIDS Journal*. 2006;**20**(16):2116-2118

[33] Erlandson KM, Allshouse AA, Jankowski CM, Mawhinney S, Kohrt WM, Campbell TB. Relationship of physical function and quality of life among persons aging with HIV infection. *AIDS Journal*. 2014;**28**:1939-1943